Feb. 4, 1964 J. M. CROM 3,120,047

METHOD OF MAKING A LIQUID IMPERVIOUS WALL

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Fig. 1.

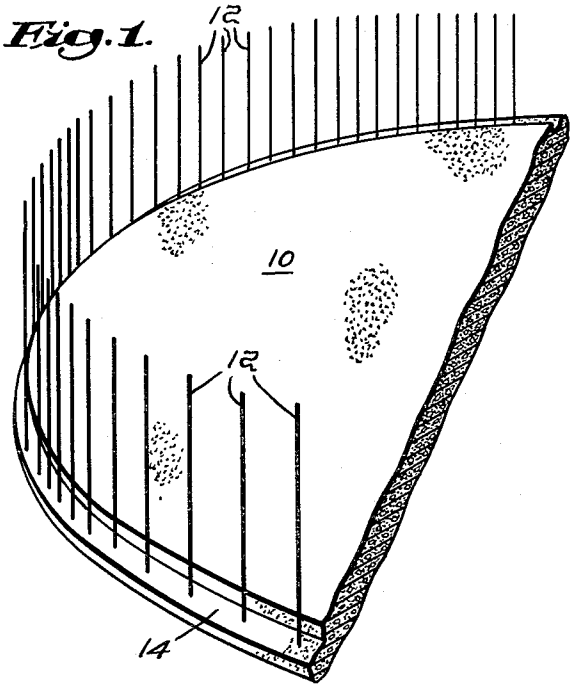
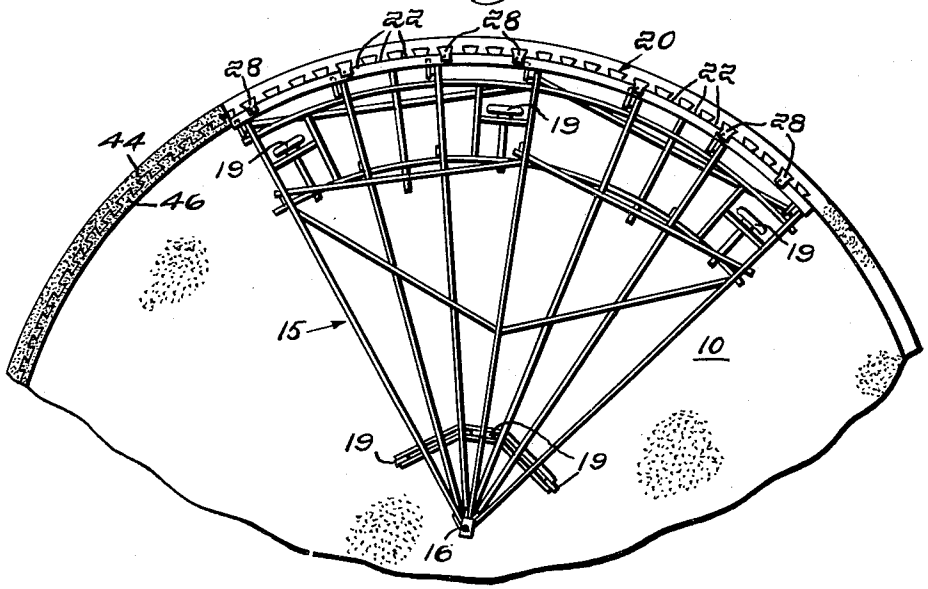


Fig. 2.



