W. C. FLANNERY.

CONSTRUCTION OF CONCRETE SEWERS, AQUEDUCTS, &c.

APPLICATION FILED JULY 19, 1911.

1,167,159.

Patented Jan. 4, 1916.

3 SHEETS—SHEET 1.

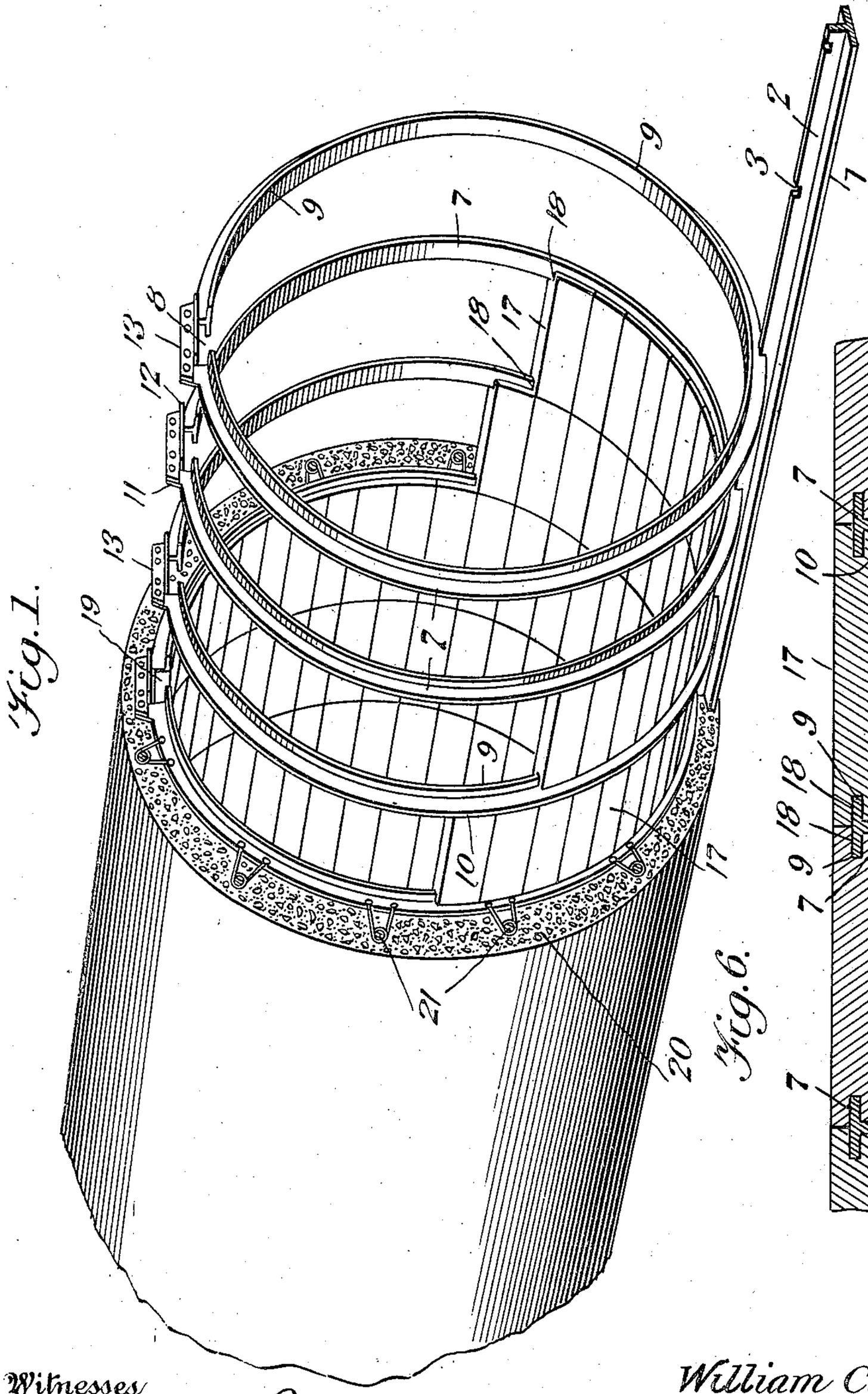

Fig. 1.

