D. B. LUTEN.

ARCH, VAULT, CONDUIT, &c.

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1,009,676.

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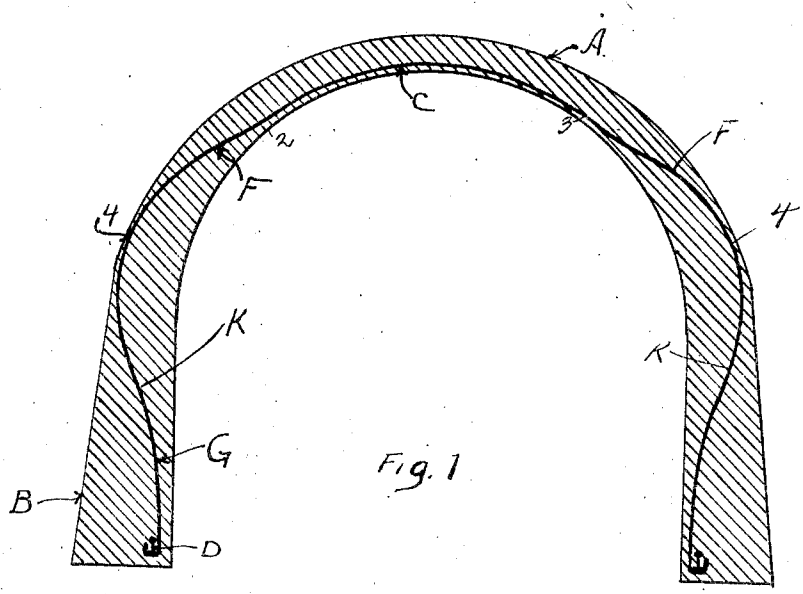

Fig. 1

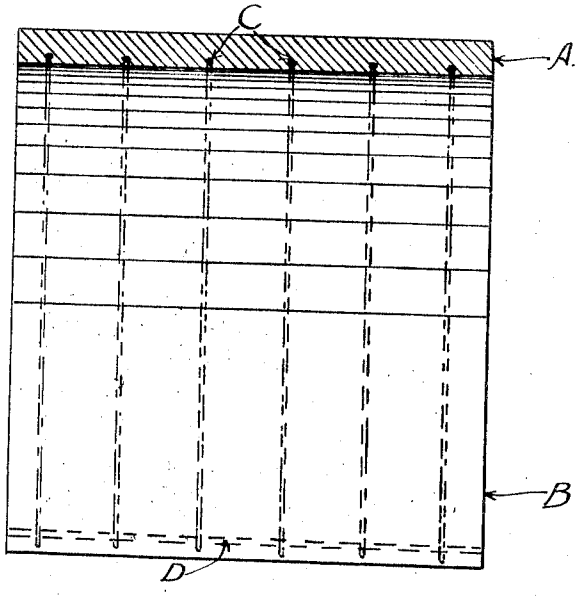

Fig. 2.

WITNESSES:

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ARCH, VAULT, CONDUIT, &c.

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To all whom it may concern:

Be it known that I, DANIEL B. LUTEN, a citizen of the United States, residing at La Fayette, in the county of Tippecanoe, in the State of Indiana, have invented certain new and useful Improvements in Arches, Vaults, Conduits, &c., of which the following is a specification.

My invention relates to improvements in concrete, brick or other arches, vaults, conduits, sewers, etc., and has for its objects the provision of structures of the classes described, which shall be of equal or greater strength than the ones in general use, but which will be considerably lighter and require less material, that will have sufficient resistance to support an unequally distributed load without injury, and that can be easily constructed at comparatively small cost.

It is well known that when a load is applied to an arch rib, extreme compression will be induced in the material of the arch at certain points and there is a tendency to induce tension at the opposite points. If, however, the thickness of the arch rib be increased to a certain relation to the imposed load, so that the line of resistance lies wholly within the middle third of the arch rib, compression alone will be induced in the material of the rib and no tension can occur for that loading. Such commonly is the method of designing arches of stone masonry in which the material is incapable of resisting any considerable tension. But if it be desired to construct a more economical arch rib by reducing the thickness, it becomes necessary to employ materials that will resist tension, as for example, in a steel arch rib where the section of the rib is much lighter than would be possible if steel were, like masonry, capable of resisting compression alone.