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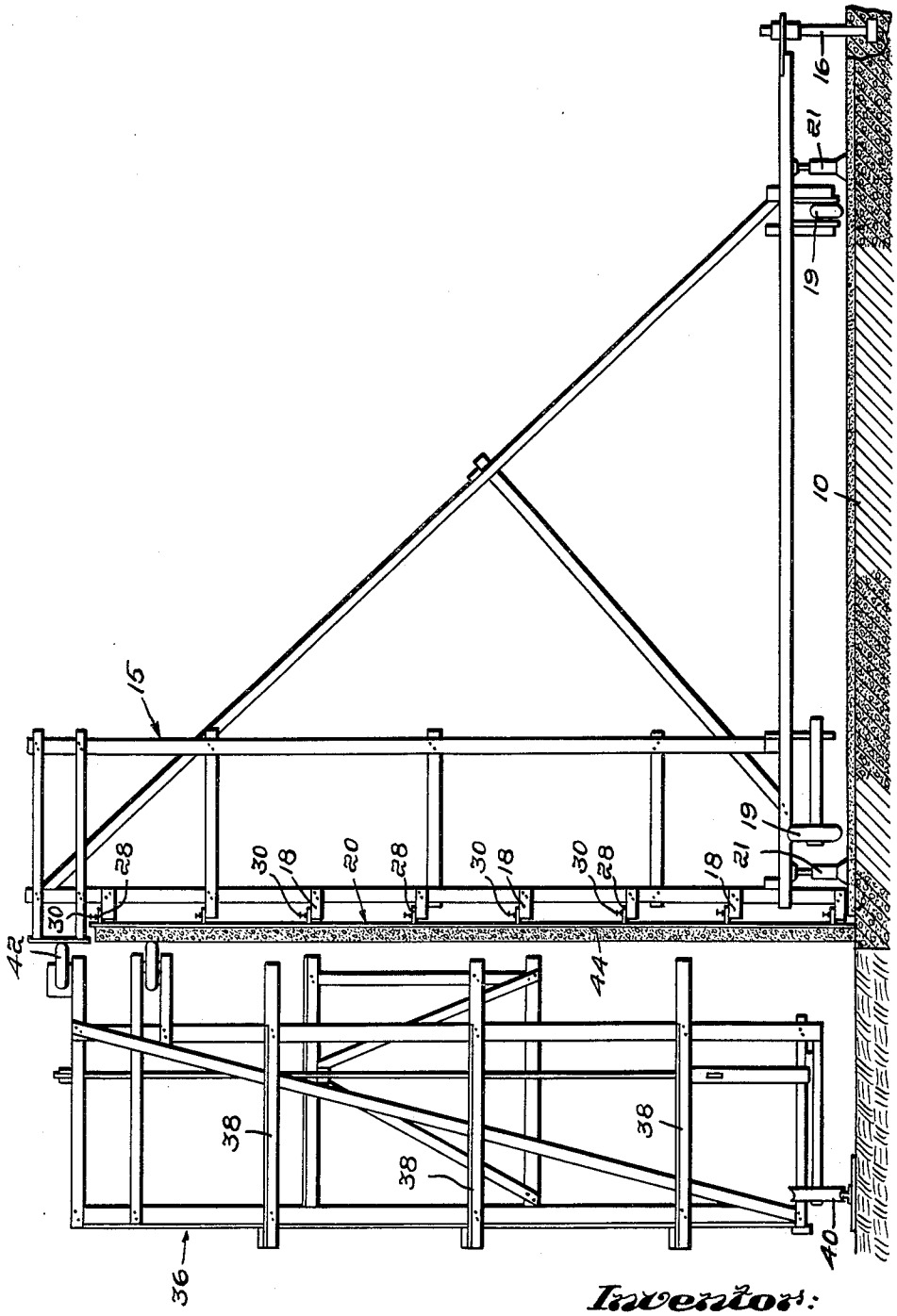


Fig. 3.

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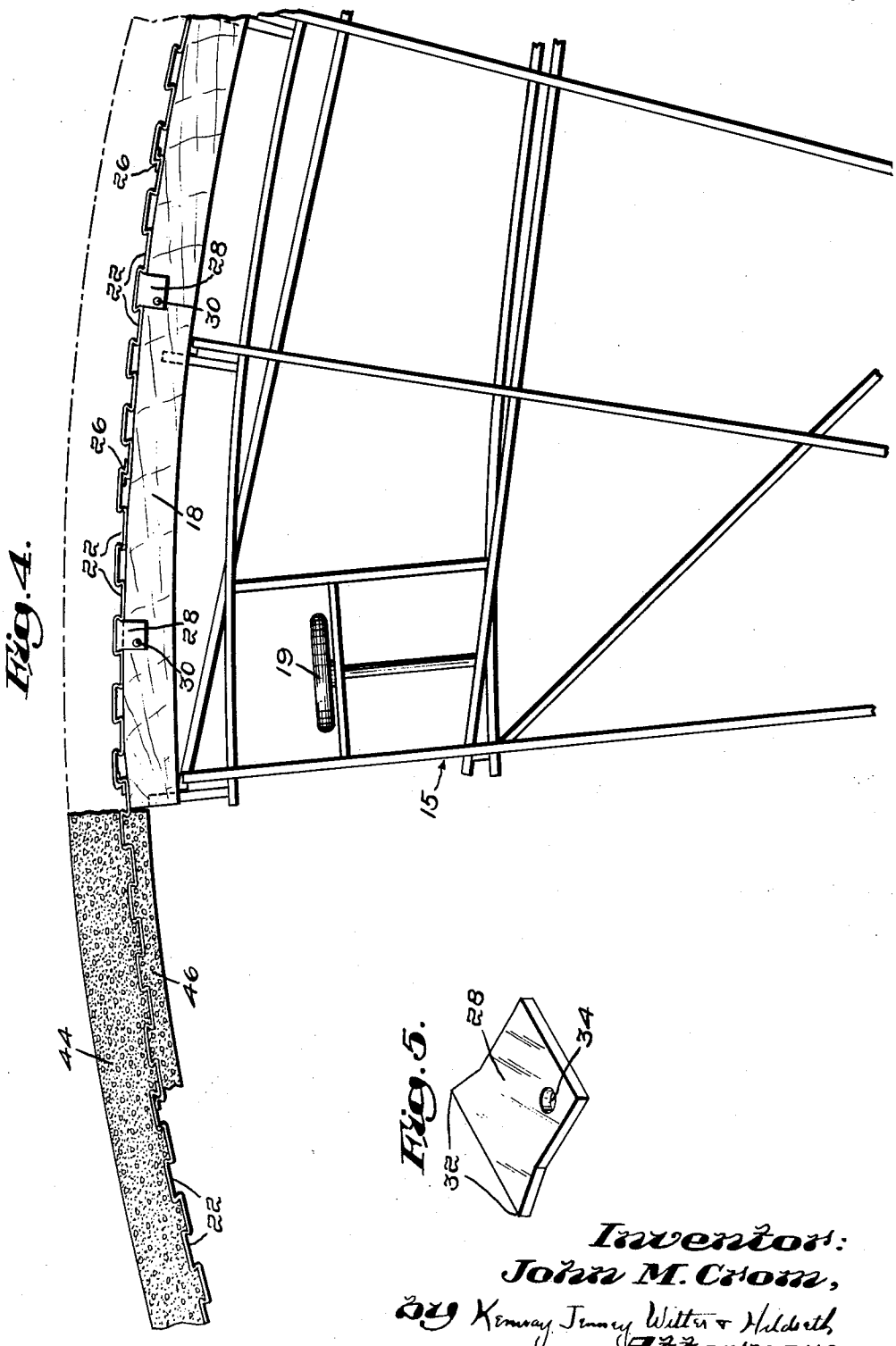


Fig. 4.