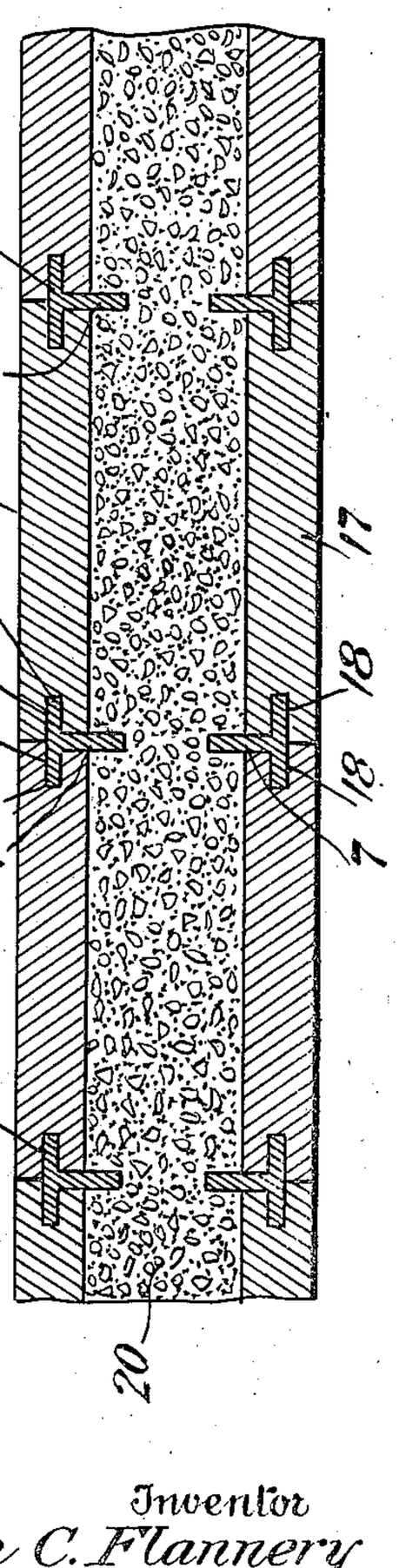

Fig. 6.

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Fig. 3.

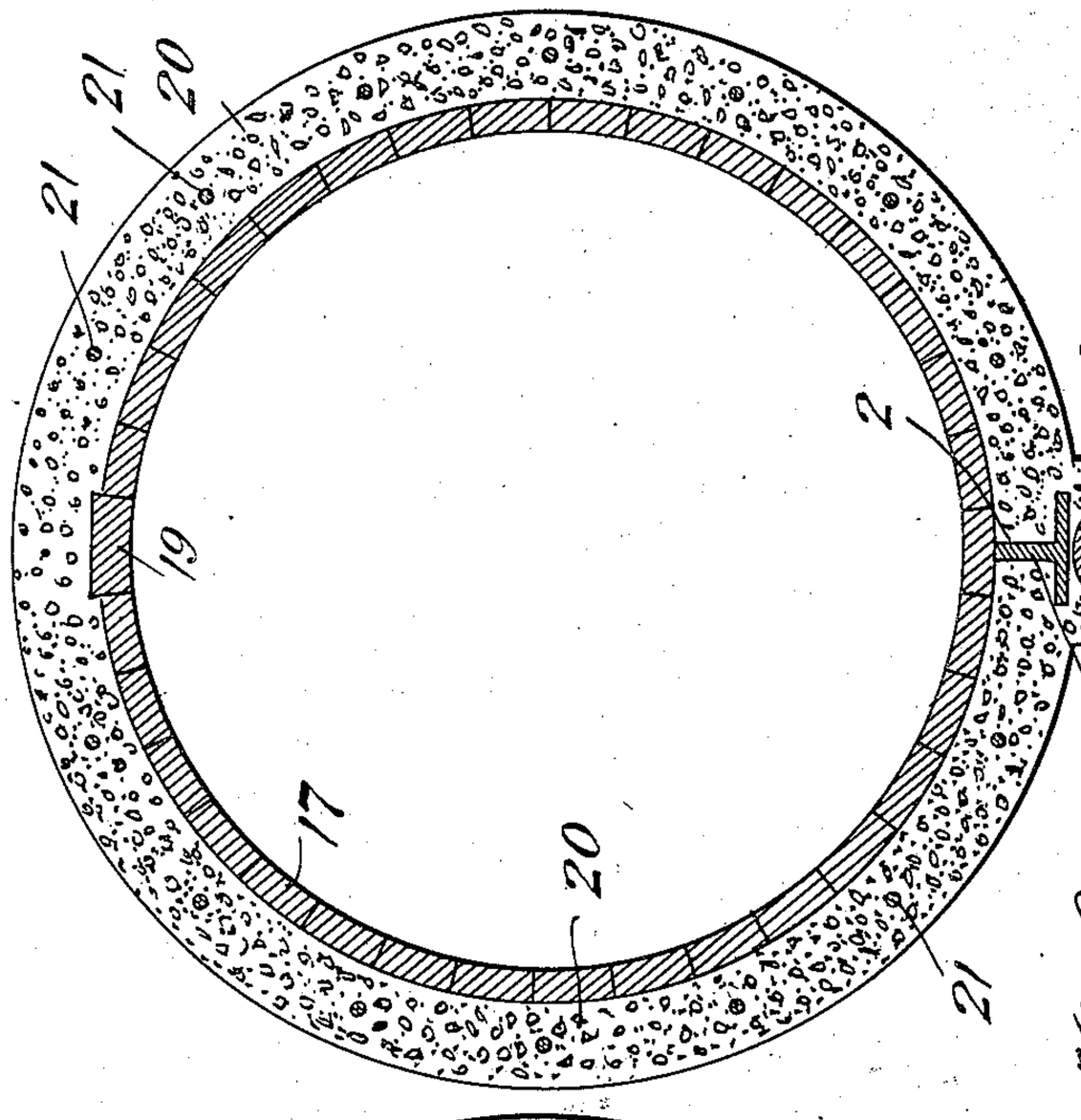


Fig. 13.

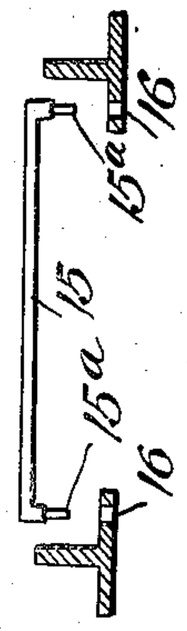


Fig. 9.

