Sept. 14, 1943. L. A. SCHMIDT, JR 2,329,223

SUBSTRATUM WATER CONTROL

Filed June 23, 1942 2 Sheets-Sheet 1

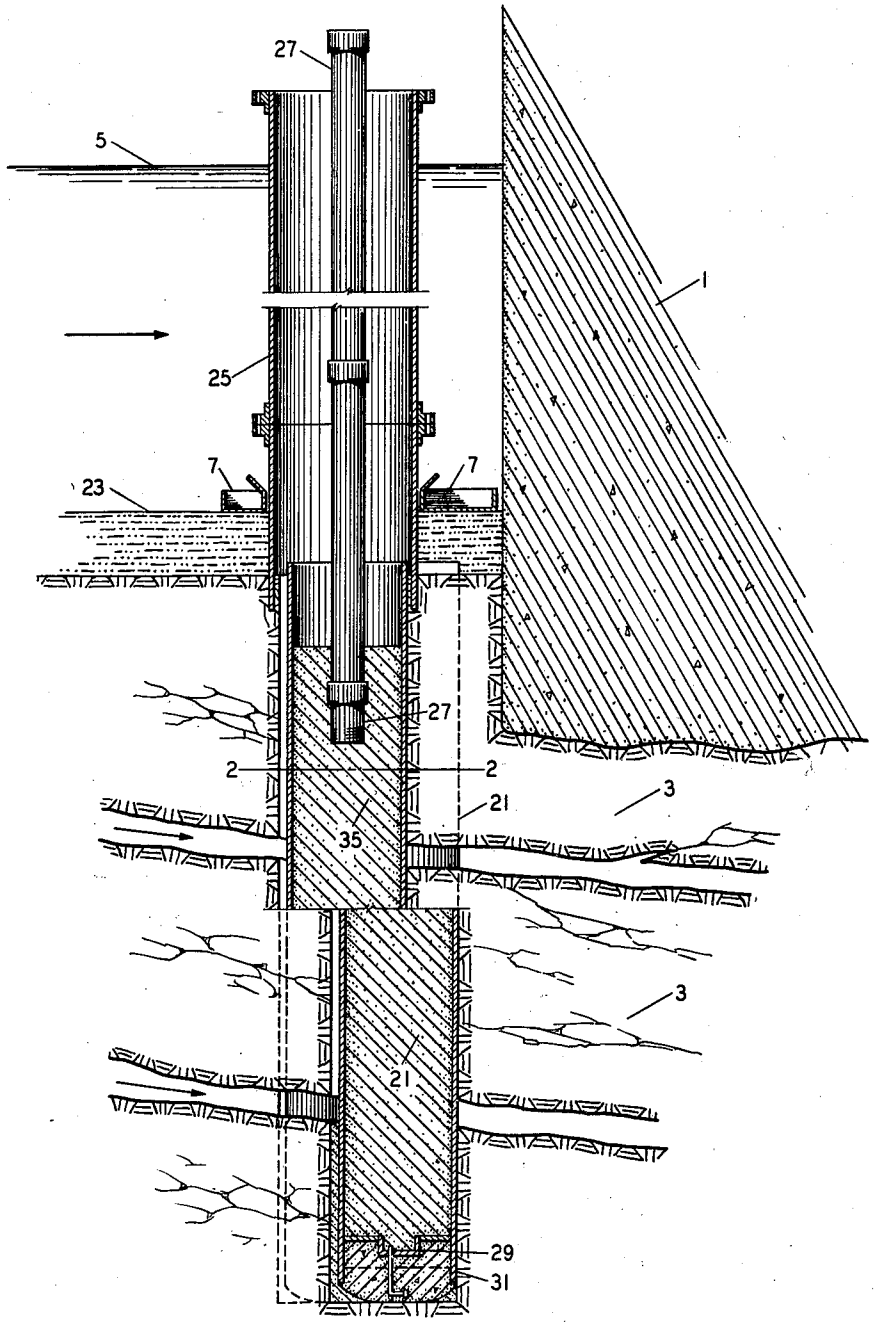


FIG 1

Lewis A. Schmidt, Jr.
INVENTOR
BY Arthur L. Davis
ATTORNEY

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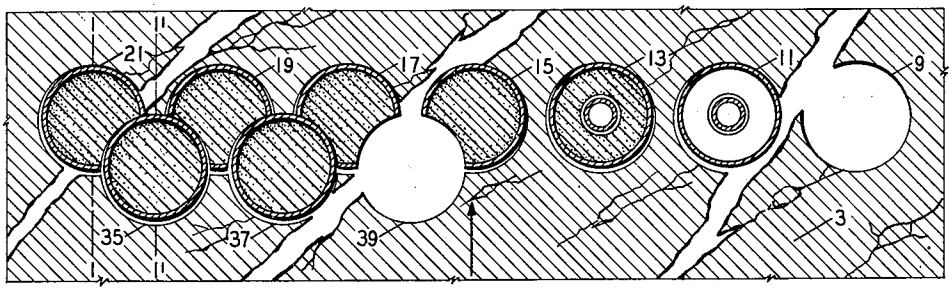


FIG. 2

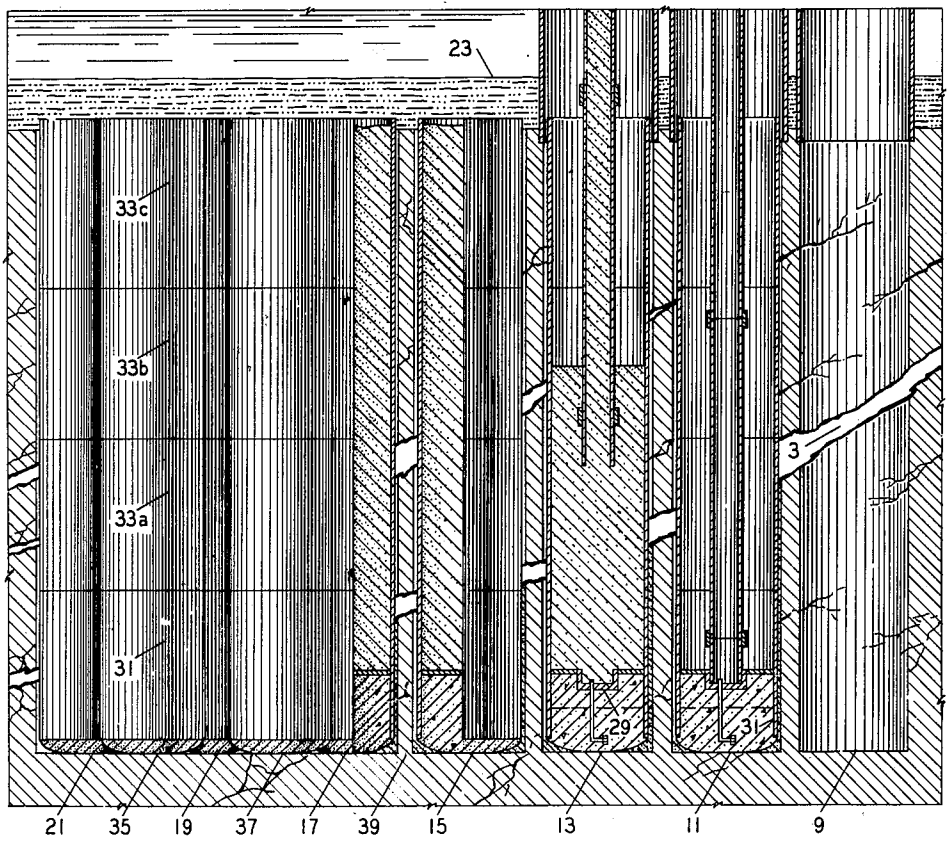


FIG. 3

Lewis A. Schmidt, Jr.
INVENTOR
BY Arthur L. Davis
ATTORNEY

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SUBSTRATUM WATER CONTROL

Lewis A. Schmidt, Jr., Lookout Mountain, Tenn.

Application June 23, 1942, Serial No. 448,171

4 Claims. (Cl. 61—11)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

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

This invention relates to a process of forming monolithic or integrated structures, at least a portion of which rests in a pervious substratum.

This invention is directed particularly to hydraulic structures which have a foundation leakage of such magnitude that any attempt at a normal grouting procedure is precluded. It further concerns hydraulic structures having a head differential of such magnitude that the flow of water through the cavity in the substratum is of such velocity that the grout is washed away as fast as it is placed. Also, the invention concerns a foundation condition where the size or extent of the cavities is too great to permit successful grouting with tenacious material such as asphalt.

