N. L. HALL.

DAM.

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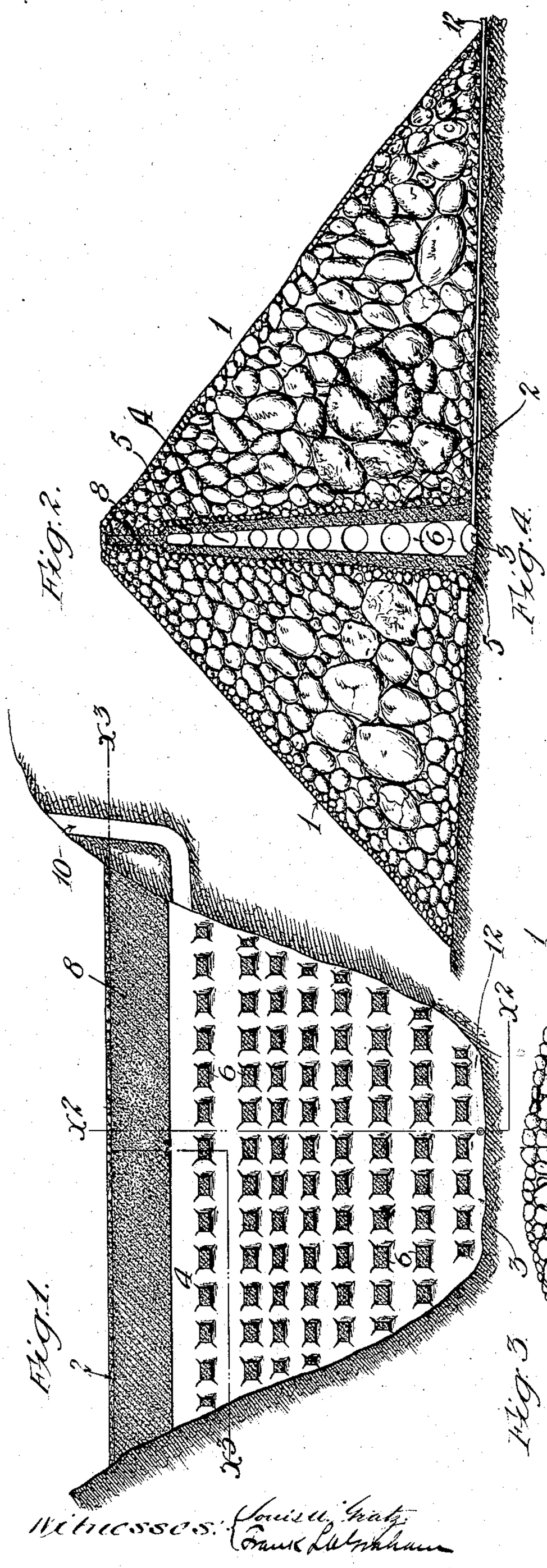
923,831. Patented June 8, 1909.



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UNITED STATES PATENT OFFICE.

NEWTON L. HALL, OF SAN DIEGO, CALIFORNIA.

DAM.

No. 923,831. Specification of Letters Patent. Patented June 8, 1909.

Application filed January 2, 1908. Serial No. 409,092.

To all whom it may concern:

Be it known that I, NEWTON L. HALL, a citizen of the United States, residing at San Diego, in the county of San Diego and State of California, have invented a new and useful Dam, of which the following is a specification.

This invention relates particularly to the class of dams wherein the body of the dam is of relatively permeable or open material, such as loose rock or rock fill or earth fill, the sealing of the dam being effected by a wall of relatively small mass but of impermeable structure, extending throughout the dam from end to end. In these dams, known as fill dams, the impermeable wall may be either a core wall in the interior of the dam, or a lining, generally at the upstream face of the dam.

The present invention is directed particularly to the construction of such a wall, whether used as a core wall or as a lining, and the main object of the invention is to enable the condition of the wall as to leakage to be readily ascertained at any time, and if defects occur, to enable repair of the wall where defective. In this connection, the invention provides also for the inspection and repair of the rock bed, and for detecting and remedying a condition of leakage under the dam.

A further object of the invention is to provide a wall for the above stated purpose, of maximum strength and stability for a given amount of material used.

In the accompanying drawings: Figure 1 is a longitudinal, vertical section of a dam, looking downstream. Fig. 2 is a transverse section on the line x^2—x^2 in Fig. 1. Fig. 3 is a horizontal section on the line x^3—x^3 in Fig. 1. Fig. 4 is a transverse section of a dam showing the application of the invention to the lining of a rock fill dam.

Referring to Figs. 1 to 3, the dam comprises a fill portion 1 of loose rock or earth, sloping on both upstream and downstream faces, and a heart wall or core wall 2, extending vertically within the dam directly below the crest of the dam, said core wall being built up directly from the rock bed or sub-base 3. The core wall 2 is hollow or formed with an interior chamber or open space 4, and the two side walls 5 of said core wall preferably diverge downwardly so that this chamber is wider at the bottom than at the top. The walls 5 of the core may also be wider at the bottom than at the top, the core wall thus having steeply sloping up and downstream faces. Walls 5 are separate at the bottom, leaving the sub-base exposed.

To brace the structure and withstand the inward pressure on these walls, spreaders 6 are formed between the walls, extending from wall to wall, said spreaders being preferably arched. The hollow core wall, including the spreaders, is preferably formed of cement or concrete so as to form an integral mass, the concrete being preferably reinforced. The term cement is herein used to include all such integral molded cement construction. At its upper end this core wall may have a solid portion, indicated at 8.