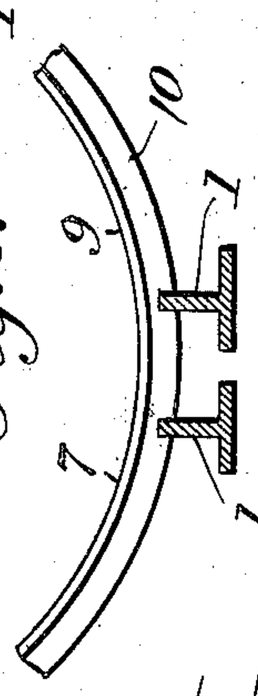


Fig. 2

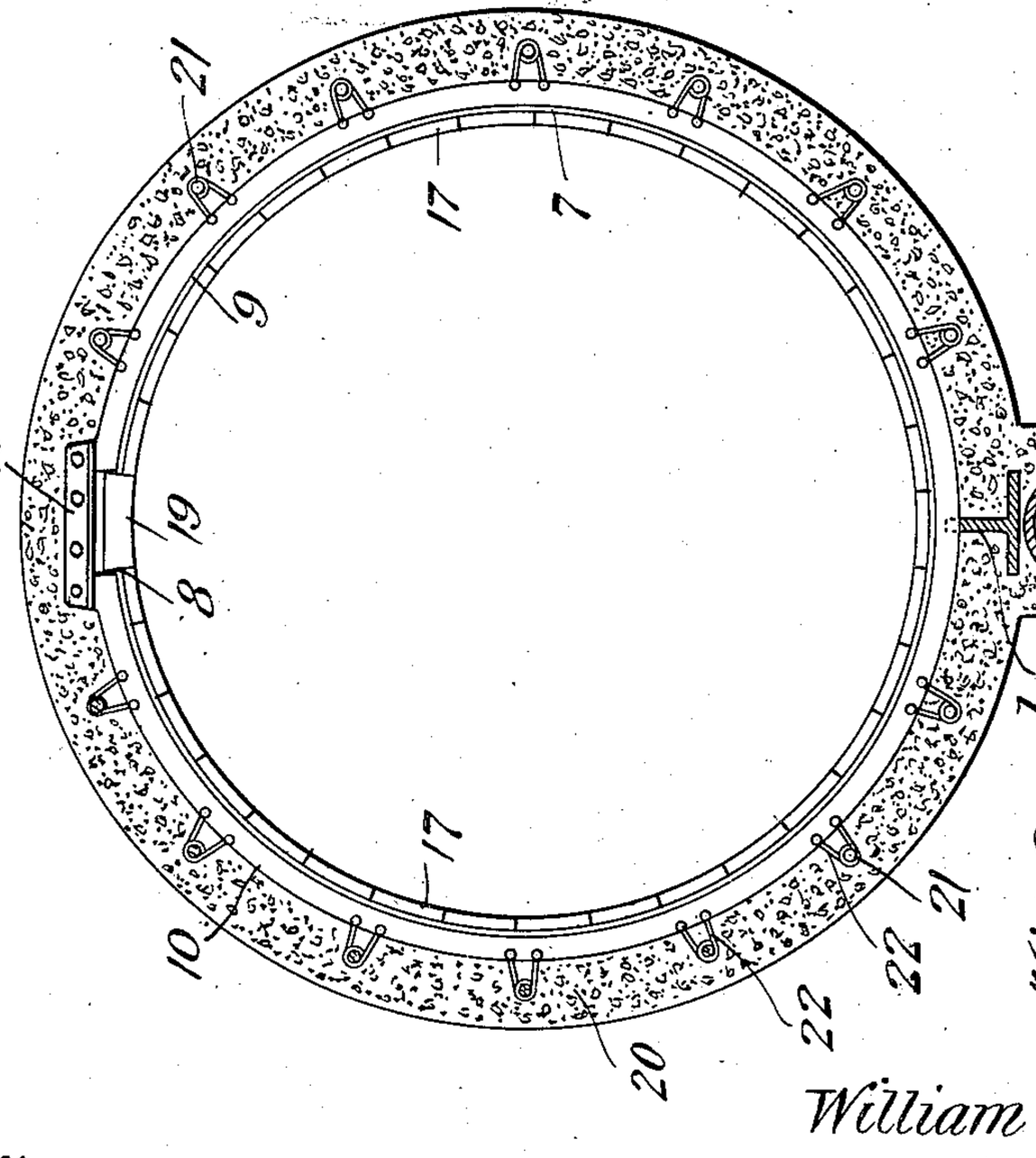


Fig. 8.

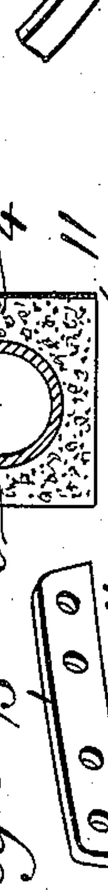
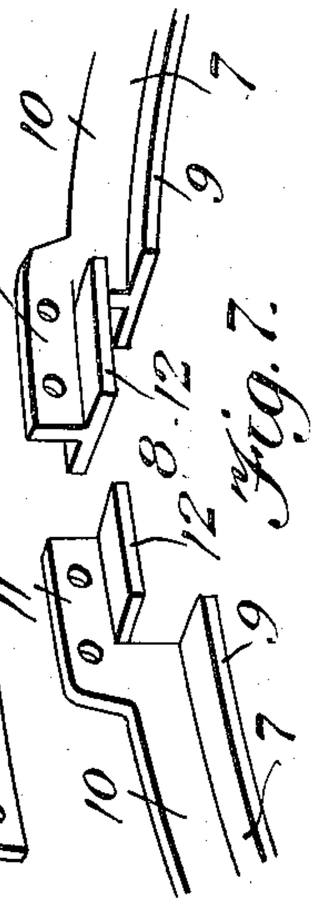


Fig. 7.



