Sept. 14, 1926. 1,600,179

C. F. A. INGERSLEV

CONCRETE BLOCKS AND STRUCTURE BUILT THEREOF

Filed Nov. 24, 1925 3 Sheets-Sheet 1

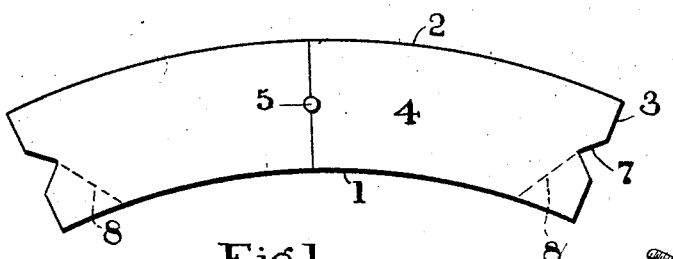


Fig.1.

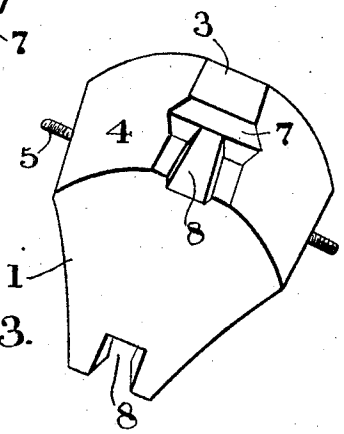


Fig.3.

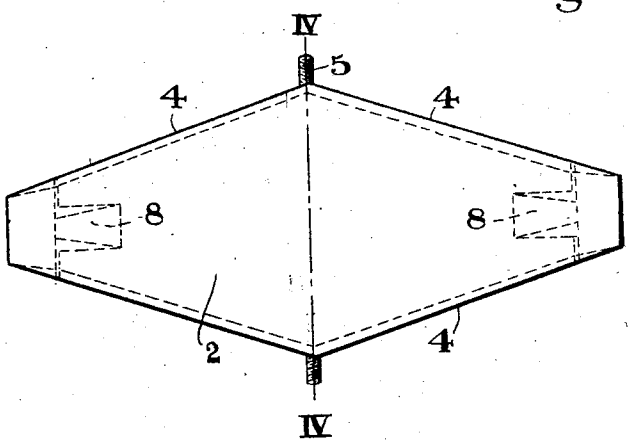


Fig.2.

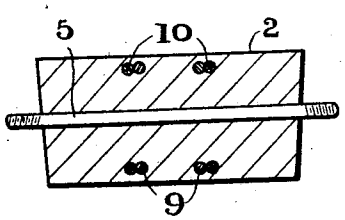


Fig.4.

INVENTOR

C.F.A. INGERSLEV

BY

ATTORNEY

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C. F. A. INGERSLEV

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Fig.5.

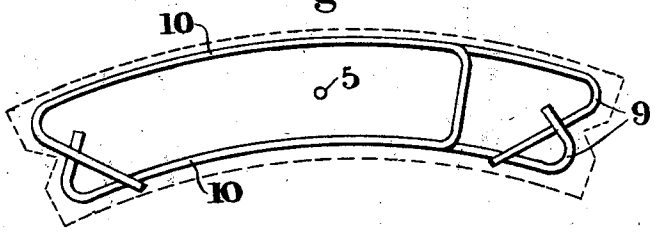


Fig.6.

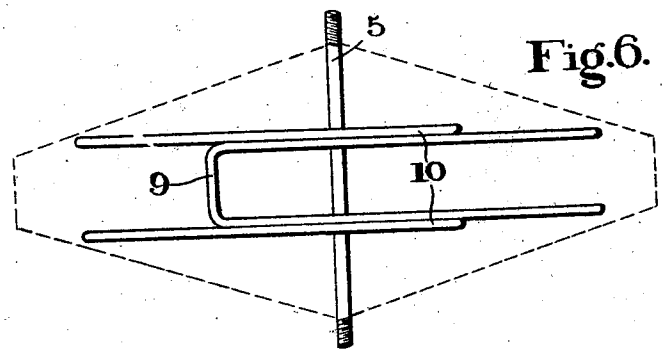


Fig.7.

