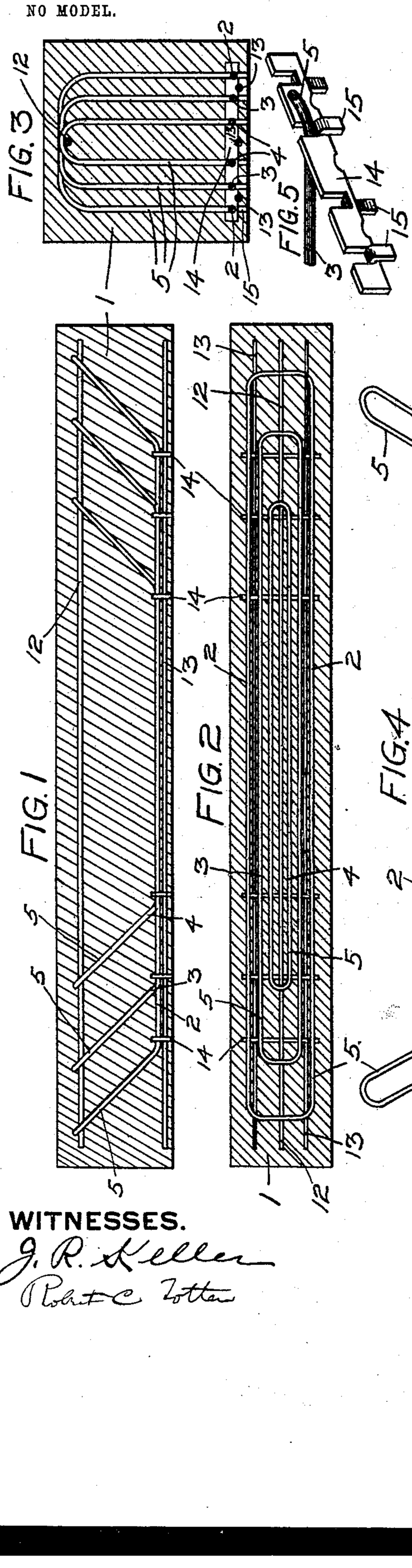
No. 764,884. PATENTED JULY 12, 1904.

R. A. CUMMINGS.

METAL AND CONCRETE GIRDER.

APPLICATION FILED OCT. 19, 1903.

NO MODEL. 2 SHEETS—SHEET 1.



WITNESSES.

J. R. Keller

Robt C Totten

INVENTOR.

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NO MODEL. 2 SHEETS—SHEET 2.