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3 SHEETS—SHEET 3.

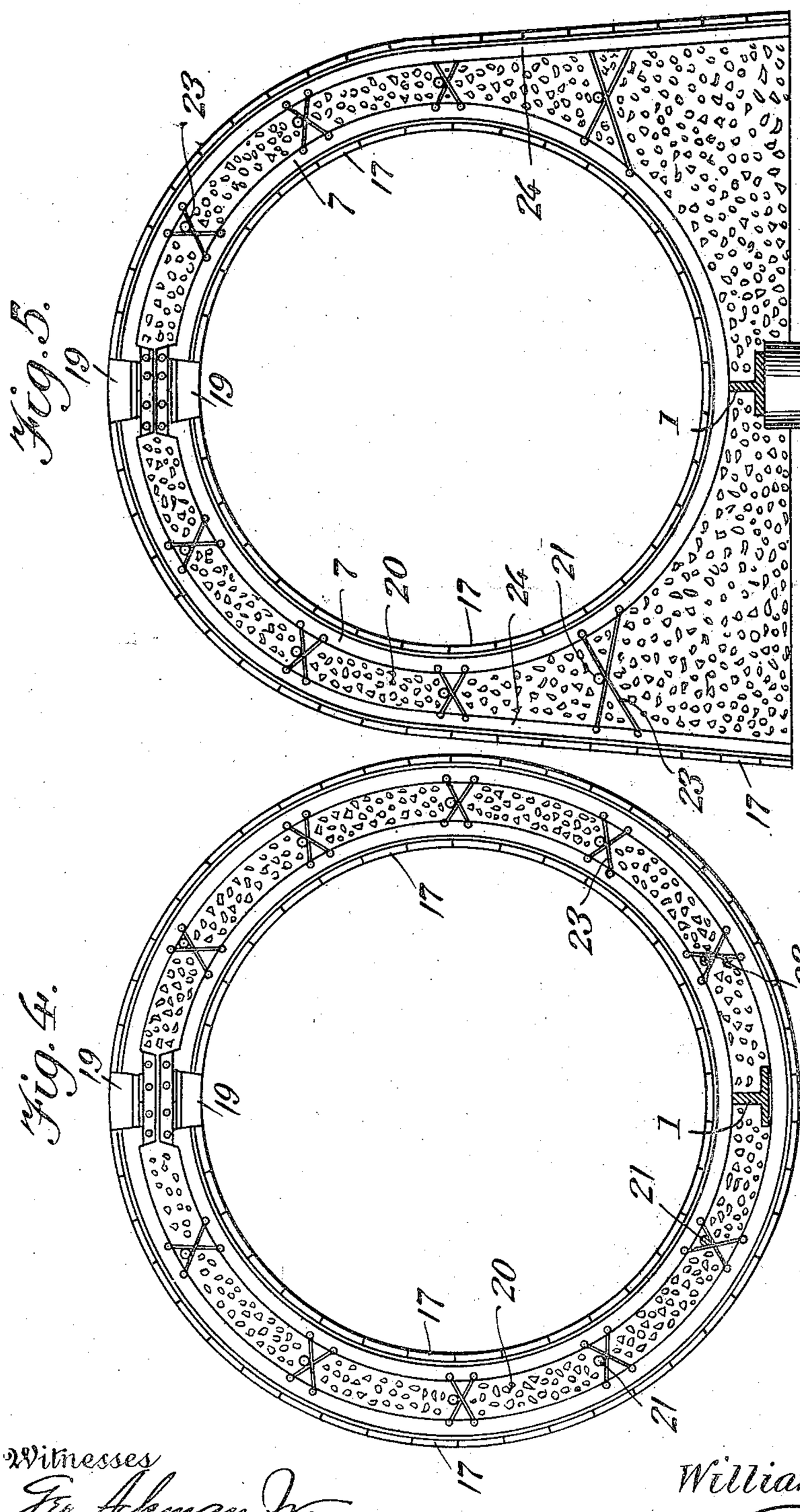

Fig. 5.

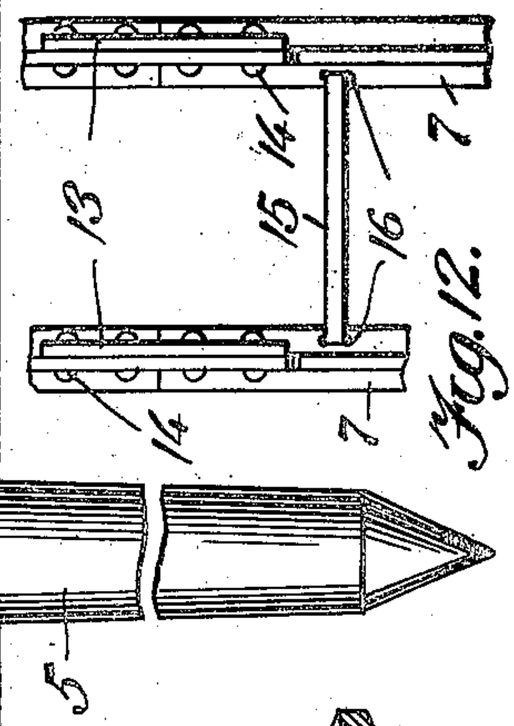

Fig. 12.

