No. 749,771. PATENTED JAN. 19, 1904.

E. H. ARNOLD.

BRIDGE.

APPLICATION FILED SEPT. 13, 1902.

NO MODEL.

Fig. 1.

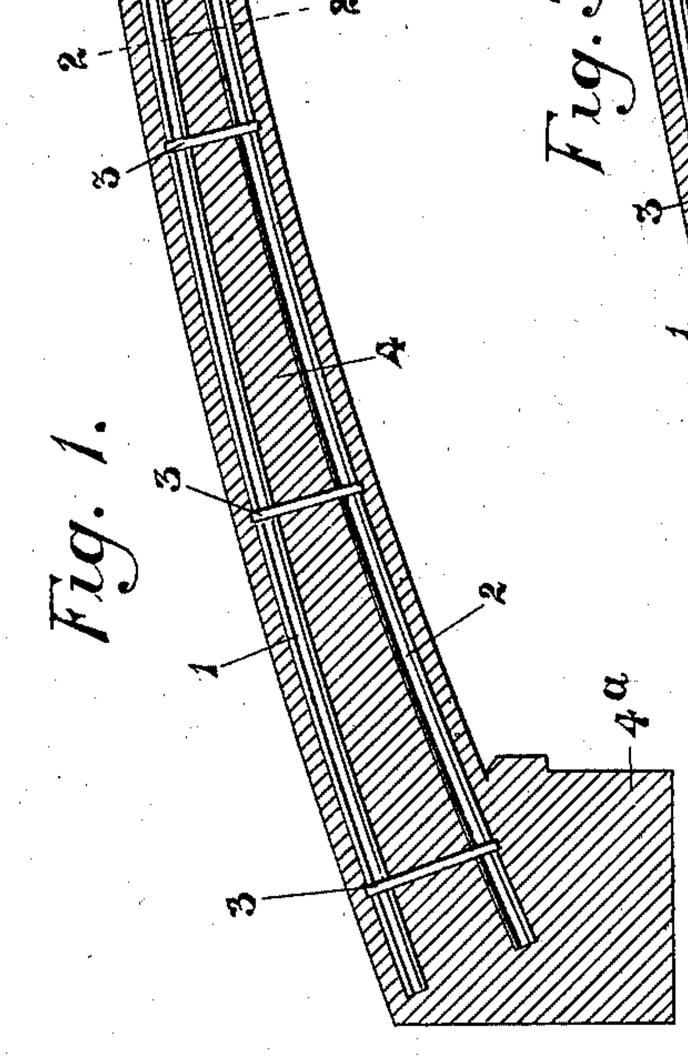


Fig. 2.

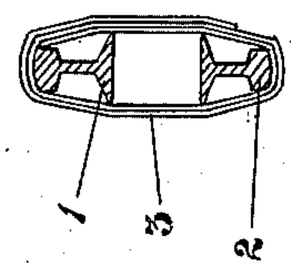


Fig. 3.

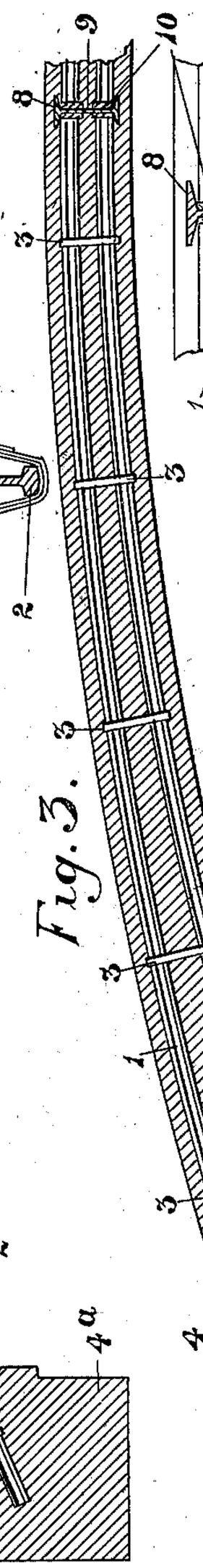


Fig. 4.