This invention also contemplates the formation of structural elements such as piles in strata, whether or not such strata are porous, under conditions such that it is not feasible to permit exclusive vibrations which usually accompany the driving of conventional forms of piles. Under the conditions encountered in certain locations, there is objection to the use of cast-in-place pile based upon the probability of injury to the green concrete from the back pressure set up by driving the forms for adjacent piles.

The principal object of this invention is to provide a process for the formation of a cutoff wall for a dam structure in order that its foundation may be preserved from harmful erosion, thereby protecting the dam structure itself. Another object of this invention is to provide a method for arresting the leakage of water through a dam foundation in order that such water may be otherwise effectively utilized. Still another object of this invention is to provide a method for forming integrated structures in substrata of unknown characteristics in a manner such that the character of the stratum and the integrity of the structure may be progressively determined. A further object of this invention is to provide a method for the production of a monolithic structure in unstable substratum. A further object of this invention is to provide a method for forming a monolithic structure in substratum with a minimum of vibration in order that adjacent structures susceptible to substantial vibration may be unaffected by injury through use of the usual procedures employed. An additional object of this invention is to provide a method for forming monolithic or integrated structures in pervious substratum in a manner such as to prevent fluid penetration between portions of solidifiable material used to form the structure after such solidifiable material is placed, to prevent the solidifiable material from being removed by flowing underground water, to prevent adjacent material in the substratum intermingling with the solidifiable material and prevent failure of the solidifiable material due to initial intermingling therewith by the constituents of the ground water as such material is being placed. Other objects of this invention include the provisions of an economical method for forming monolithic or integrated structures in porous substratum without dewatering such substratum.

I have discovered a method for the control of water in a liquid pervious substratum by providing a plurality of spaced parallel channels in said substratum transversely positioned in respect to the normal direction of flow of water through said substratum; by forming a monolithic element in each of said channels; by providing a spaced channel on the upstream side, parallel to and intersecting substantially the entire length of each adjacent pair of said monolithic elements; and by forming a monolithic element in each of said second-mentioned channels contiguous to each pair of said first-mentioned monolithic elements.

In the accompanying drawings, which form a part of the specification, and wherein reference symbols refer to like parts wherever they occur,

Fig. 1 is a transverse, vertical sectional view through the spillway section of a dam structure and the subjacent liquid pervious substratum taken on 1—1 and 1'—1' of Fig. 2, showing one embodiment of the present invention;

Fig. 2 is a sectional plan view through the liquid pervious substratum taken on 2—2 of Fig. 1, showing the various stages in the operation of the method of effecting water control therein;

Fig. 3 is a vertical, part-sectional view of the arrangement shown in Fig. 2.

A dam structure 1 rests upon a cavernous rock foundation 3 and the difference in the elevation between the headwater 5 and the tailwater (not shown) creates a leakage in the porous substratum of such magnitude that conventional grouting methods are impossible due to the velocity of the water flowing therethrough and the tendency to wash away any grout as fast as it is placed. A template 7 with openings therein to correspond to the spaced relationship of channels 9, 11, 13, 15, 17, 19, and 21 is secured in place beneath the headwater 5 on overburden 23. Casing 25 is inserted into the template 7 at the position corresponding to channel 9, and said channel is then drilled to the desired depth. The spaced parallel channels 11, 13, 15, 17, 19 and 21 are successively drilled and a monolithic element formed therein after the formation of a monolithic element in channel 9 as illustrated stepwise in the resepctive channels 11, 13, and 15 as shown in Fig. 3. An assembly com-

prising a tremie 27 screwed into a threaded cap 29 set and spaced within a reinforced concrete filled nose section of transite pipe 31, together with affixed successive sections of transite pipe 33*a*, 33*b*, and 33*c*, is lowered to the bottom of the drilled channel. Tremie 27 is unscrewed from cap 29 and raised gradually as concrete delivered thereto discharges into and fills pipe section 31 and superposed pipe sections 33*a*, 33*b*, and 33*c*. When the concrete has set, the casing 25 is moved to the next position in template 7 and the process repeated until a monolithic element has been formed in each of the parallel spaced channels on the downstream side. Thereafter, the position of template 7 is moved to a position upstream such that channels drilled therethrough will intersect two adjacent previously formed monolithic elements. Channels 35, 37, and 39, and additional channels (not shown) on the upstream side and intersecting channels 13—15, 11—13, and 9—11 are successively drilled and monolithic elements formed therein in the same manner as provided for channels 9, 11, 13, 15, 19, and 21. The diameter of each element on the upstream side is smaller than the diameter of the channel in which it is placed, in order that compressive forces exerted on each of the upstream monolithic elements will force it securely in position against the respective downstream monolithic elements which are intersected by the channel in which the upstream element is placed.