FIG. 10

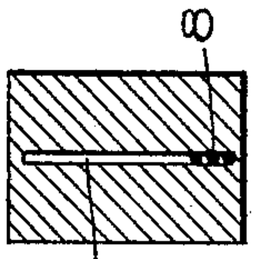


FIG. 12

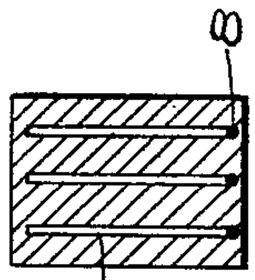


FIG. 15

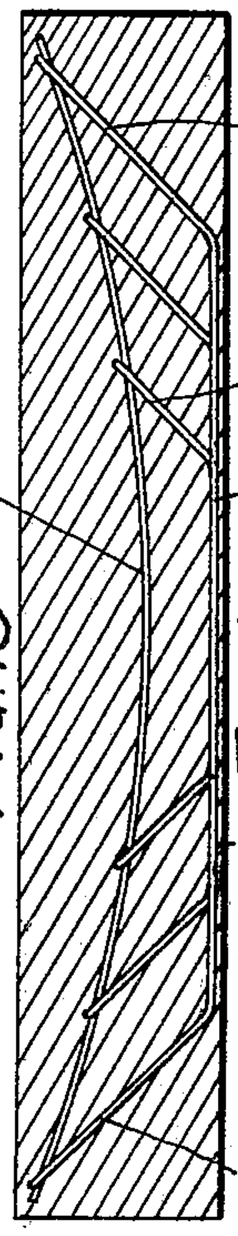


FIG. 16

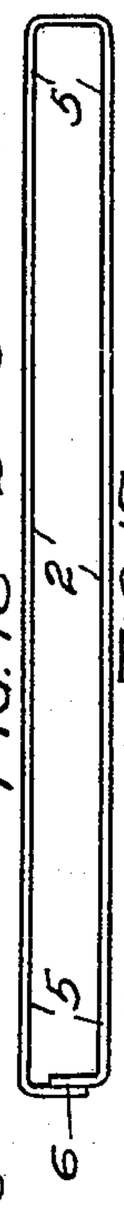


FIG. 17

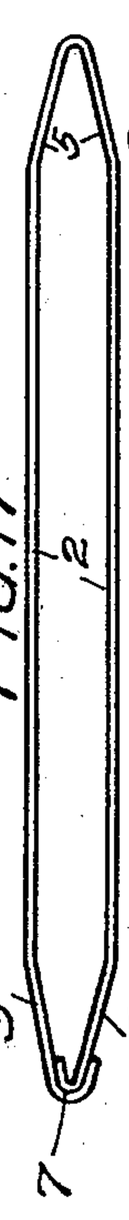