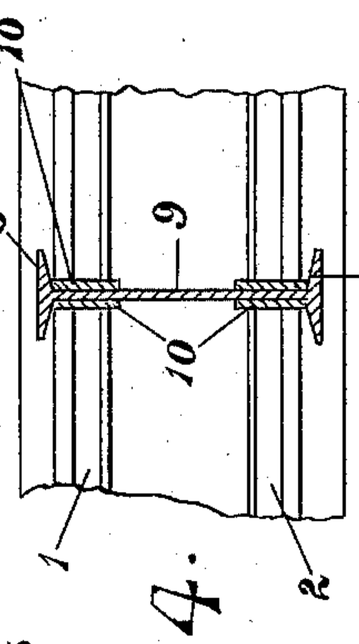


Fig. 5.

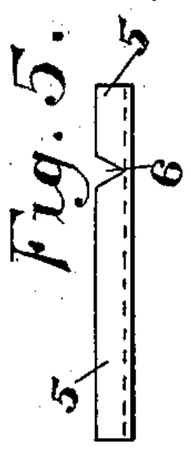


Fig. 6.

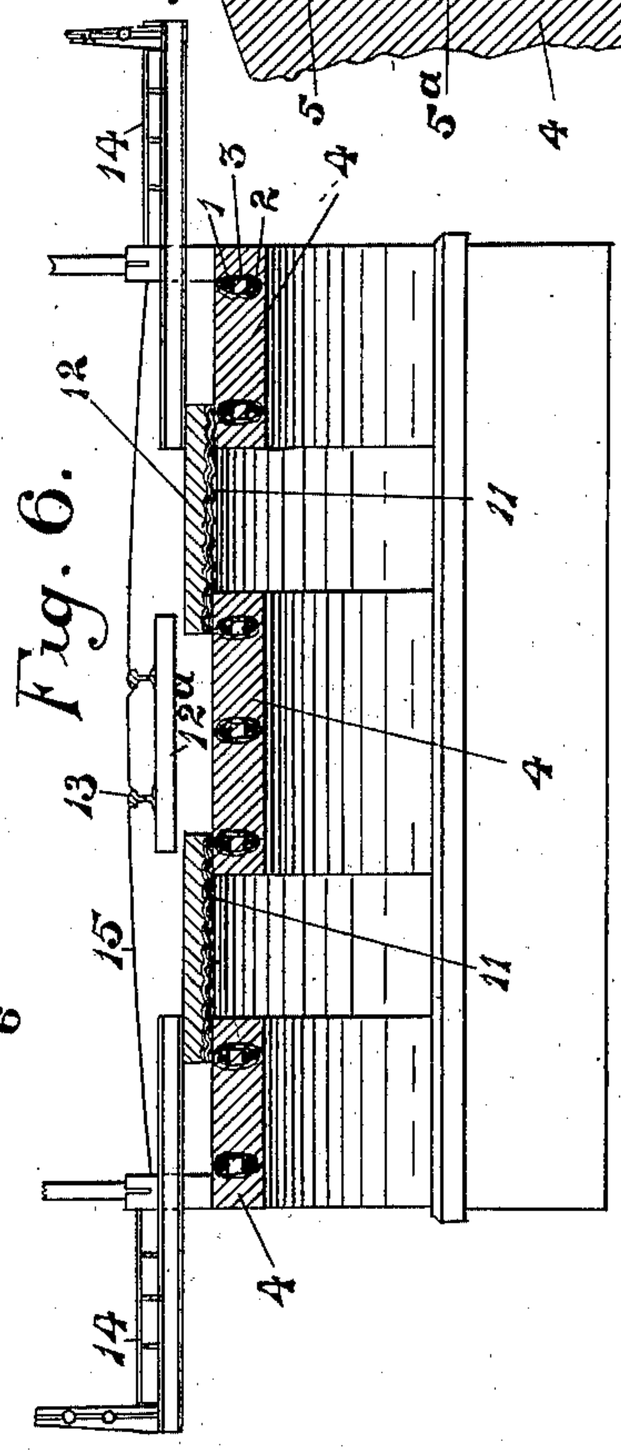
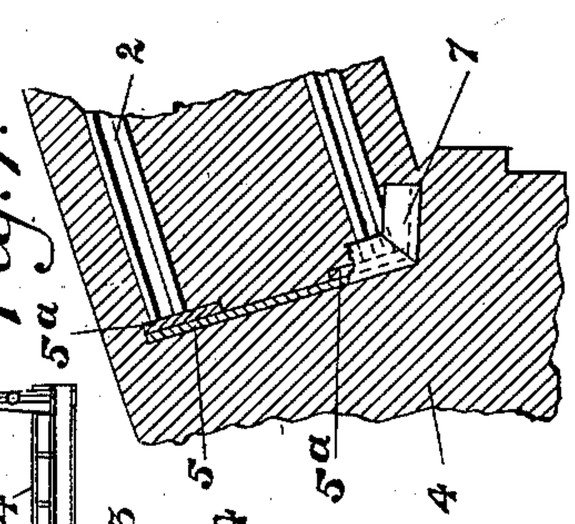


Fig. 7.