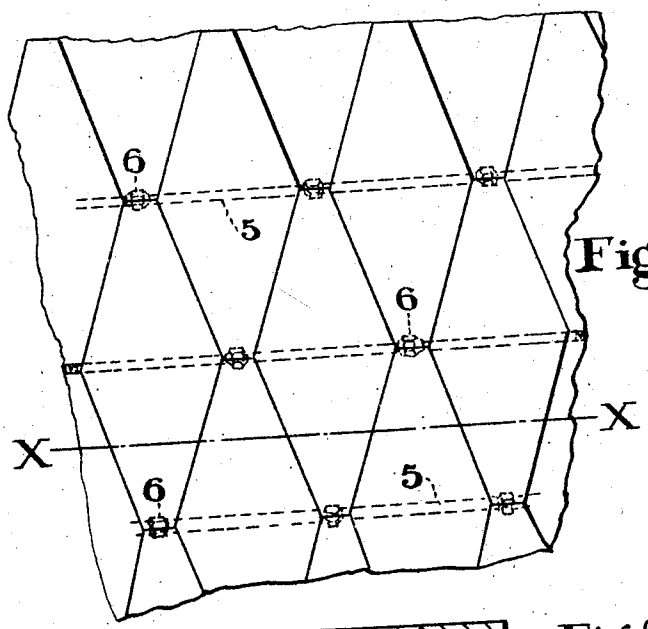
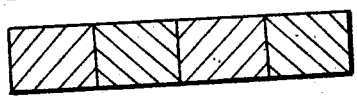


Fig.8.



INVENTOR
C. F. A. INGERSLEV

BY

ATTORNEY

Sept. 14, 1926. 1,600,179

C. F. A. INGERSLEV

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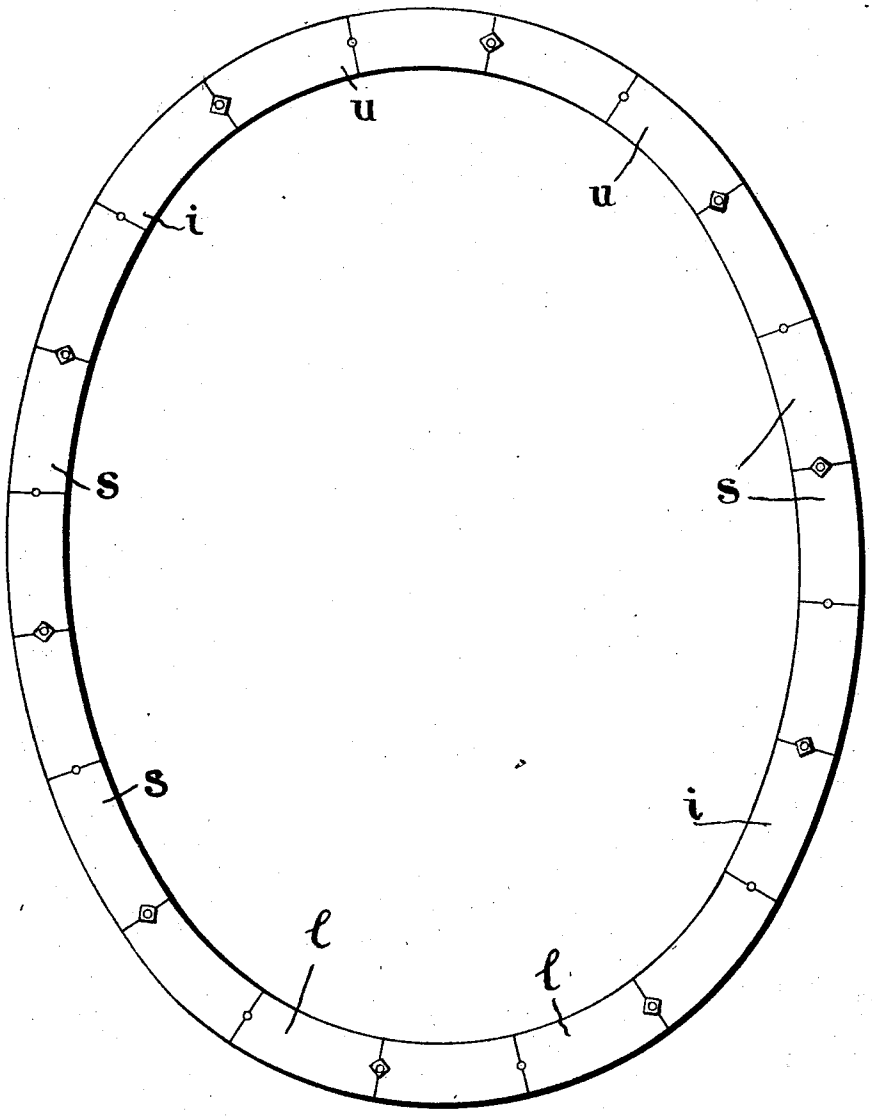