Fig. 5.

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METHOD OF MAKING A LIQUID IMPERVIOUS WALL

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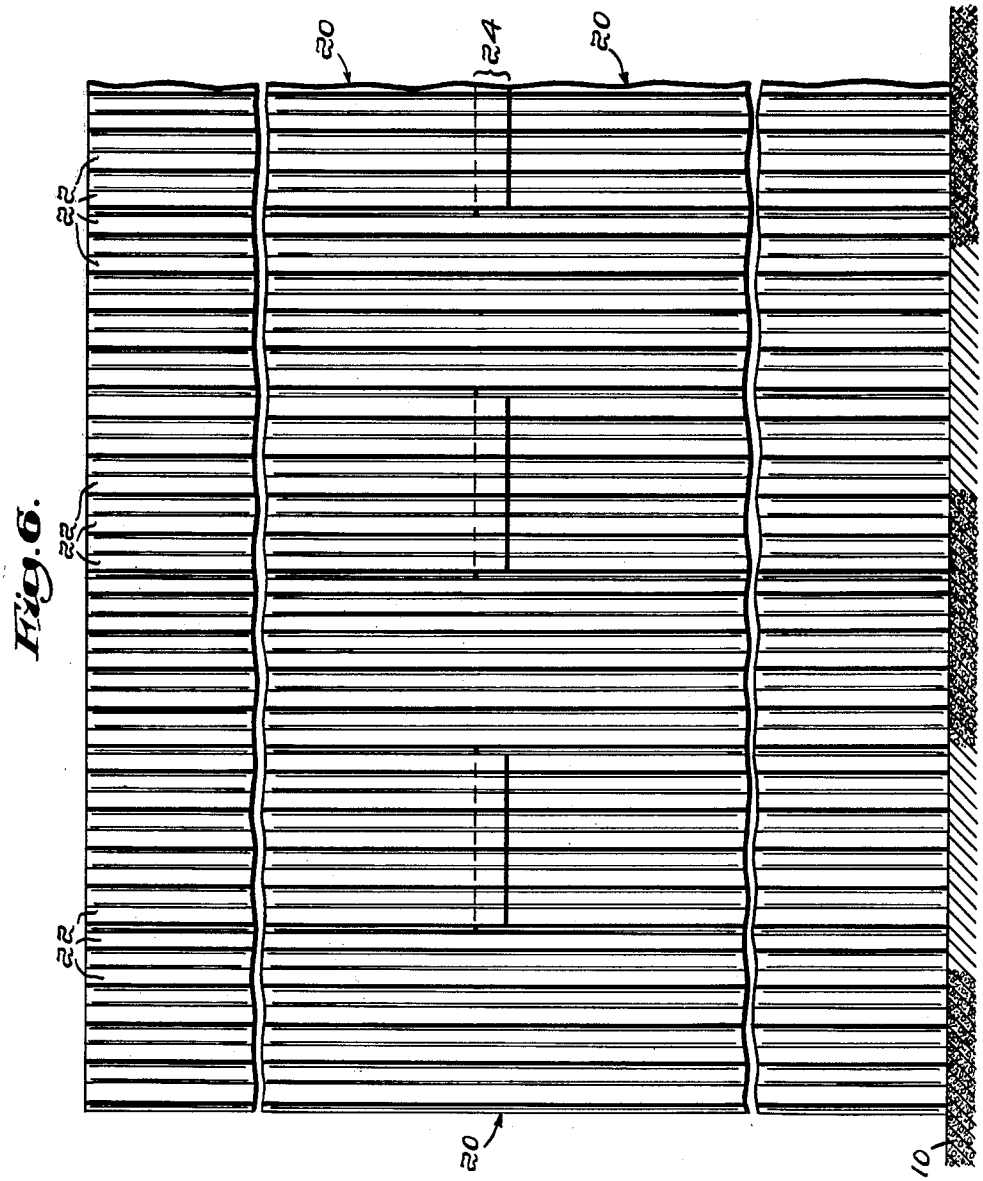


Fig. 6.

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METHOD OF MAKING A LIQUID IMPERVIOUS WALL

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Fig. 7.