WITNESSES:

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No. 749,771. Patented January 19, 1904.

UNITED STATES PATENT OFFICE.

EUGENE H. ARNOLD, OF WHEATON, ILLINOIS.

BRIDGE.

SPECIFICATION forming part of Letters Patent No. 749,771, dated January 19, 1904.

Application filed September 13, 1902. Serial No. 123,204. (No model.)

To all whom it may concern:

Be it known that I, EUGENE H. ARNOLD, of the city of Wheaton, in the county of Dupage and State of Illinois, have invented certain new and useful Improvements in Bridges, of which the following is a full, clear, and exact specification.

This invention relates to improvements in bridges in which arched metallic beams extend from abutment to abutment and are embedded in concrete or other plastic materials which subsequently set and harden.

Prior to my invention these metallic arched beams have been formed by arranging flat bars of iron the one above the other at a distance apart without any connection between them or else by rigidly connecting said bars by vertical rods or zigzag bars between and rigidly riveted or bolted at intervals of both of said beams, the purpose being to have the two beams perfectly rigid against any pressure or strain tending to independently move the one vertically toward the other, and also in which the arched beams thus formed are rigidly embedded in the concrete, are continuous throughout their length, and therefore rigid against any endwise movements at any and all times, and which in some instances several arches of a bridge structure are rigidly connected the one with the other by cross-bars, the opposing ends of which are respectively bolted to adjacent arches. There are also prior structures in which the arched beam is formed of several short sections of **I**-beams, the ends of each opposing section being supported upon transversely-extending **I**-beams, also forming between adjacent arches, the arches themselves each being broken, so to speak, into a number of segments of a circle instead of being on the arc of a circle continuing throughout the arch, as in the structures first above referred to, and a perfect rigidity of the arch as a whole being secured by the employment of wedged plates forced between the ends of the arched ribs and the transverse **I** beams or girders, the rigidity of the said structure being further increased, as is also the arches first above referred to, by wedges driven between the extreme ends of the arched beams and the abutments.

All the structures above referred to are objectionably expensive, which is due, for example, in the structure first referred to to the use of the numerous bolts and expensive cross-bars and their riveting and, on the other hand, to the employment of a large number of transverse **I** beams or girders and their wedging of the girders of a sectional arch supported thereon, and besides such arches are owing to their extreme rigidity prevented when loaded from proper initial settling to place, and that when in use this rigidity does not provide for at all compensating for the difference in expansion between concrete and iron while the bridge is settling to place, and as result there is either an undue strain to the arched beams, the prevention of the equalizing of a load throughout the arch, or a cracking and displacement of the concrete or other plastic filling during and after the drying period thereof.

One of the objects of my invention is to dispense with the necessity of using flat iron and sectional **I**-beams for the arched metallic beams of a bridge structure and instead thereof to provide for the utilization of railroad-rails, and thereby devices which, in proportion to the cost of flat and **I**-beam structures, are substantially stronger, more durable, and readily joined in lengths throughout the length of an arch and which when used in pairs with the one rail above the other provide against the necessity of a rigid connection, and thereby permit of a sufficient spring to enable a bridge when finished with its filling of concrete to in an uninjured condition set itself on being loaded.

A further object is to secure together each pair of rails or ribs forming the arched metallic beam in such a manner that the one directly supports the other and that they cannot spread apart, but that the one may have an independent movement toward the other or that both may simultaneously move toward the other should occasion require.

Another object is to equalize the difference between the contraction and expansion, as far as may be necessary for the best results, of the metallic ribs and the concrete, and particularly when the bridge is settling to place un-

der a load, and this by devices which are cheap, easily obtained, and readily put in place.

A still further object is to provide a simple and effective means for permitting the bridge to settle to place against the abutments and which will limit the settling of the bridge to a fixed point with reference to the abutment and without preventing the movement therefrom under a rising of the arch of the bridge.