Fig.9.

INVENTOR
C.F.A. INGERSLEY,
BY
ATTORNEY

Patented Sept. 14, 1926. 1,600,179

UNITED STATES PATENT OFFICE.

CHRISTIAN FREDERIK AAGE INGERSLEV, OF WESTMINSTER, LONDON, ENGLAND.

CONCRETE BLOCKS AND STRUCTURE BUILT THEREOF.

Application filed November 24, 1925, Serial No. 71,182, and in Great Britain November 12, 1924.

This invention relates to concrete blocks, usually reinforced with metal members, and to structures built with such blocks arranged in courses, for example, tunnel linings, walls, floors and so forth.

In tunnel linings the courses are usually arranged in the form of rings and the term course is used in this specification and in the claims to include rings where such is applicable.

Attempts have been made to build structures such as above referred to with blocks provided with tongues and recesses on and in their sides so that each block or course of blocks is so interlocked with adjacent blocks or courses that loads are transmitted from one block or course to the other and the blocks are capable of resisting bending moments due to the stresses transmitted.

The object of the invention is to obtain these effects without the use of tongues which are liable to fracture, namely, by using blocks having plain sides and setting up sufficient friction between the sides of adjacent blocks to permit of the necessary transmission.

With this object in view the blocks of alternate courses, or those of all alternate courses, are drawn towards one another by metal ties so that they clamp the blocks of the intervening courses between them. The blocks are preferably increased in width at their centres so as to increase their resistance to bending moments at those parts and to provide at any cross-section just enough material for the strain on that section. The ties connecting the blocks of alternate courses pass between the adjoining ends of the blocks of the intervening course and are united preferably at these positions by tension devices. The ties may be interlocked with the ends of these blocks, so as to afford support for them.

By uniting the ties at these positions and providing the ends of the blocks with openings to permit of access to the ties and their unions, erection is facilitated, the openings being subsequently filled in with cement grout when a continuous surface is required.

Although the sides of the blocks are herein referred to as plain, this does not necessarily mean smooth surfaces as the plain sides may be roughened or otherwise adequately prepared in a manner well known in the art for the reception of cement grout. The plain sides of the blocks may be so shaped as hereinafter described that they effect a keying action.

The invention is not limited to any particular shape of block but a substantially rhombic form is particularly suitable. The outer and inner faces of the blocks may be flat or curved to suit the contour of the lining, wall or other structure, for instance, for a lining of circular cross section all the blocks are of the same curvature but for a lining of non-circular or oval cross-section the upper and lower blocks, for example, may be of different curvature from that of the side blocks, the blocks which are intermediate of these differently curved blocks being curved partly to correspond to one curvature and partly to the other.

The ties may form the only reinforcement for the blocks but additional reinforcement may be used according to requirements.

The ties are preferably formed in short lengths set in the blocks during moulding and adapted to be coupled during building so as to set up the required tension.