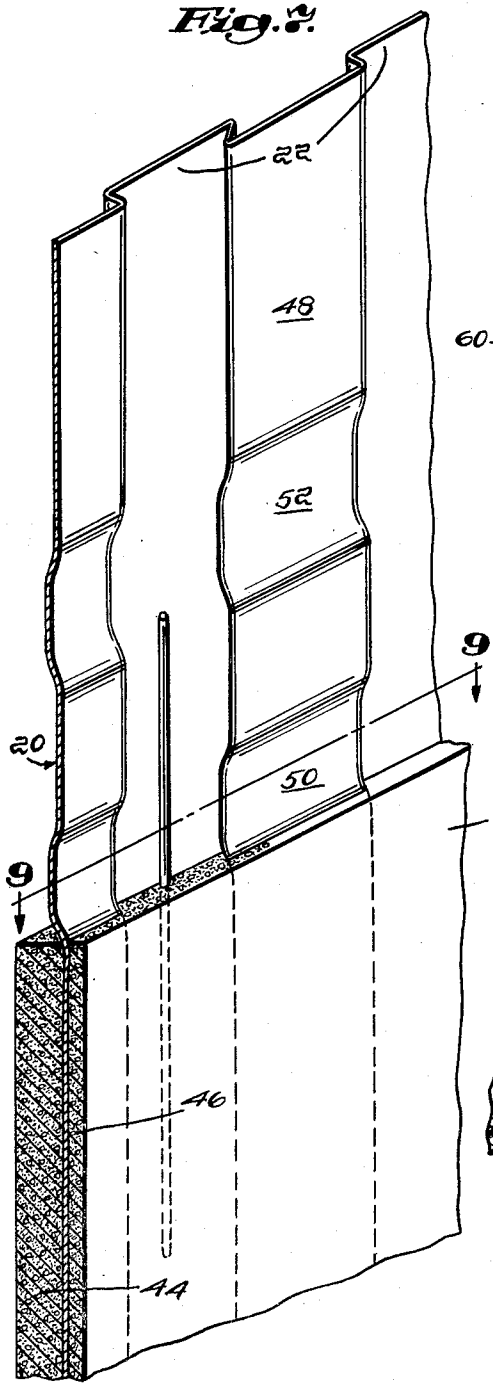


Fig. 8.

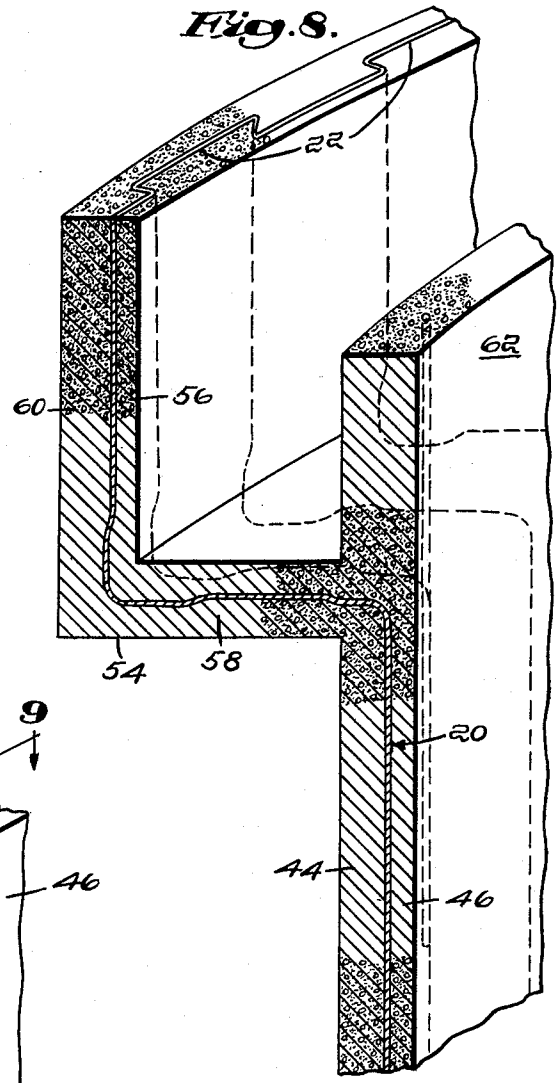
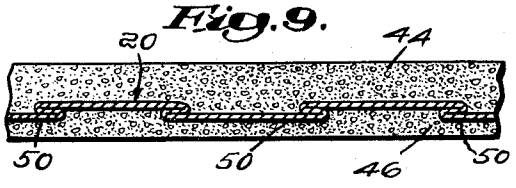


Fig. 9.



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METHOD OF MAKING A LIQUID IMPERVIOUS WALL

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Fig. 10.

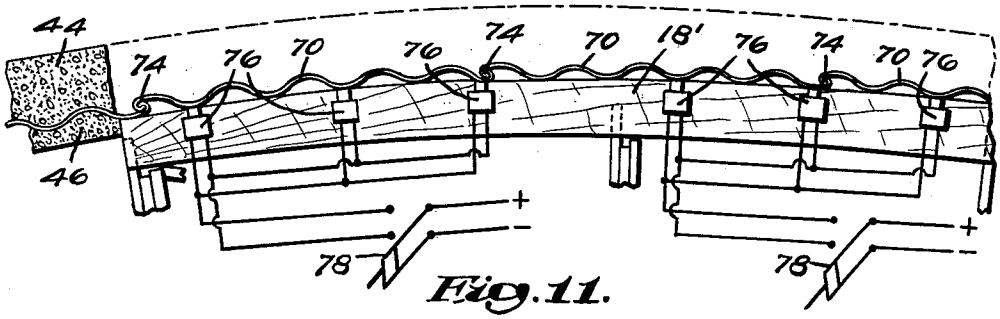


Fig. 11.