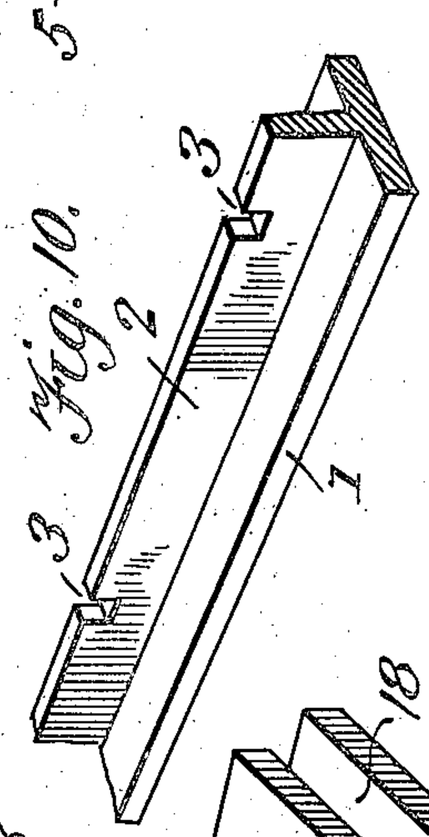

Fig. 10.

Fig. 11.

Fig. 4.

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UNITED STATES PATENT OFFICE.

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CONSTRUCTION OF CONCRETE SEWERS, AQUEDUCTS, &c.

1,167,159. Specification of Letters Patent. Patented Jan. 4, 1916.

Application filed July 19, 1911. Serial No. 639,454.

To all whom it may concern:

Be it known that I, WILLIAM C. FLANNERY, a citizen of the United States, residing at Washington, District of Columbia, have invented certain new and useful Improvements in the Construction of Concrete Sewers, Aqueducts, &c., of which the following is a specification.

My invention relates to improvements in the construction of concrete sewers of that type provided with a vitrified brick or other acid-proof lining, whereby the concrete is protected from the disintegrating action of acids and other destructive constituents of the sewage, and to a method by which the principles of construction of my invention may be rapidly, efficiently and economically carried out.

In the construction of ordinary concrete sewers as heretofore practised a trench of the required depth and width is first dug, after which a concrete base or invert is formed at the bottom of the trench. When this base or invert has thoroughly set and hardened, which usually requires about two days' time, forms for the side walls are set up and properly tied and braced, and the concrete is then filled in and tamped down about the same up to the spring line of the arch. After these walls have set and hardened which usually consumes about two days' further time, molds and centers are placed in position and properly braced and the final filling of concrete laid thereon to form the arch or crown of the sewer. When this arch has set and hardened, after another interval of two days' time, the molds and braces are removed, the interior of the sewer so constructed if to be made acid proof lined with vitrified brick, and the trench filled with dirt up to the earth line. The construction of sewers of this character as above carried out is, therefore comparatively expensive on account of the loss of time involved during the setting of the fillings of concrete, the large number of forms and amount of false-work material which must be made and carried, the amount of labor necessary in placing in position and removing the forms, and the cost of the final work of laying the vitrified brick.

The object of my invention is to provide a construction and method of building operation whereby the cost of building such sewers may be materially reduced; whereby a strong, durable and acid-proof sewer may be built at the expenditure of less time, labor and building material; and whereby the use of forms or false-work construction in the erection in the body of the sewer is avoided, the operation involving merely the erection of a skeleton framing and filling of tiles to form a shell constituting, in one and the same structure, the sewer frame, molds and acid-proof lining, about which the concrete may be continuously packed without loss of time, and without the expense and labor of setting and removing forms, braces and centers, or the usual final and expensive work of laying a brick lining.

In the accompanying drawings I have shown certain means for carrying my invention into practical effect, without, however, intending to limit the invention to the structural features which, for the purposes of exemplification, I have set forth.

In said drawings: Figure 1 is a perspective view of a section of a concrete sewer constructed in accordance with my invention, showing a portion of the sewer completed and the remainder in the course of erection. Fig. 2 is a vertical transverse section through the completed sewer, taken in the plane of one of the frame rings, hoops or ribs, and showing one form of base which may be employed. Fig. 3 is a vertical transverse section similar to Fig. 2, taken on a plane between adjacent frame rings, hoops or ribs. Fig. 4 is a view similar to Fig. 2 of a modified construction of sewer made up of inner and outer circular frames and an intermediate body or wall of concrete. Fig. 5 is a similar view of a type of double-framed sewer particularly adapted for soft earth, beds or foundations, showing also a mode of utilizing piles. Fig. 6 is a horizontal transverse section through a portion of the type of sewer shown in Fig. 4 or Fig. 5. Fig. 7 is a perspective view of the meeting ends of one of the frame rings, hoops or ribs, showing one form of construction thereof which may be employed to receive the key-bricks or tiles and to secure a rigid coupling connection. Fig. 8 is a perspective view of one of the coupling or joint plates used in conjunction therewith. Fig. 9 is a detail transverse section showing the use of a plurality of rails in forming a keel piece.