FIG. 19

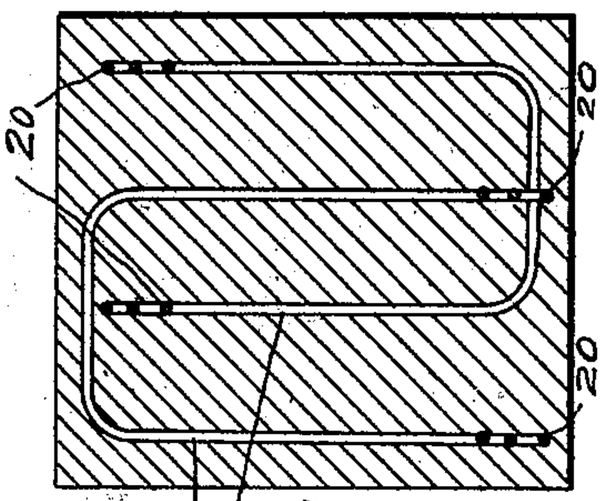


FIG. 9

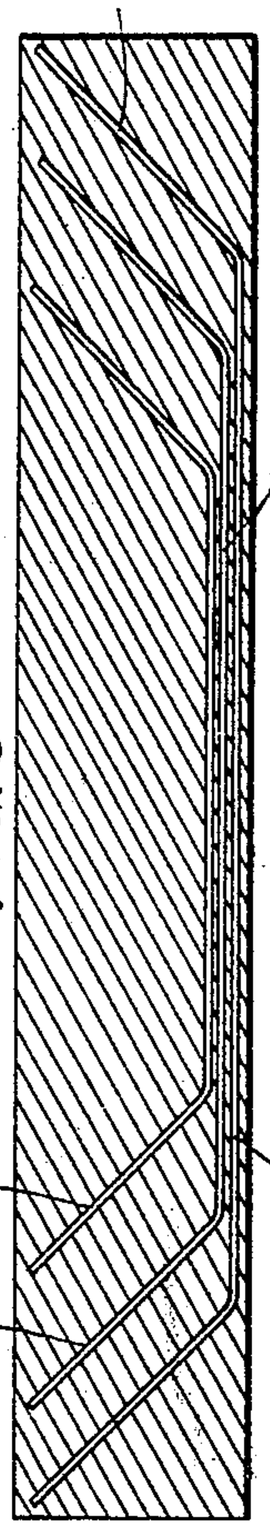


FIG. 11

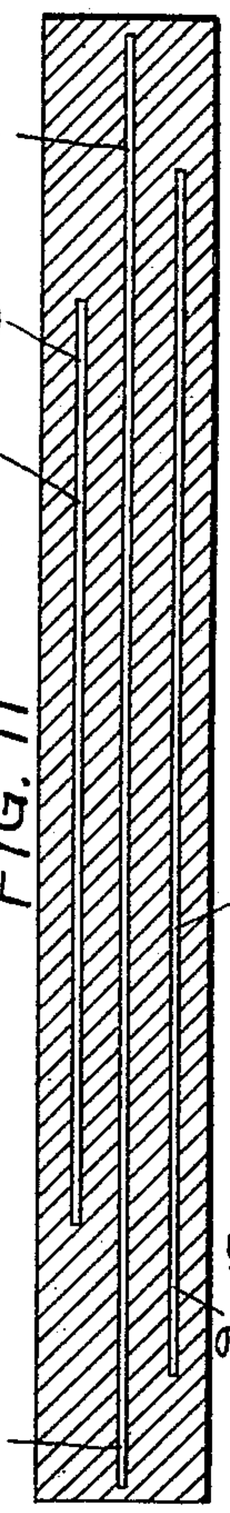


FIG. 13

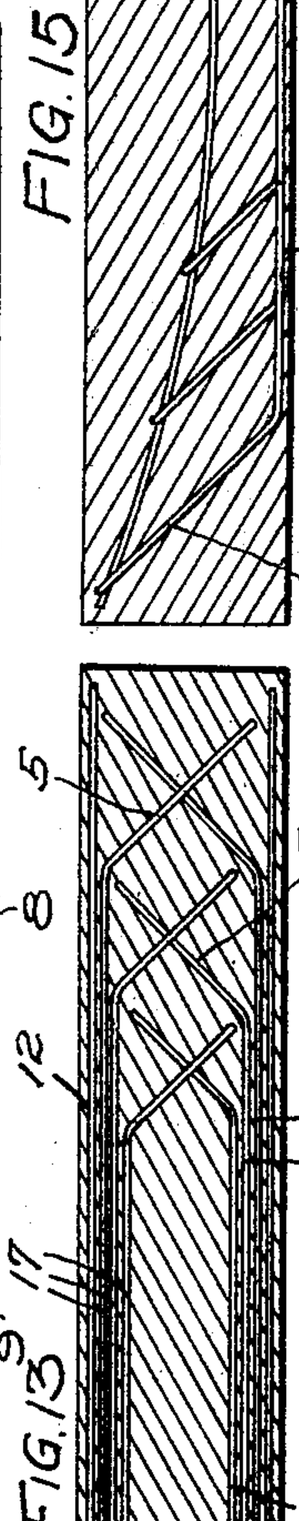
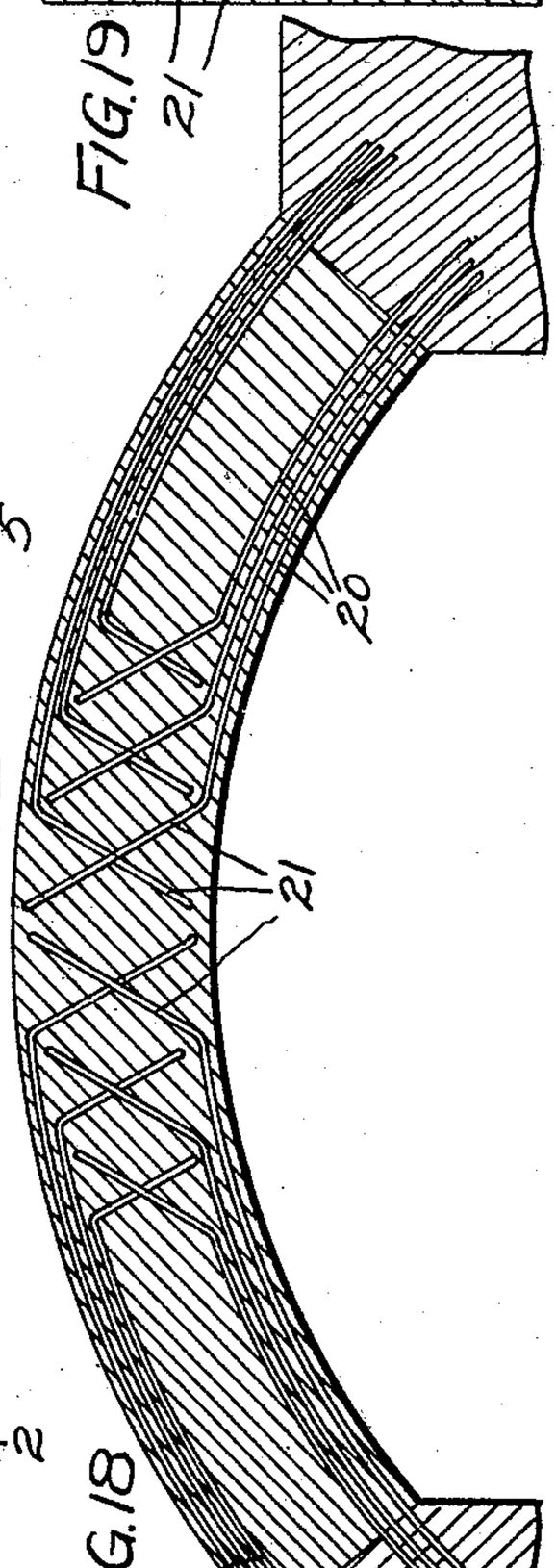