To permit access to the interior of the hollow core wall, an entry passage 10 is formed in the rock at the side of the dam, this entry passage opening at one end at a convenient point for access, and opening at the other end into the interior chamber 4 in the core wall. The space between the spreaders in said chamber is of sufficient size to permit of the passage of a man in such space, and thus enable inspection of every part of the inner face of each wall of the core, as well as inspection of the rock bed or sub-base where it is exposed at the bottom of the core chamber.

To continually drain away any leakage that may occur, a drainage pipe 12 is provided extending from the lower end of the core chamber to the downstream face of the dam.

If at any time it appears from inspection of the inner faces of the walls of the core 2, particularly the upstream wall, that a leakage is taking place, the defect can be remedied by filling that portion of the core solid from wall to wall with cement or concrete. By going to the bottom of the interior chamber of the core wall, the inspector can examine the section or strip of the rock bed extending the entire length of the dam, from one side of the rock bed to the other, so that if there is seepage under the rock bed or sub-base below the dam at any point, it can be detected and can be remedied by grouting out the rock thereat and filling in with cement.

The hollow structure of the core wall has the advantage that it gives a greater transverse dimension and, therefore, a greater stability for a given weight of material as compared with a solid wall, and this increase of stability is augmented by the effect of the

slope of the core wall. The wall acts as a hollow beam, braced by spreaders 6, and is stiffer and stronger than a solid core of the same weight. This is of special value with an arched dam. The pressure of the rock fill, or of the water, as the case may be, in contact with each face of wall 1, being normal to the sloping face of the core wall, such pressure has a component directed downwardly tending to hold the core wall in position at the base and to bring the line of pressure within the base, thereby increasing the stability, both as regards longitudinal displacement and overturning. This self-bracing of the core also enables the reinforcement to be reduced to a minimum.

In applying the invention to the lining of a rock filled dam, as shown in Fig. 4, the lining 13 is formed with an interior chamber 14, with spreaders 15, extending across from the upstream wall 16 to the downstream wall 17, and said lining will conform in a general way to the shape of that face of the dam, and may be applied to either or both faces of the dam. Thus, with the form of dam shown, the lower portion of the lining is vertical and the upper portion slopes to rest on the upstream face of the upper portion of the rock fill 18 of the dam. A drain pipe 19 leads from chamber 14 of the lining, under the rock fill, to the lower end of the dam, to discharge any water leaking into said chamber. The interior of this hollow lining is reached from the outside by a passage, as shown in Fig. 1, enabling inspection of the interior chamber 14 of the lining so as to enable any leakage in the wall thereof to be detected and remedied by making that portion of the lining solid, and also to enable leakage in the sub-base to be detected and remedied, as in case of the core wall, the upstream and downstream walls of the lining being sufficiently separated to expose a strip of the rock bed or sub-base the entire length of the dam.

The hollow construction of the lining has the same advantages as above set forth for the hollow construction of the core wall, with the addition that the greater stiffness of the lining for a given weight enables it to meet the special strains brought thereon due to settling. In any case the seal wall 2 or 13 is of insufficient width, relatively to its height, to present the moment of stability required for withstanding the pressure of the water on the upstream face, the weight of the rock fill being relied on to prevent, by its lateral pressure, the overturning of the dam.

A further advantage of the hollow construction of the wall, particularly in case of the lining wall, is that it is adapted to withstand the effects of changes of temperature, the hollow wall or interior space serving as a heat insulation between the outer and inner faces so that the cracking strains due to rapid change of temperature, between the inner and outer faces of a solid wall, are obviated. With a hollow wall, moreover, any crack that forms in one wall will not extend or spread to the other wall of the core.

The essential feature of the invention resides in means for providing a wall of sufficient thickness to act as a seal but not to present the required weight and base for stability, and supporting the wall against the pressure of the water by a rock fill in such manner that a space is left between the wall and the rock fill, for inspection of the wall and for repair at points of leakage. For this purpose the invention comprises in addition to the seal wall, namely, the upstream wall 5 or 13, and the rock fill 1 or 18, a supporting or back wall, namely, the wall 5 or 13 on the downstream side of the seal wall, to receive the pressure of the rock fill and transmit it to the seal wall, this back wall being separated from the seal wall and connected thereto by the spreaders 6 or 15 so as to transmit the lateral pressure of the rock fill to the seal wall.

What I claim is:—

1. In a dam, a seal wall, the proportion of the width of said wall to its height presenting insufficient moment of stability to prevent overturning of the wall by the pressure of water exerted against its upstream face, said seal wall being formed with upstream and downstream portions separated to allow access to the back of the seal wall, a rock fill on downstream side of the wall and exerting pressure against the downstream face of the wall, and spreaders transmitting the lateral pressure of the rock fill from the downstream to the upstream portion of the wall.

2. In a dam, a seal wall built on the rock bed of the dam, the proportion of the width of said wall to its height presenting insufficient moment of stability to prevent overturning of the wall by the pressure of water exerted against its upstream face, said seal wall being formed with upstream and downstream portions separated to allow access to the back of the upstream portion of the seal wall and to the rock bed at the bottom of the dam, a rock fill on downstream side of the wall and exerting pressure against the downstream face of the wall, and spreaders transmitting the lateral pressure of the rock fill from the downstream to the upstream portion of the wall, and means for draining the space between the two portions of the seal wall.

In testimony whereof, I have hereunto set my hand at Los Angeles, California, this 26th day of December, 1907.

NEWTON L. HALL.

In presence of—
GEORGE T. HACKLEY,
FRANK L. A. GRAHAM.