Fig. 10 is a fragmentary perspective view of the keel piece. Fig. 11 is a perspective view of one of the tiles. Fig. 12 is a fragmentary top plan view of two adjacent frame rings, hoops or ribs, showing the manner of holding the same in position during the course of building the sewer. Fig. 13 is a sectional elevation of parts shown in Fig. 12.

In the construction of a tunnel embodying the general characteristics of my invention, I provide a shell formed of a metallic skeleton framework and a body of tiles filling the open spaces thereof and arranged to form the inner face or lining of the sewer, which shell is embedded in an outer body or wall of concrete binding the parts of the shell firmly together. The skeleton framework is made up of ring sections between which the tiles are arranged and on which said tiles are supported in position, and the said ring sections are preferably mounted upon a longitudinal keel or girder, whereby they are mutually sustained and properly spaced with relation to each other. The parts of the set up framework so formed may be suitably braced and reinforced, and, if desired, inner and outer shells may be employed and the general construction and arrangement of parts may be modified in many respects, other than hereinafter stated, to meet different conditions, as circumstances require.

Referring to the drawings, 1 designates the keel, which is arranged longitudinally at the bottom of the trench, and which may consist of a single rail, as shown in Figs. 1 to 5, inclusive, or of two or more parallel rails, as shown in Fig. 9. Metal keel rails of T-form are preferably employed, and the vertical web 2 of each rail is provided with notches or seat recesses 3 at regular and desired intervals apart. In the use of a plurality of rails, the notches in the rails are arranged in transverse alinement with each other. The keel rail or rails are embedded in the concrete invert and their body portions may rest upon or be disposed immediately above a concrete base 4, as shown in Figs. 2 and 3, or upon piles 5 anchored at their upper ends in the invert, as shown in Fig. 5, said bases or piles being employed to give a firmer foundation support when or wherever a solid earth foundation is not afforded. The base 3 may inclose a conduit 6 for drainage purposes, when occasion requires.

The split rings, hoops or ribs 7 of which the skeleton framework is formed consist in the form shown of split metallic T-rails bent into form. These rings are arranged at regular intervals apart upon and transversely of the keel with their slots or open spaces 8 disposed at their highest point. As shown, the body portion of each rail faces inwardly and provides laterally extending flanges or webs 9, while the central web or flange 10 thereof projects outwardly, the said flanges 10 of the rings being seated in the notches 2 of the key.

For the purpose of enabling the ends of each ring to be coupled, and the keel-bricks or tiles hereinafter described to be fitted and held in position, the extremities of such ends may be transversely split and offset upwardly to form elevated coupling portions 11 and retaining plates 12, leaving the ends of the body portions relatively arranged to flare the spaces or openings 8. The coupling portions 11 are perforated for coöperation with one or more joint or coupling plates 13, through which coupling portions and plates, pins, bolts or rivets 14 are passed to hold the ring against expansion or contraction while the concrete is being filled in, and to impart greater stability of construction to the completed shell and sewer as a whole. This construction also adapts the rings to be adjusted or contracted to take up or compensate for any slight irregularities in the dimensions of the parts and to draw the tiles together and hold them firmly assembled. Any other suitable mode of coupling the ends of the split rings may, however, be emphasized. In order to hold the rings erect in the process of construction until the concrete is built up sufficiently to sustain the same, temporary gage and stay bars 15 (one or more) may be arranged to connect the upper portions of adjacent rings, said bars having pins or projections 15^a to engage openings 16 in the webs 9. In addition to these temporary gage and stay bars, any other temporary braces may be employed, as circumstances or conditions may require.

The spaces between the rings of the skeleton frame are filled and closed by rows of tiles 17 of vitrified clay, glass, porcelain or other suitable acid-proof material, or tiles of any suitable composite construction having acid-proof inner faces. The tiles of each row are strung upon the rings, said tiles having grooved end edges 18 to slidably engage and interlock with the flanges or webs 9 of adjacent rings. As shown, the outer walls of the grooves in the tiles abut against the webs 10 and are relatively shorter than the inner walls thereof, which abut and lap over the inner surfaces of the body portions of the rings, whereby the interior of the framework is completely covered and protected from atmospheric influences and the action of acids and other destructive constituents of the sewage. The tiles are fitted in position by disposing them between the crown portions of adjacent rings with their grooved ends inserted in the openings 8 of said rings and in alinement with the ends of the webs 9, and then sliding them onto the

ends of the webs alternately at opposite sides of the rings until the space between the rings is filled up to opposite sides of the openings 8, after which a tapered key-brick or tile 19 of ordinary or any preferred form is slid laterally into position between the ends of the rings and beneath the retaining plates 12 to close the openings 8. The tiles of successive rows may be arranged to break-joint or not, and mortar or other binding and sealing means may be employed to close any crevices which may exist between the inner walls of the grooves of adjacent tiles when it is desired to make the joints absolutely tight and fasten the inwardly projecting portions of the tiles firmly together. The shell constructed as above described is inclosed and surrounded by an outer wall 20 of concrete in which the framework and tiles are both embedded and which binds the framework and tiles solidly together, forming a practically homogeneous structure of great strength and durability and capable of resisting all earth vibrations and strains to which it may be subjected. For the purpose of securing additional strength and stability longitudinal reinforcing rods 21 may be embedded in the concrete and connected with the rings by anchor ties 22, preferably consisting of looped wires engaging the rods and perforations in the webs 10 of the rings.