In the accompanying drawings:—

Figures 1 and 2 are, respectively, a side elevation and a plan of one form of block according to the invention suitable for tunnel lining.

Figure 3 is an elevation projected on a plane parallel to one end face.

Figure 4 is a cross section on IV—IV, Figure 2.

Figure 5 and 6 show, respectively, an elevation and plan of one form of metal reinforcement which may be adopted for the block shown in the previous figures, the outline of the block being indicated in dotted lines.

Figure 7 is a diagram indicating a number of flat blocks built together.

Figure 8 is a cross-section on X—X Figure 7.

Figure 9 is a cross-section illustrating by way of example a lining of oval cross-section built with blocks of different curvature.

The form of block illustrated in Figures 1 to 4 has inner and outer cylindrical surfaces 1 and 2 of substantially rhombic form in plan, the acute angles of the rhombuses being cut off to enable end faces 3, 3, to be formed, each having a general surface radial to the centre of curvature of the surfaces 1 and 2. The mid-cross section of

the block and the end cross sections are trapezoidal but the trapezoidal section at the middle is in reverse relation to that at each end, for example, it will be seen from Figure 3 that the end face is substantially a trapezoid with the smaller of the parallel sides uppermost while the cross section of the middle of the block as seen in Figure 4 is a trapezoid with the larger of the parallel sides uppermost. A cross section midway between these two parts would be a rectangle.

Each of the four sides 4 is plain but in this example the peculiar form of the sides effects a keying action with the corresponding sides of adjacent blocks against a force acting on the centre of the block and directed towards the axis of the tunnel.

Each block is provided with a central tie-rod 5, the projecting ends being screw threaded with threads of opposite hand so that when the blocks are set together with their lateral jointing faces 4 in contact the tie-rods 5 of the blocks of alternate courses can be coupled by unions 6 and drawn together firmly so that they clamp the blocks of the intermediate course between them.

The blocks have notches 7 in their end faces to receive the ends of the tie rods and unions, and with notches 8 to permit of access to the unions during building. These notches may be filled in ultimately with cement grout. The tie-rods of the blocks of two alternate courses thus provide a support for the adjacent ends of the blocks of the intermediate course, in addition to the mutual support afforded by the abutting of the adjacent end faces 3, 3.

When the blocks are being set or erected the jointing faces are preferably washed with cement grout.

The outer and inner faces 1, 2, of the blocks may be flat or curved according to the nature of the structure to be built or lined, and when a tunnel of oval cross-section for example is to be lined some of the blocks may be of different curvature from others. In the example shown in Figure 9 two upper and lower blocks *u*, *l*, of each course are of a smaller radius than two side blocks *s* of the same course, while the blocks *i* intermediate of the side blocks and the upper and lower blocks, are partly of the curvature of the side blocks and partly of that of the upper and lower blocks, so that their adjacent parts conform to one another and their adjacent lateral meeting faces make tight joints and effect keying in the manner above described.

The blocks may be reinforced in any suitable way. In the example shown in Figures 5 and 6 the reinforcement comprises steel rods bent to form two frames 9 and other rods bent to form frames 10, 10, the frames being set as shown. This arrangement is convenient as the frames are mutually supported in the mould.

Figures 7 and 8 show somewhat diagrammatically a number of flat blocks with their tie rods connected by unions 6. The flat blocks may be reinforced in any suitable manner. They have vertical sides 4 and are of rectangular cross section throughout. When such blocks are suitable for floors or roadways the tie rods need not have screw threaded unions as, other forms of union may be used.

The adjacent ends of the blocks may be spaced apart and the spacing be varied when the courses have to be set out of parallelism to allow for curves or other peculiar conditions.

I claim:—

1. A structure composed of concrete blocks arranged in courses, with the blocks of an intermediate course fitting in between the blocks of adjacent courses, the blocks of any one course being normally held in wedging and spaced relation by the blocks of the next adjacent course, and means for drawing the spaced blocks of any two alternate courses relative to adjacent blocks of that course to thereby wedge the blocks of the intermediate course.

