No. 764,302. PATENTED JULY 5, 1904.

W. C. PARMLEY.

CONCRETE ARCH CONSTRUCTION.

APPLICATION FILED MAR. 24, 1902.

NO MODEL.

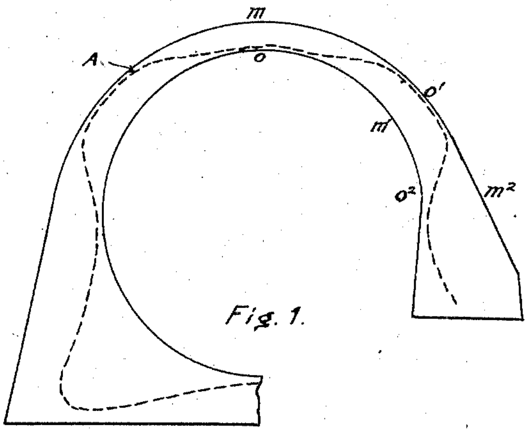

Fig. 1.

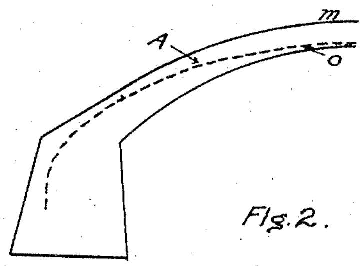

Fig. 2.

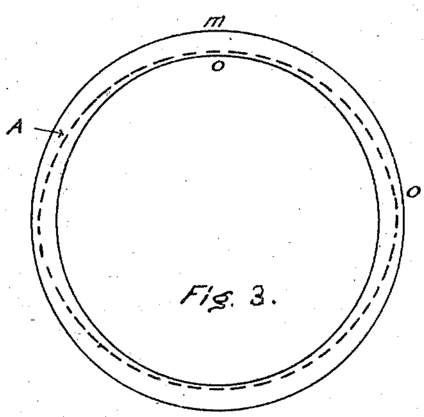

Fig. 3.

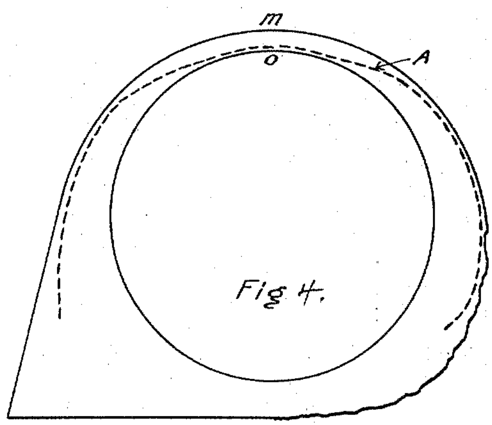

Fig. 4.

WITNESSES:
Walter J. Lister

Walter C. Parmley INVENTOR.

BY D. E. Foulks ATTORNEY.

No. 764,302. Patented July 5, 1904.

UNITED STATES PATENT OFFICE.

WALTER C. PARMLEY, OF CLEVELAND, OHIO.

CONCRETE-ARCH CONSTRUCTION.

SPECIFICATION forming part of Letters Patent No. 764,302, dated July 5, 1904.

Original application filed June 4, 1901, Serial No. 63,090. Divided and this application filed March 24, 1902. Serial No. 99,666. (No model.)

To all whom it may concern:

Be it known that I, WALTER C. PARMLEY, a citizen of the United States, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented a new and useful Improvement in Concrete-Arch Construction, of which the following is a specification.

My invention relates to improvements in concrete-arch construction, this application being a division of my prior application, Serial No. 63,090, filed June 4, 1901. As was stated therein, the objects of the invention are to gain increased strength in sewers, vaults, domes, &c., that are built of masonry or concrete or partly of masonry and partly of concrete and also to diminish the amount of material used, thereby securing a reduced cost of construction combined with an increased strength. These objects are attained by embedding in the concrete or masonry strips rods, bars, shapes, &c., of metal, which assist in withstanding the tensional strains, the compressive strains being sustained mainly or wholly by the concrete or masonry.

In the accompanying drawings, forming part of this application, Figure 1 represents in vertical section an arch structure that has embedded therein tension members that for a given loading pass transversely to the axis and through the regions of tension in both the intrados and extrados. In order to indicate the general application of this structure to all forms of arches, the left side of the figure is made to illustrate a portion of a tubular arch and the right side a portion of a segmental arch that has a region of tension in the intrados near the base. Fig. 2 also shows the invention as applied to a segmental arch in which the only tensional region in the intrados for a given loading is at and near the crown of the arch. Fig. 3 illustrates a tubular structure built according to my invention, so as to sustain heavy loads at the crown; and Fig. 4 shows a tubular structure in which the masonry or concrete support laterally at the sides or vertically under the haunch is insufficient in itself to prevent the structure from becoming distorted, but which is strengthened in these parts by the tensional bars. In order to indicate the general application of this structure, the right side of the figure is rounded, while the left side is made angular.

