

J. G. F. LUND.
STRAIGHT VAULT.
APPLICATION FILED FEB. 10, 1908.

Patented June 4, 1912.
3 SHEETS—SHEET 1.

1,028,578.

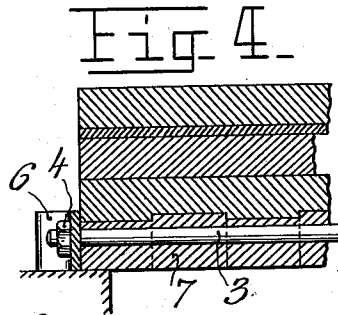
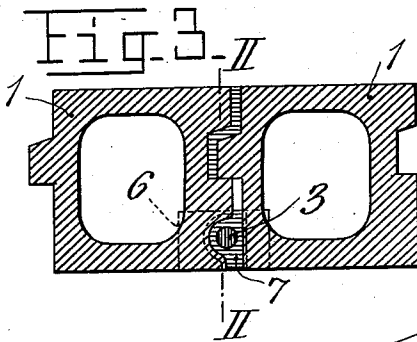
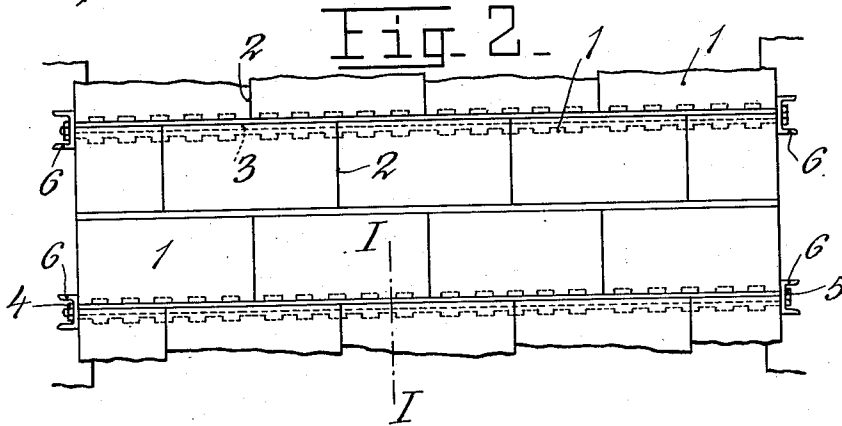
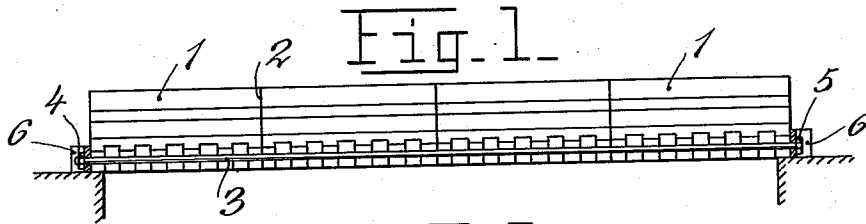
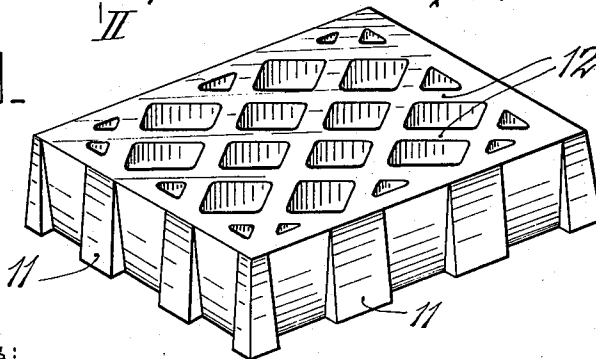


Fig. 9.