2. A structure composed of courses of concrete blocks and metal ties adapted to draw blocks of alternate courses towards one another for the purpose of clamping the blocks of intervening courses between them, each of said blocks being of maximum width at a position intermediate of its ends for the purpose of increasing the resistance to bending moments at that part and said metal ties passing through said blocks at said positions of maximum width, substantially as hereinbefore set forth.

3. A structure composed of courses of concrete blocks and metal ties adapted to draw blocks of alternate courses towards one another for the purpose of wedging the blocks of intervening courses between them, said blocks each having a metal tie passing through it, and tension devices for uniting the adjacent ends of the metal ties of the blocks of alternate courses, substantially as and for the purpose hereinbefore set forth.

4. A structure composed of courses of concrete blocks, said blocks having plain sides and being set so that the ends of the blocks of one course are opposite to the centres of the blocks of adjacent courses, and metal ties passing through the centres of the blocks of alternate courses and between the ends of the blocks of the intervening courses, said ties being adapted to draw said blocks of alternate courses towards one another for the purpose of clamping said blocks of the intervening courses between them, substantially as hereinbefore set forth.

5. A structure composed of courses of

concrete blocks, said blocks having plain sides and being of greater width at their centres than at their ends, metal ties embedded in said blocks and projecting from the sides thereof at positions intermediate of their ends, said ends of said blocks being provided with notches, said blocks being set so that the ends of blocks of one course are opposite to the centres of the blocks of adjacent courses and the metal ties of the blocks of alternate courses enter the notches in the ends of the blocks of intervening courses, substantially as and for the purposes hereinbefore set forth.

6. A structure composed of courses of concrete blocks of substantially rhombic form in plan and having plain sides, said blocks having metal ties embedded therein and projecting from two lateral edges, and means for joining the adjacent ends of the ties of the blocks of alternate courses for the purpose of drawing said blocks towards one another to clamp the blocks of intervening courses between them, substantially as hereinbefore set forth.

7. A structure composed of courses of concrete blocks having a substantially rhombic form in plan, plain sides and curved inner and outer faces, and provided with metal ties for the purpose of tying the blocks of alternate courses together and clamping the blocks of one course between those of two adjacent courses, substantially as hereinbefore set forth.

8. A structure composed of courses of concrete blocks, the blocks of all alternate courses being tied together and formed to wedge the blocks of intervening courses between them, each block being of substantially rhombic form in plan, having plain sides, curved inner and outer faces, and trapezoidal cross sections at the middle and at the ends, the trapezoidal mid section being in reversed relation to that of each end section, substantially as and for the purpose hereinbefore set forth.

9. A tunnel lining composed of rings of concrete blocks and metal ties which draw the blocks of all alternate rings towards one another to wedge the blocks of intervening rings between them, said blocks being curved on their inner and outer faces, blocks of different parts of the lining being of different curvature, and other blocks of other parts of the tunnel intermediate of and joining the said blocks of different curvature, each having a curvature corresponding in part to that of the blocks with which it joins, substantially as and for the purpose hereinbefore set forth.

10. A tunnel lining composed of rings of concrete blocks and metal ties which draw the blocks of all alternate rings towards one another to wedge the blocks of intervening rings between them, said blocks being of substantially rhombic form in plan, having plain sides and curved inner and outer faces, the curvature of the inner and outer faces of the blocks of the upper and lower parts of the lining being different to that for the inner and outer faces of the blocks for the sides of said lining, the blocks intermediate of and connecting the upper and lower parts of the lining to the blocks of the sides thereof having their inner and outer faces of a curvature corresponding in part to that of the blocks with which they join, substantially as and for the purpose hereinbefore set forth.

11. A concrete block for use in building walls, linings and floors, having a substantially rhombic form in plan, plain sides, curved inner and outer faces, and cross sections at the middle and ends of relatively reversed trapezoidal form, said block also having a metal tie passing laterally through the block at its middle trapezoidal section, substantially as and for the purpose hereinbefore set forth.

In testimony whereof I have signed my name to this specification.

CHRISTIAN FREDERIK AAGE INGERSLEV.