FIG. 14

FIG. 18



WITNESSES.

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Robert C Totten

INVENTOR.

Robert a Cummings

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No. 764,884. Patented July 12, 1904.

UNITED STATES PATENT OFFICE.

ROBERT A. CUMMINGS, OF BEAVER, PENNSYLVANIA.

METAL-AND-CONCRETE GIRDER.

SPECIFICATION forming part of Letters Patent No. 764,884, dated July 12, 1904.

Application filed October 19, 1903. Serial No. 177,648. (No model.)

To all whom it may concern:

Be it known that I, ROBERT A. CUMMINGS, a resident of Beaver, in the county of Beaver and State of Pennsylvania, have invented a new and useful Improvement in Metal-and-Concrete Girders and the Like; and I do hereby declare the following to be a full, clear, and exact description thereof.

My invention relates to composite girders, arches, and the like formed of cement, concrete, beton, or similar material with metallic strengthening members embedded therein.

The invention consists in general in the peculiar arrangement and shape of the strengthening members in the body of a girder or arch, so as to effectively take care of both the bending moments in a girder, arch, or the like, as well as the shear and other stresses therein.

My invention relates to that class of beams, girders, arches, or the like having the larger portion thereof formed of cement, concrete, beton, or similar cementitious substances and having embedded therein metallic strengthening members. Heretofore these metallic members have been arranged to act as tension-members for the girders and take care of the bending moments occurring therein. Girders, arches, and the like of this construction are also liable to shearing fractures on horizontal or other lines, and especially near the ends thereof, and it has heretofore been the practice to embed in concrete girders, and especially near the ends thereof, metallic pieces, loops, or stirrups arranged at an angle and whose function it is to take care of the horizontal shear. These stirrups or loops, however, have been formed as pieces separate from the metallic tension members, and difficulty is experienced in holding them in place while filling the cement around the same. Furthermore, as they are separate from the tension members, they do not efficiently carry the stresses into said members.

My invention relates to this general class of girders, beams, arches, and the like; and its object is to so arrange the metallic strengthening members as to effectively take care of the horizontal or other shear and also so as to properly distribute the metal to most effectively take care of the bending moments and other stresses in a girder.

To these ends one feature of the invention consists in embedding in the concrete or similar body of the girder, arch, or the like a plurality of metallic strengthening members having stirrups or loops formed integrally therewith or at least rigidly secured thereto.