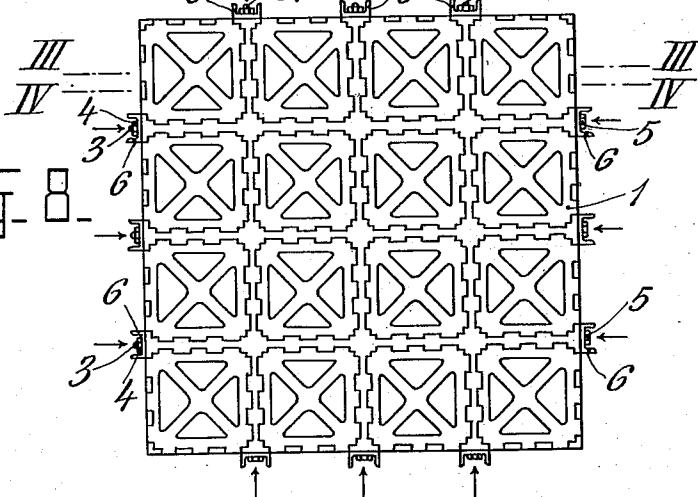
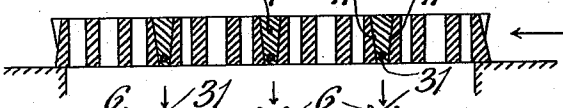
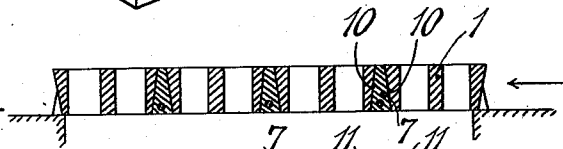
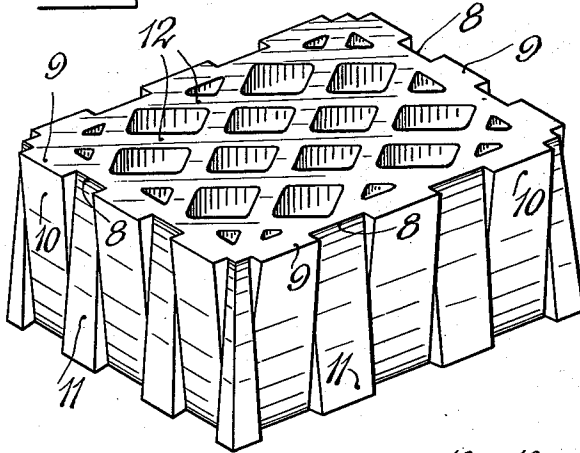
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3 SHEETS--SHEET 2.



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3 SHEETS-SHEET 3.

Fig. 10.

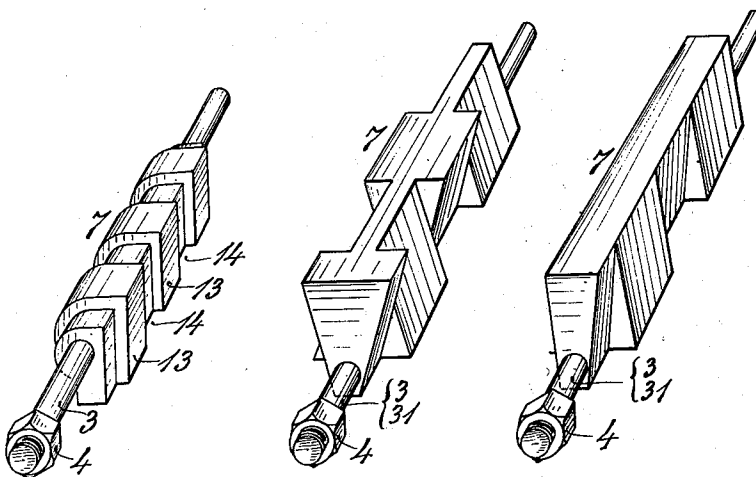
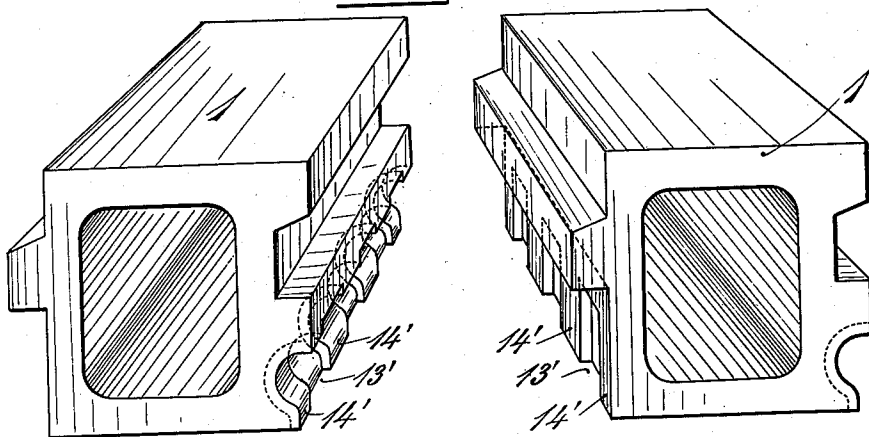


Fig. 11.

Fig. 12.

Fig. 13.

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UNITED STATES PATENT OFFICE.

JENS GABRIEL FREDRIK LUND, OF CHRISTIANIA, NORWAY.

STRAIGHT VAULT.

1,028,578.

Specification of Letters Patent.

Patented June 4, 1912.