As above stated, the general structure may be modified to suit special conditions. For instance, to reduce the cost of construction where a full-tiled sewer is not needed, the tiles may terminate at the spring line of the arch or at any level between the same and the crown of the arch, in which event the top of the shell may be filled and closed by cement or concrete. Also, when desired, inner and outer counterpart circular shells of the construction described may be employed, as shown in Fig. 4, which are reversed as to position to arrange the tiles of the outer shell upon the outer surface of said shell. In this case the body or wall of concrete lies between the shells and binds the component parts of both shells together. Crossed wire stays or ties 23 are provided in this construction for coöperation with the rods to connect and reinforce both shells, said ties being fastened to the adjacent webs 10 of both shells and bearing against the rods. Where soft foundation ground is encountered, and a broad solid concrete base or invert is used to provide a solid bed or support for the sewer, as shown in Fig. 5, the frame elements of the outer shell, in a double-shelled type of sewer, may be in the form of arched T-rails 24 split and constructed at the crown like the frame rings, and on which the tiles may be strung in the manner before described. In some cases plain rings or bands may be employed and the tiles suitably fastened thereto. These and other modifications, and variations required by special conditions, are held to fall within the spirit and scope of my invention.

In the construction of a simple type of sewer embodying my invention, the keel or girder is first laid at the base of the trench, the frame rings or elements set up and braced and the tiles slipped into position. After a sufficient number of tiles to close the bottom of the skeleton frame are inserted, the concrete to form the base or invert is filled in and packed. The operation of applying the tiles is meanwhile continued, and, as the tiles are inserted upwardly at the sides, the concrete is filled in and tamped, whereby the operation of building up the sides of the concrete wall is made continuous with the closing of the sides of the shell by the tiles. When the tiles have been filled up to the sides of the openings 8, the key-bricks or blocks are inserted and the concrete to form the arch or crown of the outer wall filled in and tamped, after which the trench is filled with earth up to the ground line in the usual manner. This operation is the same in building all forms of sewers embodying the features of my invention, except where it is first necessary to prepare a special foundation by driving piles or forming concrete bases, the parts of the two shells in the double-shell construction disclosed being simultaneously assembled in the erection of the sewer. The reinforcing stays and ties are, of course, placed in position as the concrete wall is built up, but it will be seen that as the shell or shells and concrete wall are simultaneously in course of construction no loss of time is experienced, as in ordinary sewer construction, as a result of the necessity of separately building portions of the concrete wall and allowing time for the same to set and harden. Moreover, as the shell constitutes, in a unitary structure, the frame and lining of the sewer, as well as a form about which the concrete wall is built, the necessity of constructing, carrying, erecting and removing forms, centers, interior braces and other similar false-work is avoided, as well as the ordinary final work of laying a brick lining. By my construction and process of building, the cost of erecting sewers of the character described is materially reduced, and at the same time a simpler, stronger, more durable and otherwise superior type of sewer is provided.

In some cases the tiles may be assembled and cemented or locked together without the use of a framework and the concrete filled about the conduit formed thereby. The inner faces of the tiles will then form the acid-proof lining.

It will be seen from the foregoing description that my invention provides an acid-proof-lined sewer which, in addition to the above-noted advantages, can be built under-

ground, overground, or on a trestle without the assistance of shields or jacks, and wherein the use of any temporary supports or forms is obviated. Furthermore, the method of construction disclosed obviates the necessity of building slowly in small sections and enables the work of setting up the frame rings, applying the tiles and pouring the concrete to be carried on simultaneously and continuously for any length or distance desired, with the advantage of effecting an enormous saving of time and expense and the production of a monolithic concrete pipe, whereby the stability of the structure is greatly increased. My method of construction also provides for the formation of the inner wall and acid-proof lining at one and the same time, as well as the homogeneous binding of the parts together, as the frame and rear faces of the tiles are left exposed in assembling the same, so as to cause both the frame ring and the tiles to be bound together by the concrete. This method of construction also permits of sewers of large diameter being constructed without danger of leaky joints, as the tiles will fit snugly together, whereas in the construction of large sewers in which the bricks or tiles are finally laid on the interior gaps are invariably left which must be closed by mortar or cement, which in course of time will be destroyed by the action of the acid.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. In a sewer, aqueduct or like conduit construction, the combination of a longitudinally extending frame girder, vertical transverse frame members supported and held in spaced relation by said girder, tiles supported by and closing the space between said frame members, and an outer wall of concrete in which the aforesaid parts are invested.

2. A sewer, aqueduct or like horizontal conduit including a longitudinally extending girder, vertical, transverse rings or bands arranged at spaced intervals along the girder, an inner wall or lining of tiles supported by and internally filling the spaces between the rings or bands, and an outer wall of concrete in which said girder, rings or bands and tiles are embedded.