The present invention provides a method for the control of water in a liquid pervious substratum by forming monolithic elements in channels which intersect the upstream side of elements previously formed in the porous substratum to form an integrated structure which is fluid impervious as has been set forth above in considerable detail. It is generally preferable that not only the original shape of the downstream row of individually spaced elements but the upstream row of individual elements be cylindrical in form. This is primarily a matter of convenience as a result of drilling through the porous substratum. However, the invention in its broadest aspect contemplates that the individual elements may have any suitable vertical cross-section so long as each element in the upstream row intersects two adjacent elements in the downstream row.

As the channels are produced, it is generally desirable to insert a form therein which becomes a part of the final individual monolithic element. Transite pipe has been particularly effective for this purpose. In order that the monolithic element be properly formed, a nose section of the pipe is prepared with a centrally spaced inverted threaded cap affixed in one end in set reinforced concrete. The cap of this nose section is screwed onto the tremie or visa versa, the nose section started into the channel, additional plain sections of transite pipe affixed thereto until the nose section reaches the bottom of the channel where an examination of the channel into which the transite pipe is to be lowered indicates the presence of a cavity or cavities of some magnitude. The transite pipe section or sections which are to be placed in position adjacent thereto are reinforced internally in order that the form will not only retain its shape, but the monolithic element of which it becomes a part will be sufficiently strong to withstand the force projected against it.

The application of the present invention has been found to be effective in sealing off the water in a porous substratum beneath a dam which hitherto had caused a serious diversion of stream flow which could not be interrupted by the use of any method then available without the diversion of water from the zone of operation.

It will be seen, therefore, that this invention actually may be carried out by the modification of certain details without departing from its spirit or scope.

I claim:

1. A method for the control of water in a water pervious substratum, which comprises (*a*) excavating a plurality of spaced parallel channels in said substratum transversely positioned in respect to the normal direction of flow of water through said substratum, (*b*) forming a monolithic element of concrete in each of said channels, (*c*) drilling a spaced channel on the upstream side, parallel to and intersecting the entire length of each pair of said monolithic elements, and (*d*) forming a monolithic element of concrete in each of said second-mentioned channels contiguous to each pair of said intersected first-mentioned monolithic elements.

2. A method for the control of water in a water pervious substratum, which comprises (*a*) drilling a plurality of spaced parallel channels in said substratum transversely positioned in respect to the normal direction of flow of water through said substratum, (*b*) forming a monolithic element of concrete in each of said channels, (*c*) drilling a spaced channel, with circular cross-section, on the upstream side, parallel to and intersecting the entire length of each pair of said monolithic elements, and (*d*) forming a monolithic element of concrete in each of said second-mentioned channels contiguous to each pair of said intersected first-mentioned monolithic elements.

3. A method for the control of water in a water pervious substratum, which comprises (*a*) drilling a plurality of spaced parallel channels, with circular cross-section, in said substratum transversely positioned in respect to the normal direction of flow of water through said substratum, (*b*) forming a monolithic element of concrete in each of said channels, (*c*) drilling a spaced channel, with circular cross-section, on the upstream side, parallel to and intersecting the entire length of each pair of said monolithic elements, and (*d*) forming a monolithic element of concrete in each of said second-mentioned channels contiguous to each pair of said intersected first-mentioned monolithic elements.

4. A method for the control of water in a water pervious substratum, which comprises (*a*) drilling a plurality of spaced parallel channels, with circular cross-section, in said substratum transversely positioned in respect to the normal direction of flow of water through said substratum, (*b*) forming a monolithic element of concrete in each of said channels, (*c*) drilling a spaced channel, with circular cross-section, on the upstream side, parallel to and intersecting the entire length of each pair of said monolithic elements, and (*d*) forming a monolithic element of concrete with circular cross-section and a slightly smaller diameter than the diameter of said second-mentioned channels contiguous to each pair of said intersected first-mentioned monolithic elements.

LEWIS A. SCHMIDT, JR.