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To all whom it may concern:

Be it known that I, JENS GABRIEL FREDRIK LUND, engineer, citizen of the Kingdom of Norway, residing at Björn, Farmands gade 2, city of Christiania, Norway, have invented a new and useful Improvement in Straight Vaults; and I do hereby declare the following to be a full, clear, and exact description of the same.

The object of my invention is to provide a method for preventing, so far as can be done, cracks occurring in straight vaults built of brittle material, when perfectly steady supports cannot be obtained. This has been heretofore attempted by the use of reinforced concrete construction. In order that such construction be durable and safe, it is absolutely necessary that the iron parts be completely covered by concrete free from cracks, and thereby hermetically protected against the influence of moisture, heat, fire, and the like. It has been found by experiment, however, that the capability of extension of the concrete is not increased by iron reinforcement, but minute cracks are formed at comparatively small strains of the iron (about 250-350 kg. per square cm.) In many constructions in which the iron reinforcing cross-section is very large compared with the area of the stretched concrete, the cracks often appear soon after the centering has been removed and the normal load begins to act. On account of the vault being frequently loaded and unloaded the cracks will be successively increased, and as the cracks permit the moisture to reach the iron parts, these latter will be consumed by rust and weakened. Moreover, the cracks are a source of danger to the stability of the construction, in case of conflagrations, because the gases of combustion have direct access to the unprotected iron. If the formation of cracks shall be prevented under normal load, the cross-sectional area of the iron reinforcement must be low compared with the area of the stretched concrete, or the iron must be loaded to a very low strain. Both arrangements result in heavy and consequently expensive constructions.

The object of the present invention is to provide a construction of straight vaults, which may be freely supported without cracks being formed in the mortar covering placed around the necessary iron reinforcements, when the strength of the latter is to

be fully utilized, for instance, up to a strain of 1000-1200 kg. per square cm.

The invention is illustrated in the accompanying drawing, in which:

Figure 1 is an elevation, Fig. 2, a plan view of part of a straight vault constructed according to my invention. Fig. 3 is a cross-sectional view on the line I—I in Fig. 2, drawn to an enlarged scale. Fig. 4 is part of a vertical section on the line II—II in Fig. 3. Fig. 5 is a perspective view of a suitably formed block or stone, which is used when the vault is to be reinforced in two directions. Fig. 6 is a sectional view on the line III—III, of Fig. 8, through a vault which is built up of stones of the type shown in Fig. 5. Fig. 7 is a similar sectional view, on the line IV—IV in Fig. 8. Fig. 8 is a plan view of rectangular vault, and Fig. 9 is a perspective view showing a modified stone or block. Figs. 10, 11, 12 and 13 illustrate the shape of the mortar covering and of the coacting parts of the block.

The straight vault is assumed to be built up of one or more large or small parts ready to lay, for instance, blocks of brick, lime-sandstone, concrete, etc.

Referring to the drawing, 1 are hollow blocks laid in parallel rows between the supports of the arch and provided with tongues and grooves engaging each other, the joints 2, being in bond.

3 is a tie-bolt, provided with a nut 4 and a head 5.

6 are stiff washer plates, against which is screwed the nut 4 of the tie-bar 3.

7 is a monolithic cement covering hardened only after the rod 3 has been stretched.

8, 9, 10 and 11 are teeth and grooves fashioned on certain forms of separate blocks, and 12 are diagonal stiffening parts to enable the hollow block to better sustain a lateral pressure or strain.

The distinguishing feature of my invention, and the one in which it differs from all previously known, is the fact that into the bottom of the blocks I insert tie-rods 3, under strain, but before stretching the rods I surround them with a mortar covering, having projections, which engage in depressions in the blocks, and then, before the mortar covering is hardened, I stretch the rods. In this manner the covering, being unhardened, will not take up any strain,

but the force is transmitted through the washer plates 6 to the block material and compresses it at the bottom. Now, when the cement hardens, it hardens onto the tie-rod, which is stretched as far as it is deemed best. This gives the tie-rod a covering that is under no strain, nor under pressure longitudinally; but the adjacent blocks, into whose grooves the mortar covering has already set, are under pressure at their bottom. The covering should, therefore, not have a tendency to crack, until the load on top has stretched the tie-rod beyond the point to which it has been formerly stretched, before the covering hardened. Then, when the rod moves, it also carries all the blocks connected therewith by the mortar projections and acts upon the blocks slowly and independently of the adhesion between the blocks and the cement covering. In this way cracking of the cement covering of the rod 3 is minimized to the highest possible extent.