Another feature of the invention consists in providing a plurality of metallic strengthening members of varying lengths and having end portions, preferably loops or stirrups, projecting diagonally upwardly or downwardly toward the opposite face of the girder or arch, these projecting portions taking care of the horizontal or other shear occurring at the ends of the girder and in arches, while the horizontal portions of said members being of varying length give the maximum amount of metal at or near the central portion of a girder or near the ends of an arch, where the bending moment is greatest.

The invention also consists in one or more metallic members formed as an endless loop or a bend of metal, so that the bent-up portion forms a stirrup.

The invention also consists in placing one or more of these members in an inverted position near the upper face of the girder or arch, and especially over the point or points of intermediate support of a continuous girder.

The invention also consists in other details of construction and arrangement, which will be hereinafter described and claimed.

In the accompanying drawings, Figure 1 is a longitudinal vertical section through a simple girder constructed according to my invention. Fig. 2 is a plan view of the same. Fig. 3 is a transverse section through the same. Fig. 4 is a perspective view of one of the metallic strengthening members. Fig. 5 is a detail perspective view through one of the spacing-pieces. Fig. 6 is a vertical longitudinal section through a continuous girder constructed according to my invention. Fig. 7 is a similar view of a simple girder, showing a modification. Fig. 8 is a transverse section through the latter. Fig. 9 is a vertical longitudinal section of still another modification. Fig. 10 is a transverse section through the

same. Fig. 11 is a plan view of still another modification. Fig. 12 is a transverse section through the same. Figs. 13, 14, and 15 are vertical longitudinal sections of other modifications. Figs. 16 and 17 are plan views of modified forms of strengthening-loops. Fig. 18 is a vertical longitudinal section of an arch constructed according to my invention, and Fig. 19 is a transverse section through the same.

In carrying out my invention the body 1 of the girder, beam, arch, or the like is formed of cement, concrete, beton, or similar cementitious substances. Embedded in this body are a plurality of metallic strengthening members which are peculiar to my system, three such members being shown in Figs. 1, 2, and 3 and marked, respectively, 2, 3, and 4. These members preferably will be of varying lengths, as shown, and are located near the lower face of the beam and each having a portion thereof, preferably the ends 5, projecting upwardly toward the upper face of the girder. These upwardly-projecting portions take care of the horizontal shear near the ends of the girder. The horizontal portions take care of the bending moments in the girder, and inasmuch as these portions are of different lengths the greatest amount of metal will be at or near the middle of the girder, where the bending moment is greatest.

The metallic members 2, 3, and 4 will preferably be of either round bars of metal or of bars of irregular outline longitudinally; but this may be varied within wide limits, and the number thereof will depend upon the size of the girder or arch and character of load to be carried thereby. The end portions or stirrups 5 need not necessarily be integral portions of the bars themselves, although this is preferable, as they may be separate pieces riveted or otherwise securely fastened to the horizontal portions.