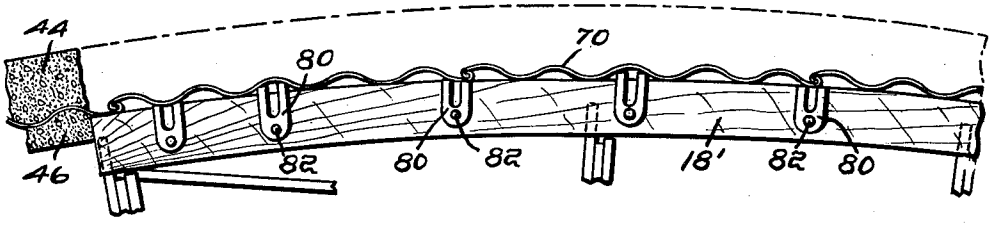
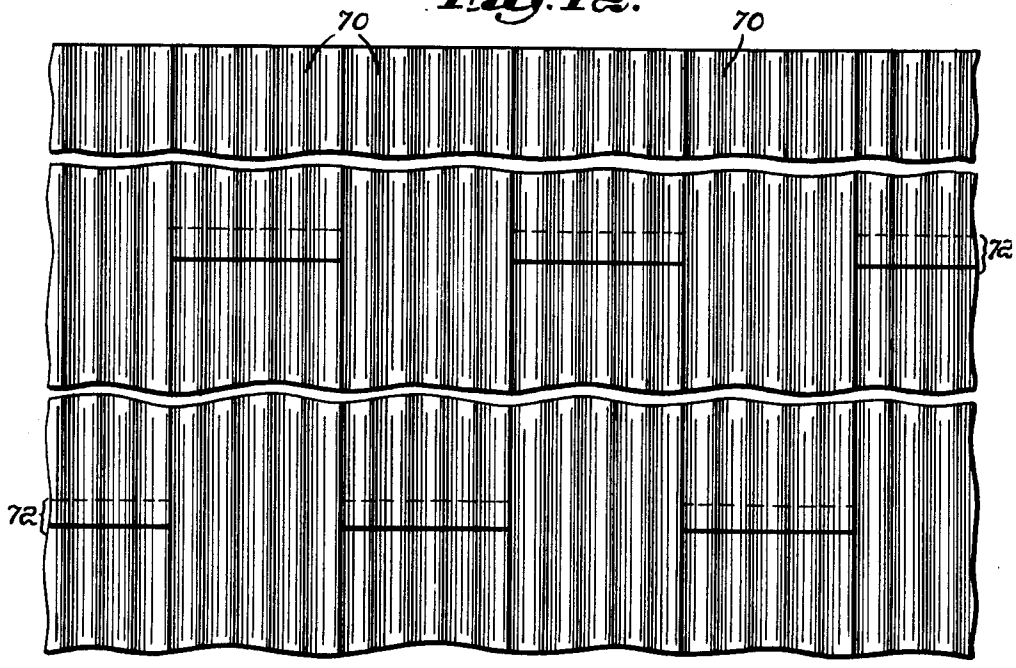


Fig. 12.



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United States Patent Office 3,120,047 Patented Feb. 4, 1964

3,120,047

METHOD OF MAKING A LIQUID IMPERVIOUS WALL

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Filed May 4, 1961, Ser. No. 152,368
5 Claims. (Cl. 264—32)

This application is a continuation-in-part of my application Serial Number 665,085 filed June 11, 1957, forfeited on May 7, 1961 and expressly abandoned on January 10, 1962.

This invention relates to a novel method of constructing a liquid-impervious wall on and embodying therein an imperforate metal diaphragm rendering the wall impervious to the passage of liquids therethrough. The invention is particularly applicable to the construction of a cylindrical tank wall and I have herein illustrated and described the invention as constructing such a wall in consecutively formed segments joined together at their junctions to form a cylindrical tank wall.

In accordance with the invention as illustrated in the drawings a skeleton frame having an arcuate convex outer face is provided at one segment of the proposed wall and a diaphragm embodying rectangular metal sheets in overlapping relation at their margins is formed and supported on the frame at said face by elements carried by the frame and in non-penetrating and detachable supporting contact with the sheets at their inner faces, thus leaving the outer face of the diaphragm free and unobstructed. The overlapping margins of the sheets are treated with plastic composition or other suitable means to render them impervious. A monolithic wall of predetermined thickness is then formed on and over the front face of the diaphragm by shooting a continuous layer of cementitious composition thereover. When the monolithic wall has set sufficiently to be self supporting the supporting engagement of the sheets on the frame is released and the frame is moved to the next adjacent segment of the proposed wall.

The detachable and non-penetrating supporting of the sheets on the frame at their inner faces makes possible such early and expeditious movement of the frame and continuation of the wall construction work without loss of time, labor or materials and equipment employed and permits the disengaging of the frame from the diaphragm and relatively soft wall without damage to the wall. The above described operations are repeated until the entire cylindrical wall is completed, and the production of a tank wall of this nature and the novel, useful and economical method herein described of producing the wall comprises the primary object of the invention.