The initial stress in the metallic reinforcements, as well as the initial pressure in the under side of the vault is obtained by arranging the reinforcing rod 3 as a screw-bolt with the nut 4 and head 5 bearing against wide and stiff angular plates 6 of U-shape iron. The washer plates engage the lower parts of the blocks at both ends of the vault. By turning the nuts, the tie-bolt is brought to the desired tensile stress, and the desired pressure is established in the under side of the vault blocks. The cement mortar having hardened onto the tie-bolt after the latter has been completely stretched, the bolt 3 and the mortar covering 7 will form an integral body, (see Figs. 11, 12, 13) the elastic properties of which are not utilized until the horizontal pressure is larger than the mechanically produced initial stress, or until a sliding of the blocks in relation to or along the mortar covering takes place.

If an effective and safe coöperation between the vault blocks 1 and the monolithically produced support (stretched tie-bolts 3 and mortar covering 7) is to be established on the entire length of the covering, it is necessary to render the construction independent of the adhesive covering 7 and the blocks 1. This is accomplished, in the manner illustrated in the drawings, by providing the contacting surface with cross ribs, or teeth alternating with cross grooves so that horizontal forces may be transmitted from the blocks 1 to the mortar covering 7 without any utilization of the adhesive force. In Figs. 10 and 11 the cross teeth on the blocks —1— are shown at 14'. They engage corresponding cross grooves —14— in the covering —7—. The cross grooves on the blocks are designated by —13— and the corresponding teeth on the covering by

—13—. A similar formation of alternating teeth and grooves is obtained by the shape of blocks shown in Figs. 5 and 9 co-acting with corresponding mortar covering as shown in Figs. 12 and 13 respectively. The tie-bolt 3 is placed in position and the covering is rammed as soon as one longitudinal row of blocks has been mounted. The stretching of the tie-bolt is effected after the second row of blocks has been placed in position. When it is a question of vaults that are to be supported along all four edges, and which must, consequently, be able to counteract forces lying in two relatively perpendicular planes, such vaults must be provided with tie-irons 3, located in the direction of both planes, and Fig. 5 shows a form of block that can be advantageously utilized.

As shown in Fig. 8, the blocks are placed together in such a manner, that in both directions there are continuous joints in which the tie-bolts, 3 and 31 are placed in the two relatively perpendicular directions, and are stretched in the manner hereinbefore described. The mortar 7 in all joints then, as in the case of Figs. 1-4, will form around the tie-bolts a monolithically hardened and cross-grooved covering, (see Figs. 11, 12, 13) by means of which the horizontal strains produced by the load in the underside of the vault is distributed on the entire length of the tie-bolt independent of the adhesion between mortar 7 and block 1.

Having thus fully illustrated and described my invention, what I claim is;

1. A method for building up straight vaults of brittle material, consisting in so placing, in parallel rows, blocks—provided at their lower part with cross grooves alternating with cross teeth—that there are formed between the rows continuous longitudinal joints each having a lower widened part limited by the said cross grooves and teeth, arranging within said widened joint parts tie-rods provided at both ends with contacting irons which engage the end faces of the end blocks of two adjacent rows, filling mortar into said widened joint parts until the mortar completely surrounds the rods and fills also the cross grooves between the cross teeth, tying up the rods to such a degree, that the contacting irons engage with pressure against the end faces of the end blocks and comparatively high compressive stresses of the lower part of the blocks are established, before the mortar is hardened and then allowing the mortar to harden under these conditions, the result being a vault having blocks compressed at their under part and containing in said under part longitudinal widened grooves filled with hardened unstressed mortar surrounding highly tensioned tie-rods.

2. A method for building up straight vaults of brittle material, consisting in so placing, in parallel rows, blocks—provided at their lower part with cross grooves alternating with cross teeth—that there are
5 formed between the rows continuous joints parallel in two directions, at right angles to each other, and each of said joints having a lower widened part limited by the
10 said cross grooves and teeth, arranging within said widened joint parts tie-rods crossing each other and provided at both ends with contacting irons, which engage
15 the end faces of the end blocks of two adjacent rows, filling mortar into said widened joint parts until the mortar completely surrounds the rods and fills also the cross grooves between the cross teeth, tying up the rods to such a degree that the con-

tacting irons engage with pressure against 20 the end faces of the end blocks and comparatively high compressive stresses of the lower part of the blocks are established in the said two directions, before the mortar is
25 hardened, and then allowing the mortar to harden under these conditions, the result being a vault having blocks compressed at their under part and containing in said under part crossing widened grooves filled with hardened mortar surrounding highly
30 tensioned tie-rods.

In testimony whereof, I have signed my name to this specification in the presence of two subscribing witnesses.

JENS GABRIEL FREDRIK LUND.

Witnesses:

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RICHARD STOKKE.