3. A sewer, aqueduct or like horizontal conduit including a longitudinally extending girder, vertical, transverse circumferentially adjustable rings or bands arranged at spaced intervals along the girder, an inner wall or lining of tiles supported by and internally filling the spaces between the rings or bands, and an outer wall of concrete in which said girder, rings or bands and tiles are embedded.

4. A sewer, aqueduct or like horizontal conduit comprising a horizontal girder extending longitudinally along the line of the trench, vertically arranged frame rings or bands supported transversely of and at spaced intervals along the girder, an inner wall formed of tiles supported by the frame rings or bands, and an outer inclosing wall of concrete in which the girder, frame rings or bands and tiles are embedded and by which they are additionally supported.

5. A sewer, aqueduct or like horizontal conduit comprising a horizontal girder extending longitudinally along the line of the base of the trench, said girder being provided at spaced intervals with seats, vertically arranged spaced frame rings or bands resting in said seats, an inner wall formed of tiles supported by the frame rings or bands, and an outer inclosing wall of concrete in which the girder, frame rings or bands and tiles are embedded and by which they are additionally supported.

6. A sewer, aqueduct or like horizontal conduit comprising a horizontal girder extending longitudinally along the line of the trench, said girder having a vertical flange or web provided at intervals with seats, vertically arranged frame rings or bands arranged at intervals corresponding to and having flanges engaging said seats, an inner wall formed of tiles supported by the frame rings or bands, and an outer inclosing wall of concrete in which the girder, frame rings or bands and tiles are embedded and by which they are additionally supported.

7. A sewer, aqueduct or like horizontal conduit including a horizontal, longitudinally extending supporting and spacing girder, vertical rings extending crosswise of and connected with the girder at spaced intervals, tiles supported by the rings and forming the inner sewer wall, and a concrete outer wall enveloping the girder, rings and tiles, and in which the same are rigidly embedded.

8. A sewer, aqueduct or like horizontal conduit comprising an outer inclosing wall or body of concrete, a horizontal longitudinally extending girder embedded therein, vertically arranged rings or bands extending transversely of and connected at fixed intervals with the girder, said rings or bands being fastened in the concrete wall, and tiles fastened to and extending around and between the rings or bands, and also fastened in the concrete wall.

9. A sewer, aqueduct or like horizontal conduit comprising an outer inclosing wall or body of concrete, a horizontal longitudinally extending girder embedded therein, vertically arranged rings or bands extending transversely of and connected at fixed intervals with the girder, said rings or bands being fastened in the concrete wall, tiles fastened to and extending around and between the rings or bands and also fastened in the

concrete wall, and reinforcing elements embedded in the concrete wall outside said rings or bands and secured to the peripheries of the latter.

10. A sewer, aqueduct or like horizontal conduit comprising an outer inclosing wall or body of concrete, a horizontal longitudinally extending girder embedded therein, vertically arranged rings or bands extending transversely of and connected at fixed intervals with the girder, said rings or bands being fastened in the concrete wall, tiles fastened to and extending around and between the rings or bands and also fastened in the concrete wall, and longitudinal rods embedded in the concrete wall outside of and secured at points to the peripheries of the rings or bands.

11. A sewer, aqueduct or like horizontal conduit comprising an outer inclosing wall or body of concrete, a horizontal longitudinally extending girder embedded therein, vertically arranged rings or bands extending transversely of and connected at fixed intervals with the girder, said rings or bands being fastened in the concrete wall, tiles fastened to and extending around and between the rings or bands and also fastened in the concrete wall, longitudinal reinforcing rods embedded in the concrete wall outside of and about the rings or bands, and ties embedded in the concrete wall and connecting the rods with the peripheries of the rings or bands.

12. A sewer, aqueduct or like horizontal conduit comprising an outer inclosing wall or body of concrete, a horizontal longitudinally extending girder embedded therein, vertically arranged split rings or bands extending transversely of and connected at fixed intervals with the girder, said rings or bands being fastened in the concrete wall, couplings uniting the free ends of the rings or bands, and rows of tiles extending around and between the rings or bands and having grooved edges engaging the same, said tiles being also fastened in the concrete wall.

13. A sewer, aqueduct or like horizontal conduit comprising an outer inclosing wall or body of concrete, a horizontal longitudinally extending girder embedded therein, vertically arranged split rings or bands extending transversely of and connected at fixed intervals with the girder, said rings or bands having outwardly projecting flanges embedded in the concrete wall, couplings connecting the free ends of the flanges and extending across the openings in the rings or bands, tiles arranged in rows between the rings or bands and fastened in the concrete wall, said tiles having grooved edges engaging the rings or bands, and key blocks fitted in the openings in the rings or bands between the terminal tiles of the rows.

14. A sewer, aqueduct or like horizontal conduit comprising an outer inclosing wall or body of concrete, a horizontal longitudinally extending girder embedded therein, vertically arranged split rings or bands extending transversely of and connected at fixed intervals with the girder, said rings or bands having outwardly projecting flanges embedded in the concrete wall, couplings connecting the free ends of the flanges and extending across the openings in the rings or bands, tiles arranged in rows between the rings or bands and fastened in the concrete wall, said tiles having grooved edges engaging the rings or bands, and key blocks fitted in the openings in the rings or bands between the terminal tiles of the rows, and reinforcements connected with the rings or bands and embedded in the concrete wall.

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

WILLIAM C. FLANNERY.

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ROSE GROGAN.