In the construction of concrete or masonry arches it is desirable to obtain the maximum strength with the minimum amount of material and at the minimum cost. While concrete is adapted to withstand high compressive strains, it is not so well adapted to withstand strains tending to pull it apart, and for this reason arches made exclusively of this material must be excessively large, heavy, and costly, else they will fail in the regions of tension. To strengthen such arches, it has been proposed that metallic strips, bars, or similar devices be embedded in or near the intrados or extrados of the arch; but in such cases the arrangement of the embedded bars has not been such as to secure the greatest strength for the amount of material used in the structure.

In the forms of arches shown in the accompanying drawings, in which similar reference characters designate corresponding parts throughout the several views, the loads, and consequently the positions and intensities of the strains in the arch, are at least approximately known. Suppose, for example, that the load is applied at the crown or at the points designated *m*. This will put the extrados at these points in compression and will at the same time induce a tensile strain upon the materials forming the intrados at the points *o*. The load strains must ultimately be sustained by the abutments, and in passing thence the tensile strains are transmitted from the intrados at *o* to the extrados at the haunch, as at o', and to the intrados again at or near the springing line, as at o^2. (See Fig. 1.) As will be understood, the compression strains in like manner suffer an opposite reversal and appear at m' m^2.

The concrete is abundantly able to take care of the compressive strains itself; but in order to sustain the tensional strains at o, o', and o^2 it is necessary unless an excessive amount of material is employed to strengthen the structure at these points, which I do by passing a single bar or metal member A through the adjacent tensional regions of both intrados and extrados and far enough beyond the same to secure a firm anchorage, or by passing it through a plurality of such tensional regions in succession, or through all of the same, according to the requirements of the particular case. This single bar passing back and forth through the arch and extending through the tensional regions in both intrados and extrados is the equivalent as far as results are concerned to two sets of bars, one in the regions of tension in the intrados and the other in the corresponding regions in the extrados. It is a much lighter structure, however, and effects a very considerable saving over the form just referred to. When the positions and limits of the tensional regions are accurately or approximately known, it is preferable to pass the bars through the neutral points between tensional regions or as near to such points as may be, so that the tension of the extradosal region is made to oppose that of an intradosal region and the bar in one region securely anchors itself, so as to sustain the strain or pull from the other region. In case the location of said tensional regions is such that a single bar passing from one to another through the neutral point would have some portion more or less unprotected against tension it may be desirable to deviate somewhat therefrom and to place the bar in such a way as to oppose the points of maximum opposite strains in intrados and extrados, thus depending upon the concrete for withstanding a small amount of tension in places near the neutral points.

In the left-hand side of Fig. 1 the bar A is shown as continued around the side and underneath the structure, so as to support it against the tendency to deformation in those parts. In the other side of the figure the arch is shown as terminating in suitable abutments, which may be developed into any form desired. In Fig. 2 the bar A is placed so as to reinforce the concrete in the intrados at the crown and is then passed through to the extrados at o', from which point it is continued through the extrados at the abutments. Fig. 3 shows a tubular arch that is circular in section, although it may obviously be oval, elliptical, or any other suitable shape. The bars A are placed in this form so as to resist the tendency to deform that is due to a load applied from above, said bars passing through the intrados at the crown, then through the body of the arch and along the extrados regions at and near the sides, and then through the body of the arch again to the intrados at the bottom.

In Figs. 1, 2, and 3 the bars A are shown in the positions in which they are best adapted to resist the strains when the vertical loads are in excess of the horizontal loads; but in case the horizontal loads become excessive the bars in the arches would be shifted about through ninety degrees, so that they would lie in the intrados at the sides and in the extrados at the crowns and bottoms.

The forms of arches shown and described are merely suggestive of the almost universal application of my invention to such structures, and I do not desire it to be understood that the invention is limited to such forms. The term "bar" in the claims is used also in a generic sense and is intended to include all forms of rods, plates, angles, webs, cables, built-up bars, or metal shapes of any kind that may be at all adapted to the purpose described, while the word "concrete" is used to include mortar or mortar in combination with broken stone, gravel, and the like, or it may also include brick or stone masonry laid in mortar.

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

1. A concrete arch having embedded therein continuous metal bars each of which passes through a plurality of regions of tension in intrados and a plurality of regions of tension in extrados and that extend far enough beyond said regions to afford secure anchorage.

2. A concrete arch having metallic strengthening-bars embedded therein and passing through the intrados at or near the crown and the springing line, and through the extrados at an intermediate point.

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

WALTER C. PARMLEY.

Witnesses:
S. E. Fouts,
Walter J. Lister.