Another object is to provide an arched metallic concrete bridge structure in sections and in such manner that said sections may be joined by simple and effective means of cheap construction and so as to form, in effect, a continuous structure throughout its length and breadth.

With these ends in view my invention consists of certain features of novelty in the construction, operation, and arrangement of parts by which said objects and certain other objects hereinafter appearing are attained, all as fully described with reference to the accompanying drawings, and more particularly pointed out in the claims.

In the said drawings, Figure 1 illustrates a detailed longitudinal section through about one-half of an arch and a portion of the abutment of a bridge embodying my invention, with one set of the arched metallic beams, with their bonds shown in full lines and projecting into the body of the abutment; Fig. 2, a transverse section on the line 2 2 of Fig. 1; Fig. 3, a similar view to Fig. 1 of a modified form of the structure shown in Fig. 1; Fig. 4, an enlarged detailed view illustrating the use at the center apex of the arch of a transverse metallic beam and a soft metallic packing between said beam and the opposing ends of the arch formed in two sections. Fig. 5 illustrates a detailed view of the abutment-plate shown in Fig. 3, opposing the ends of the arched metallic beams, and more particularly illustrating a convenient means of forming said plate; Fig. 6, a transverse section through a bridge structure containing my invention and at a point between the extreme ends thereof, and Fig. 7 a detail section of plates 5.

Similar numerals of reference indicate the same parts in the several figures of the drawings.

1 indicates the upper rib, and 2 the lower rib, of an arched metallic beam containing my invention, which said beams are preferably of steel railroad-iron, which may first be heated and then bent to the desired curve which the arch is designed to have, said railroad-rails when several lengths are used being preferably secured together at their meeting ends by fish-plate and bolts ordinarily employed for jointing railroad-rails; but it will be no substantial departure from my invention, as hereinafter described, to substitute any other form or kind of iron—such, for example, as **I**-beams or other angle-iron or, for that matter, flat iron bars.

After the ribs 1 and 2 are properly formed and spaced apart to form an arched metallic beam, with one of the ribs directly above the other, they are then bonded together by bonds 3 at proper and desired intervals, which bonds consist of strap-iron and may be wire-wound about the ribs and fastened in any suitable manner, as indicated in Fig. 2.

With an arched metallic beam constructed as above described and embedded in concrete or other plastic, subsequently drying and hardening, materially the one rib directly supports the other and uniformly throughout the lengths of both against the strain thereon, both of the weight of the structure as a whole and the load which it may be at any time carrying and distributes this strain throughout both ribs instead of centering it at one or more intervals thereof, as occurs when two ribs similarly arranged are rigidly jointed by bars or rods.

Fig. 1 indicates a structure embodying my invention, in which the arched metallic beams are indicated as being continuous throughout the arch, with the ends thereof projected into and embedded in the abutment 4, which is in these structures usually concrete, but may be of masonry.

For some purposes the projection and embedding of the arched metallic beams in the abutment may be desirable or sufficient; but in practice where the arched structure as a whole is of considerable length and very heavy and subject to heavy loads I prefer to oppose the extreme ends of the arched metallic beams by lead or other soft metal 5^a, constituting a facing for metallic plates 5, preferably channel-iron pieces, which latter, as indicated in Fig. 5, may be given the desired form by cutting **V**-shaped notches 6 in the flanges thereof, as indicated in Fig. 5, so as to form an angular bend 7 at the lower end of this channel-iron plate, upon which the lower rib of the arch may rest and have a bearing.

The concrete or masonry of the arch is so formed as to firmly support the plate in a plane on a radial line to the curve of the arch and at a right angle to the direction of the movement of the respective ribs in their effort to straighten out under load and so that the resistance offered by the contact of the ends of the ribs against the plate will be equalized in the straightening-out process, while at the same time the channel-iron plates provide a stop, limiting the endwise movement of the arched metallic beams.