Where the tank thus constructed requires a lining, a coating of predetermined thickness is formed on and over the rear face of the diaphragm, as soon as possible following removal of the frame and while a substantial portion of the drying and shrinking of the wall on the front face yet remains to take place, by shooting a continuous layer of cementitious composition thereover. The outer and inner coatings thereupon dry and shrink simultaneously and at substantially equal rates to form a unitary wall construction. The above described detachable and non-penetrating supporting of the sheets on the frame at their inner faces makes possible the early removal of the frame and the application of the liner coating before the wall has completed a substantial portion of its drying and shrinking function, thus providing for the simultaneous drying and shrinking of the wall and coating. The novel steps of thus making a lined tank of the nature described comprises a further object of the invention.

The diaphragm sheets are preferably bent alternately in opposite directions to form substantially parallel ribs with troughs therebetween extending vertically of the wall and

are in nesting engagement at the overlapping margins of the sheets. The ribs include overhanging margins adapted to receive removable clips therebeneath and secured to the frame for removably supporting the sheets on the frame.

Tanks of this nature are commonly employed in the treatment of sewage and a further feature of the invention relates to a cylindrical tank wall of the nature described and including an annular overflow trough on and disposed laterally of and about the top rim of the wall and to the novel construction of the trough on the wall.

These and other features of the invention will be best understood and appreciated from the following description of preferred embodiments thereof selected for purposes of illustration and shown in the accompanying drawings in which—

FIG. 1 is a fragmentary view of a tank bottom constructed to receive a cylindrical tank wall,

FIG. 2 is a fragmentary plan view of the cylindrical tank wall being constructed in accordance with my invention,

FIG. 3 is a fragmentary elevation of frames employed in constructing the wall,

FIG. 4 is an enlarged fragmentary plan view showing construction of the wall.

FIG. 5 illustrates a supporting clip employed in FIGS. 3 and 4,

FIG. 6 is a fragmentary rear elevation of the partially completed wall,

FIG. 7 is an enlarged fragmentary view of a modified wall construction,

FIG. 8 illustrates the same in a further step of construction,

FIG. 9 is a sectional view taken on line 9—9 of FIG. 7.

FIG. 10 is an enlarged fragmentary plan view of another modified wall construction,

FIG. 11 is a fragmentary view showing a further modified construction, and

FIG. 12 is a fragmentary rear elevation of the partially completed wall.

In FIGS. 1–6 I have illustrated the construction of a lined cylindrical diaphragm tank wall in accordance with my invention. The cementitious bottom **10** of the tank is first constructed as illustrated in FIG. 1 and is provided with reinforcing rods **12** anchored in the bottom and extending upwardly from its marginal portion **14** in position to be bonded into the cylindrical wall of the tank. The cylindrical wall illustrated incorporates a metal diaphragm therein between inner and outer cementitious walls bonded thereto and objects of the invention reside in novel steps of constructing the wall, including (1) the non-penetrating and detachable supporting of the diaphragm at its inner face while the outer portion of the wall is being applied to the outer face of the diaphragm, whereby the diaphragm support can be readily moved to the next adjacent position as soon as the said outer portion of the wall has set sufficiently to be self-supporting, thus facilitating rapid and economical construction of the wall as herein described and, (2) when a liner is required, such early shifting of the diaphragm support permits immediate application of the liner coating to the inner face of the diaphragm whereupon the outer and inner coatings can dry and shrink simultaneously as a unit.

In accordance with my invention I provide a skeleton frame having an arcuate portion disposed inwardly of and adjacent to a segment of the proposed cylindrical wall. As illustrated in FIGS. 2 and 3 this frame **15** is preferably of segmental shape and anchored at the center **16** of the bottom wall **10**. The outer face of the frame is disposed arcuately about the marginal portion **14** of the bottom wall inwardly of the reinforcing rods **12**. This outer face portion of the frame embodies arcuately

disposed ribs 18 carried at different elevations on the frame, the ribs being spaced vertically apart distances to receive and support thereon the metal sheets 20 of the diaphragm. Wheels 19 are provided on the frame for conveniently shifting it about the center 16 and jacks 21 are employed for supporting the frame during wall construction thereon.

Each diaphragm sheet 20 is of rectangular shape and is bent zig-zag as illustrated in FIG. 4 to form troughs or channels 22 therein at both faces of the sheet and with overhanging marginal ribs along both lateral edges of each channel. While the channels are substantially parallel, they do have a very slight taper whereby the channel end portions at one end of each sheet are adapted to telescope within the relatively wider channels at the overlapped end of a companion sheet as illustrated at 24 in FIG. 6. The sheets are mounted on the outer arcuate faces of the ribs 18 of the frame 15 as illustrated in FIG. 4 with adjacent sheets telescoped vertically at 24 and in lateral overlapping engagement as illustrated at 26 in FIG. 4.

An important feature of the invention resides in a novel manner of detachably supporting the sheets on the ribs 18 of the frame 15 without penetrating or perforating the sheets. As illustrated in FIGS. 4 and 5 I provide the frame with clips 28 detachably nailed thereto and in supporting engagement with the inner faces of the sheets. Each clip is a flat piece of metal having opposed ears 32 for engaging beneath the overhanging margins of each channel and is provided with a hole 34 for receiving a nail 30 whereby it is attached to and becomes a sheet supporting part of the frame. Thus the diaphragm is built up on the frame by overlapping and securing the sheets to the ribs 18 as illustrated and is supported on the frame without penetrating or perforating the sheets. The overlapping joints at 24 and 26 are then sealed as by injecting a suitable sealing compound thereinto.