The strengthening members shown in Figs. 1, 2, 3, and 6 are of the form illustrated in Fig. 4, being formed of endless loops or bands of metal having the two horizontal portions thereof substantially parallel and the ends bent upwardly to form stirrups. Instead of being endless loops they may be constructed, as shown in Figs. 16 and 17, by bending a rod into loop form with the ends overlapped, as at 6, Fig. 16, or as at 7, Fig. 17. In both cases, however, the loops or stirrups are so arranged in the body of cementitious material that the two members or legs of said loops are side by side or arranged laterally in the body, as clearly shown in Figs. 3, 8, and 19. The form of these members may be varied to a considerable extent. For instance, in Figs. 9 to 12 they are shown as mere bars 8, having upwardly-projecting ends 9 without being in the form of a stirrup or loop. Preferably, however, some form of stirrup or loop will be formed at the ends of the bars. In Figs. 7 and 8 these members are shown as formed of ordinary bars having their ends bent upwardly and again downwardly, so as to form stirrups 10. Various other forms of these members will adapt themselves to my purpose. Preferably the upwardly-projecting portions will extend at an angle of forty-five degrees to the horizontal, this angle having been found by experience to be the most effective for taking care of the shear; but, if necessary or desired, this angle may be varied. These strengthening members may be placed in various positions. When, however, endless loops are used, such as shown in Figs. 1, 2, 3, 4, 6, 16, and 17, they preferably will be arranged as indicated in Figs. 2 and 3—that is, with the longest member forming the two outside strands and the shorter members interposed between the same. The horizontal portions of these members may all be in the same horizontal plane, as shown in Figs. 1, 2, 3, 11, 12, and 15, or they may be in different horizontal planes, as shown in Figs. 6, 7, 9, 13, and 18, either directly above each other, as shown in Figs. 8 and 10, or arranged in any convenient or suitable way. With these members may be associated one or more ordinary strengthening members or bars. For instance, in Fig. 1 there is shown one such bar 12 at the top and threaded through the loops of the main strengthening members, thus serving as a means for holding the latter in place while the concrete is embedded around the same. At the bottom there may be several additional tension members, three such members 13 being shown. In all of the other figures also several additional strengthening-rods are shown. I may also use with these strengthening members spacing-pieces 14, (shown in Figs. 1, 2, 3, and 5,) which are preferably placed at the bent portions of the members and serve to hold the members in their proper vertical and lateral positions during the placing of the cement between the same. Preferably these spacing-pieces will be plates uniting the two strands of the loops and having openings or notches punched out of the same for the passage of the strengthening members and having the punched-out metal bent downwardly to form struts 15 for resting upon the centering to hold the metallic members in place while the concrete is being filled around the same. The form of these metallic members may be varied to a considerable extent. For instance, in Fig. 15 the upwardly-projecting portions 5 are shown of varying length and the top tension member 12 is shown curved downwardly. In Fig. 14 the reverse is shown, the upwardly-extending portions 5 being also of varying length and so shaped as to give to the lower face a curved effect. If desired, the upper portion could also be curved in the same way by making the upwardly-projecting portions 5 nearest the middle of the girder longer than those at the ends of the girder.

In many cases it may be desirable for additional strength to place some of the members in an inverted position, as shown, for instance, in Fig. 13, 17 indicating these inverted members, which may be of any of the forms hereinbefore described and may or may not be equal in number and symmetrical in arrangement with the members in an upright position.

In the case of a continuous girder, such as shown in Fig. 6, and which is supported not only at its ends, but also at one or more intermediate points, as at 18, two or more series of strengthening members will be embedded therein, one series in each section of said continuous girder. In these continuous girders also one or more metallic strengthening members 19 will be placed over the intermediate point or points of support, preferably in an inverted position, with the horizontal portions thereof near the upper surface of the girder and the inclined ends projecting downwardly. Two such inverted strengthening members are shown in Fig. 6; but the number thereof will be varied as desired. As shown in Fig. 6, these two members are formed of endless bands or loops of metal; but this is not necessary, as they may be of any of the other types of strengthening members shown in the drawings. These inverted strengthening members of the continuous girder take care of the tensile stresses generated in the girder at or near the intermediate points of support when said girders are unequally loaded.

In the formation of an arch the greatest tensile stresses are near the abutments, and in those cases the metallic strengthening members of my system will be formed with a curved portion 20 and an inclined portion 21, the latter being only at one end of the members. These members will be of varying lengths and placed, as shown in Fig. 18 of the drawings, with the tension members extending into the abutment, so as to give the maximum amount of metal at the abutments. Preferably in arches some members will be placed in upright position, while others will be inverted.

It will thus be seen that my improved girders and the like, while in general like those heretofore used, have the metallic members so arranged and of such lengths that not only will the shear at the ends of the girder be effectually taken care of, but also so that the maximum amount of metal in the horizontal portions of these metallic members is located at the point of maximum bending moment or tensile stress.