In constructing a bridge the channel-iron stops are so arranged as to have a filling of lead between them and the ends of the ribs for equalizing the compression and enable the bridge to subsequently settle to place, while at the same time said channel-iron provides

not only stops, but confines the metallic arches against movement and holds them in place while filling in the concrete. In other words, there is a desired flexibility provided, which is oftentimes necessary between an arched structure and its supporting-abutments. As a further means of giving a flexure and strength to this arched structure, but more important as a means of equalizing the difference between the contraction and expansion of the metallic arched beams and the concrete in which they are embedded when either or both are from any cause expanded or contracted, I employ at the center or apex of the arch an **I**-beam 8, extending transversely of the arch and on and between the flanges of which are supported and confined the ends of the ribs opposing each other at that point transversely along the arch; but instead of having the ends of the ribs abut against the web 9 of the **I**-beam I interpose between said web and the ends of the ribs and on both sides of the web a packing of lead or other metal, which is substantially more easily compressible than the metal of which the ribs are formed and which operates in the settling of the bridge to place or under a heavy load to equalize to a substantial degree the difference between the compressibility of the ribs and the concrete, as will be more fully appreciated by bearing in mind that the ratio of compression of steel inversely is about thirty, concrete seven, and lead one, and that by interposing the lead between the steel at the apex of the arch a substantial and desirable equalization between the ratio of compression of the steel and the concrete is established, and with the result that the liability of the concrete to fracture either at the time or subsequently to the settling of the arch to place is secured.

As indicated in Fig. 6, the concrete 4, in which the arched metallic beams are embedded, is for economy preferably made in sections and with considerable space between each section, but finally made substantially continuous by bridging the space between these sections with corrugated, expanded, or other sheet metal 11 in a number of layers or of sufficient thickness for the desired resistance, and subsequently covered with concrete, macadam, or other covering 12.

The bridge structure shown in Fig. 6 is intended to support a tram or other rail way, as indicated by the rails 13 and ties 12, a footwalk 14, projected laterally beyond the arch, and a roadway between the footwalks and on each side of the tramway, the line 15 indicating the level of a filling of concrete, macadam, or other material below and above the level of the railway-ties 12, which also serves to hold in place the sheet metal or other bridging between the arches. It would, however, be no departure from my invention to have the arches continuous laterally instead of in sections and to support thereon concrete, macadam, or other materials for the roadway or tramway.

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

1. In a bridge, an arch of concrete or other masonry having embedded therein arched metallic beams, each composed of two ribs of bars, rails, or other iron, arranged one above but separated from each other, and bonded by wire, or other straps wound around both ribs, substantially as described.

2. In a bridge, an arch of concrete or other masonry, having embedded therein ribs arranged one above but separated from each other and by the masonry, and composed of railroad-rails or other iron, said ribs being bonded together by metallic straps wound around them and at intervals of the length thereof, substantially as described.

3. The combination in a bridge of metallic arched beams consisting of rails or bars of iron arranged one above but separated from each other, and bonded by straps wound around both of them with a filling of concrete, or other masonry, of abutments, and plates supported by said abutments opposing the ends of the beams and forming a support therefor, and preventing an endwise movement of the beams in settling to place, or when heavily loaded, substantially as described.

4. In a bridge, an arch of concrete or other masonry, arched metallic beams embedded therein in combination with a transverse **I** or other metallic beam arranged between and supporting the ends of the arched beams at the apex of the bridge, and a lead or other metallic filling at a point between said ends, and the web of said transverse beam, substantially as described.

5. In a bridge, an arch of concrete or other masonry in transverse, separated sections, having embedded therein arched metallic beams, the space between said sections being bridged by slabs of metal or other material, and the continuous surface thus formed being covered by concrete, macadam or other paving material, substantially as described.

6. In a bridge, an arch of concrete or other masonry having embedded therein arched metallic beams, each composed of two ribs of bars, rails or other iron, arranged one above but separated from each other, bonds of wire or straps wound around both of said ribs in combination with an abutment, a plate mounted upon said abutment in a plane on a radial line to the curve of the arch, a soft-metal facing thereon forming a seat for the end of the beam, substantially as described.

7. In a bridge an arch of concrete or other masonry having embedded therein arched metallic beams, each composed of two ribs of

bars, rails or other iron, arranged one above but separated from the other, and bonded together by wire or other strap, wound around both ribs in combination with a transverse I-beam at the apex of the arch, a soft-metal packing supporting one end of said beam, a soft-metal packing between said ends and beam, an abutment, a plate mounted thereon, supporting the opposite end of said beams, and a soft-metal packing between the ends of the beams and said plate, substantially as described.

EUGENE H. ARNOLD.

Witnesses:
M. B. ALLSTADT,
A. D. LATHROP.