The placing of the diaphragm sheets and building of the wall are facilitated by an outer frame 36 having platforms 38 at different elevations and mounted to ride about the wall on wheels 40 together with wheels 42 for engaging against the top portion of the frame 15. After the diaphragm is constructed and sealed at the joints, a monolithic wall 44 is formed on and over the front face of the diaphragm by shooting a continuous layer of cementitious composition thereover, the composition filling the channels 22 and bonding tightly to the diaphragm. The wall normally sets sufficiently to be self supporting within about twenty-four hours and as soon as this has taken place the clips 28 are released and the frame 15 thus freed from the diaphragm and wall. The frame is thereupon moved circumferentially to the next adjacent segment of the proposed wall where it is immediately ready to receive sheets forming an adjacent diaphragm segment. The usual procedure is initially to form the wall 44 only of a thickness to be self-supporting when set and the frame removed. This thickness ordinarily approximates two to three inches and more cementitious composition is later added to complete the wall to the full thickness desired. Removal of the frame also exposes the diaphragm rearwardly of the monolithic wall 44 and, where the tank thus constructed requires a lining, an inner monolithic wall or coating 46 is applied to the inner face of the diaphragm by shooting a continuous layer of cementitious composition thereover as soon as possible following removal of the frame and while a substantial portion of the drying and shrinking of the wall on the front face yet remains to take place.

The inner coating 46 is applied as soon as practicably possible following removal of the frame for the purpose of effecting the simultaneous drying and shrinking of the two walls and thus forming them into a unitary structure as herein described, and to effect this function and result the inner coating must be applied while a substantial

portion of the drying and shrinking of the wall on the front face yet remains to take place. This time period gap may vary considerably but ordinarily the inner wall is applied within two or three days after formation of the outer wall but may, due to various factors, extend to as long as five or six days. These factors include the current kind of weather prevailing, the temperatures, kind of cement used and any additives included in the mix. Furthermore, the drying and shrinking rate can be retarded by keeping the wall saturated with water. The time of applying the inner coating is therefore critical to the extent described in order that the two walls may have a substantial period of simultaneous drying and shrinking together and thus form a unitary wall structure.

Thus forming the outer and inner walls 44 and 46 provides for the simultaneously drying and shrinking of the two walls together as a unit. Since the shrinking of the two walls is simultaneous and at substantially equal rates the two walls cooperate to form a unitary structure adapted to afford maximum strength resistance when circumferential banding forces are later applied by tensioned wire windings as in my Patent 2,364,696. In such unitary construction the inner wall directly cooperates with the outer wall to absorb a part of the load exerted by the wire windings. It will also be apparent that the diaphragm has been left intact and imperforate and the convenient removal of the clips 28 permits immediate shifting of the frame 15 to its new position, thus fully exposing the rear face of the diaphragm for application of the liner coating 46 thereto, when required, and permitting immediate application of the adjacent segment diaphragm to the frame.

The same operations as above described are repeated on the frame 15 each time it is shifted to a new position and these movements and steps are repeated for adjacent segments of the wall until the entire cylindrical tank wall has been constructed. It will be apparent that the novel method results in a substantially superior imperforate and unitary wall construction and also greater efficiency by providing for more continuous operations without loss of labor or materials and equipment employed.

The detachable supporting of the diaphragm sheets 20 on the frame 15 whereby the frame can be quickly and conveniently removed and leave the combined sheets and outer coating 44 intact merely by removing the nails 30 serves several important functions and comprises a primary feature of the invention. This feature permits prompt removal of the frame that has not been possible heretofore and without damage to the relatively soft wall 44, thereby not only permitting the quick shifting of the frame to the next adjacent position, together with great saving of time and labor expense, and the prompt exposing of the rear face of the diaphragm to receive the inner coating 46, when required, but also providing a great saving in form expense by permitting the use of much shorter length of forms. Also, the great saving of time effected by this quick detachable feature very substantially reduces the total time required for the construction of a complete tank.

Tanks of this nature are quite commonly employed for sewage disposal purposes and in FIGS. 7–9 I have illustrated a further embodiment of the construction particularly adapted for serving this function. In this case the diaphragm of the cylindrical tank wall includes a portion 48 extending upwardly beyond the top of the monolithic wall 44–46. The portion 48 of the diaphragm is bent outwardly to horizontal position from the top of the wall 44–46 and a marginal portion is bent upwardly, as illustrated in FIG. 8. The channel portions of the diaphragm are flattened at 50 and 52 as illustrated in FIGS. 7 and 9 to facilitate this bending operation. Cementitious composition is shot against the outer and inner faces of this portion of the diaphragm as indicated at 54 and 56. It will be apparent that the horizontal and vertical portions 58 and 60 provide the bottom and outer wall of a circular

trough disposed on and outside of the cylindrical tank wall. The trough is completed by constructing an overflow barrier 62 on the wall to provide an inner trough wall 62 of less height than the outer trough wall 60. Sludge floating at the top of the tank contents is adapted to flow over the barrier and into the trough from which it can be conveniently removed.