In my invention I so combine concrete or other material especially qualified to resist compression stresses with steel or other material particularly capable of withstanding tensile stresses, that an efficient section of arch or curved rib is secured, the tension members being embedded in the other material of the rib. It has been sought to accomplish this same object by embedding steel rods in and following the center line of the rib; also by using steel rods in pairs, one near the intrados and the other near the extrados, and by using non-continuous rods passing through a region of tension and anchored in the neighboring region of compression. In my invention, however, which is an improvement upon all these methods, the rods or other tension members are embedded in the arch ring and extend into the abutment and adjacent its inner face. It is also further designed to extend these rods to the outer side of the abutments in case of the arches supported upon abutments, to prevent fracture at the junction of the arch proper and the abutments, and the consequent overturning of the abutments.

The invention further comprises the novel details of construction and combination of parts hereinafter described and further pointed out in the appended claims, reference being had to the accompanying drawings forming a part hereof, in which the same reference characters designate like parts throughout the several views, and in which—

Figure 1 is a longitudinal sectional view of an arch showing the members embedded near the tension surfaces of the arch and abutments; Fig. 2 is a transverse sectional view of the same.

Referring first to Figs. 1 and 2, A designates an arch of concrete or other desired material in which rods or other tension members C preferably of steel are embedded and which may be arranged in a row as more clearly shown in Fig. 2, said arch being supported upon abutments B preferably of the same material as the arch. It is well understood of course, that arches may be so designed as to confine the points at which tension would occur to certain portions, regions, or zones. For example, the arch under consideration when subjected to a vertical load, or with earth fill over it, as would likely occur in practice, would have tension regions in the neighborhood of the intrados at the crown or between points 2 and 3, also approximately at the points 4, and again along the inner face G of the abutments B, the latter being due to the pressure of the earth or embankment. The rods C therefore, are here located to cross the combined structure consisting of the arch and its abutments, at the points of slight bending moment, such as F and K, and to pass close to the faces thereof through the regions of tension. When subjected to live load in this structure, the tension at the crown and over the haunches may be increased, but is effec-

tually taken up by the tension members C. In accordance with my invention therefore, the rods, bars, cables, or other tension member, or members C are located near the edges of those portions, regions, areas, or zones, where they will do the most good to take care of the tension and prevent cracking and breaking, or failure, in those localities. For example at the crown the member or members C are located in the tensional region, area, or zone, between points 2 and 3 and again at the extrados in the tensional area, zone or region 4, and at the inner face of the abutment at G. It is also apparent that there are points between these extremes of tension where but little bending moment occurs, as between 2 and 4, and between 4 and G; and it is at these points of minimum bending moment that I prefer to lead the tension members C across the arch rib as shown at F and K. The members C pass through points or regions of maximum tension and of minimum compression and alternately from side to side of the central axis of the structure, approaching both inner and outer surfaces of the structure at a plurality of regions of tension near each surface.

The points of minimum bending moment and the tensional regions may vary with the design of the arch or foundations, the loading, and other causes, and the tension members should be properly located to be embedded in the arch as approximately as possible in the regions of tension and cross at the points of minimum bending moment. In other words the invention contemplates any arrangement of tension members in an arch rib and abutments to reinforce the probable tensional regions in the arch and its abutments by passing continuously through such a region on one side of the rib, thence across the rib into the adjacent tensional region, and thence across the abutment or extension of the rib into another tension region. That is, knowing the regions of probable tension in a curved rib, the invention consists in passing tension members continuously through a plurality of such regions and into another inner region so as to have each member sustain a maximum of tension as far as practicable. T-rails D or other anchors are preferably embedded in the lower part of the abutments to which said members C are attached for secure anchorage. It will be noted also that the rods C curve outwardly to follow the inner curved surface at the intrados of the arch and that in cases where the arch has a thin rib, then in order for the tension member to pass from one side of the rib to the other and follow the inner and outer surfaces as it should do for greatest efficiency, it must have a double contraflexure, one at the crossing points and one near the inner surface.

It will thus be seen that the foregoing arrangements result in a strong, durable, light and comparatively cheap structure, and while I have described the various features of the invention with particular reference to the details of construction and arrangement, it is obvious that many changes, alterations, and substitutions may be made therein and still come within its scope and principle.

What I therefore claim and desire to secure by Letters Patent is;—

1. In an arched structure of concrete, the combination with a curved or arched member and abutments to support the same, of a series of tension members embedded in said curved or arched member, said tension member following closely the exterior of the structure at the haunch and passing near the inner face of the abutment.

2. In an arched structure of concrete, the combination with a curved or arched member and abutments to support the same, of a series of tension members embedded in said curved or arched member, and passing close to the interior faces of the abutments.

DANIEL B. LUTEN.

Witnesses:
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