What I claim is—

1. A composite girder or the like comprising a body of cementitious material, and a plurality of metallic strengthening members embedded in said body and extending longitudinally thereof, said metallic members being provided at one end at least with a loop or stirrup extending at an angle with reference to the main portion thereof, and the two members of said loop being arranged laterally in said body.

2. A composite girder or the like comprising a body of cementitious material, and a plurality of metallic strengthening members embedded in said body near one face and extending longitudinally thereof, said metallic members having end portions of loop form projecting toward the surface of the body to form stirrups therein, the two members of said loop being arranged laterally in said body.

3. A composite girder or the like comprising a body of cementitious material, and a plurality of metallic strengthening members embedded in said body and extending longitudinally thereof, said metallic members being of different lengths and having end portions of loop form projecting toward the surface of the body and forming stirrups therein, the two members of said loop being arranged laterally in said body.

4. A composite girder or the like comprising a body of cementitious material, and a plurality of metallic strengthening members embedded therein and extending longitudinally thereof, said metallic members being provided with loops or stirrups at their ends, and a supporting-rod threaded through said loops.

5. A composite girder or the like comprising a body of cementitious material, and a metallic strengthening member embedded in said body and extending longitudinally thereof, said metallic member being a loop or band of metal having its members arranged laterally in the body and its end portions bent upwardly to form stirrups.

6. A composite girder or the like comprising a body of cementitious material, and a plurality of metallic strengthening members embedded in said body and extending longitudinally thereof, said metallic members being formed of bands of metal having the two sides substantially parallel and at least one of their ends bent upwardly to form a stirrup.

7. A composite girder or the like comprising a body of cementitious material, and a plurality of metallic strengthening members embedded in said body and extending longitudinally thereof, said metallic members being of different lengths and having end portions in the form of loops projecting toward the surface of the body, the two members of said loops being arranged laterally in said body.

8. A composite girder or the like comprising a body of cementitious material, and a plurality of metallic strengthening members embedded in said body and extending longitudinally thereof, said metallic members being of different lengths and having end portions projecting toward the surface of the body, one or more of said members being formed of a band or loop of metal with the

sides substantially parallel and the end portions bent upwardly to form stirrups.

9. A composite girder or the like comprising a body of cementitious material, and a plurality of metallic strengthening members embedded in said body and extending longitudinally thereof, said members being of different lengths and having a portion at one end at least projecting at an angle to the main part thereof, some of said members being placed in an upright position and others in an inverted position, the end portions of one or more of said members being provided with loops or stirrups arranged laterally in the body.

10. A composite continuous girder comprising a body of cementitious material, and a plurality of metallic strengthening members embedded in said body and extending longitudinally thereof, said metallic members extending for a portion of the length of the body only and the meeting ends of adjacent members being adjacent to a point of intermediate support of the girder, having end portions projecting upwardly, and another metallic strengthening member or members arranged over the point or points of intermediate support and embedded in the body near the upper face thereof and having end portions projecting downwardly, said end portions being in the form of loops having the two members thereof arranged laterally in the body.

11. A composite girder or the like comprising a body of cementitious material, and a plurality of metallic strengthening members embedded therein and extending longitudinally thereof, said metallic members being formed of endless loops or bands of metal having a portion or portions thereof bent at an angle to the remainder, and spacing-pieces secured to said bands.

12. A composite girder or the like comprising a body of cementitious material, and a plurality of metallic strengthening members embedded therein and extending longitudinally thereof, said members having portions thereof projecting upwardly, and spacing-pieces secured to said members and provided with downwardly-projecting lugs for resting on the centering.

In testimony whereof I, the said ROBERT A. CUMMINGS, have hereunto set my hand.

ROBERT A. CUMMINGS.

Witnesses:
ROBERT C. TOTTEN,
F. W. WINTER.