In FIGS. 10–12 I have illustrated the tank diaphragm as constructed from corrugated metal sheets 70. The sheets are overlapped at their ends as shown at 72 in FIG. 12 and are interlocked at their side margins as illustrated at 74. The joints can be sealed as above described or otherwise as by spot welding. In FIGS. 10 and 11 I have shown the sheets as supported magnetically on the ribs 18' of the frame. Electro magnets 76 carried on the ribs and contacting the inner faces of the sheets are illustrated in FIG. 10 and the magnetic action on the sheets can be conveniently controlled by switches 78. In FIG. 11 I have illustrated the use of permanent magnets 80 which contact the inner faces of the sheets and are secured to the ribs as by nails 82. The construction of the wall on these sheets is substantially the same as described for FIGS. 1–6 and the use of the magnets serves the function of supporting the sheets at their inner faces without perforating the sheets and permits quick and convenient detaching of the frame from the sheets.

While I have herein illustrated and described the preferred form and procedure of employing my invention I desire it to be understood that various obvious and apparent departures from the procedure illustrated and described are within the scope of the invention. For example, while the interlocking joints of the sheets comprising the diaphragm preferably extend vertically as illustrated, it is well within the scope of the invention to extend them otherwise if desired. Furthermore, the trough 58–60 shown in FIG. 8 can be placed either outwardly or inwardly of the tank wall 44—46.

Having thus disclosed my invention what I claim as new and desire to secure by Letters Patent is:

1. A method of constructing an arcuate segment of a liquid-impervious and cylindrical tank wall, which consists in providing a skeleton frame having an arcuate portion disposed inwardly of and adjacent to a segment of the proposed cylindrical wall, forming a diaphragm over the convex face of said portion embodying metal sheets overlapping at their margins and bent alternately in opposite directions to form substantially parallel ribs with troughs therebetween and with the ribs and troughs in nesting engagement at said overlapping margins, detachably supporting said sheets on the frame by non-penetrating supporting contact of the frame with the sheets at their inner faces, sealing the overlapped margins of the sheets against the passage of liquids, forming a monolithic wall on and over the outer face of the diaphragm by placing a continuous layer of cementitious composition thereonto, and releasing the supporting engagement of the frame to the sheets and moving the frame from the combined diaphragm and monolithic wall to the next adjacent segment of the proposed wall soon after the wall has set sufficiently to be self-supporting.

2. A method of constructing an arcuate segment of a liquid-impervious and cylindrical tank wall, which consists in providing a skeleton frame having an arcuate portion disposed inwardly of and adjacent to a segment of the proposed cylindrical wall, forming a diaphragm over the convex face of said portion embodying overlapping metal sheets bent to zig-zag configuration forming channels with overhanging margins at both faces of the sheets and interlocked at the overlapped margins of the sheets, detachably supporting said sheets on the frame by non-penetrating supporting engagement of the frame within and beneath the overhanging margins of the channels at the rear face of the diaphragm, sealing the overlapped margins of the sheets against the passage of liquids, forming a monolithic wall over the front face of the diaphragm by shooting cementitious composition thereover and into said channels, and releasing the supporting engagement of the frame to the sheets and moving the frame from the combined diaphragm and monolithic wall to the next adjacent segment of the proposed wall soon after the wall has set sufficiently to be self-supporting.

3. The method defined in claim 2 in which said channels in each sheet are in substantially parallel relation and each channel is slightly tapered from end to end with the channels slightly wider at one end of the sheet than at the other end thereof, and telescoping the narrower channels at one end of each sheet into the wider channels at the wider channel end of the adjacent and overlapped sheet.

4. A method of constructing an arcuate segment of a liquid-impervious and cylindrical tank wall, which consists in providing a skeleton frame having an arcuate portion disposed inwardly of and adjacent to a segment of the proposed cylindrical wall, forming a diaphragm over the convex face of said portion embodying overlapping metal sheets bent to zig-zag configuration forming channels with overhanging margins at both faces of the sheets and interlocked at the overlapped margins of the sheets, detachably supporting said sheets on the frame by non-penetrating supporting engagement of the frame within and beneath the overhanging margins of the channels at the rear face of the diaphragm, sealing the overlapped margins of the sheets against the passage of liquids, forming a monolithic wall over the front face of the diaphragm by shooting cementitious composition thereover and into said channels, releasing the supporting engagement of the frame to the sheets and moving the frame from the combined diaphragm and monolithic wall to the next adjacent segment of the proposed wall soon after the wall has set sufficiently to be self-supporting, and forming a coating on and over the rear face of the diaphragm by shooting cementitious composition thereonto and into said channels while a substantial portion of the drying and shrinking of the monolithic wall yet remains to take place, whereby said monolithic wall and coating will dry and shrink together simultaneously as a unit on the diaphragm.

5. A method of constructing an arcuate segment of a liquid-impervious and cylindrical tank wall, which consists in providing a skeleton frame having an arcuate portion disposed inwardly of and adjacent to a segment of the proposed cylindrical wall, forming a diaphragm over the convex face of said portion embodying metal sheets overlapping at their margins, detachably supporting said sheets on the frame by non-penetrating supporting contact of the frame with the sheets at their inner faces, sealing the overalpped margins of the sheets against the passage of liquids, forming a monolithic wall on and over the outer face of the diaphragm by placing a continuous layer of cementitious composition thereonto, and releasing the supporting engagement of the frame to the sheets and moving the frame from the combined diaphragm and monolithic wall to the next adjacent segment of the proposed wall soon after the wall has set sufficiently to be self-supporting.

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