No. 852,970. PATENTED MAY 7, 1907.

D. B. LUTEN.

BRIDGE OF CONCRETE OR OTHER ANALOGOUS MATERIAL.

APPLICATION FILED FEB. 13, 1905.

3 SHEETS—SHEET 1.

Fig. 1.

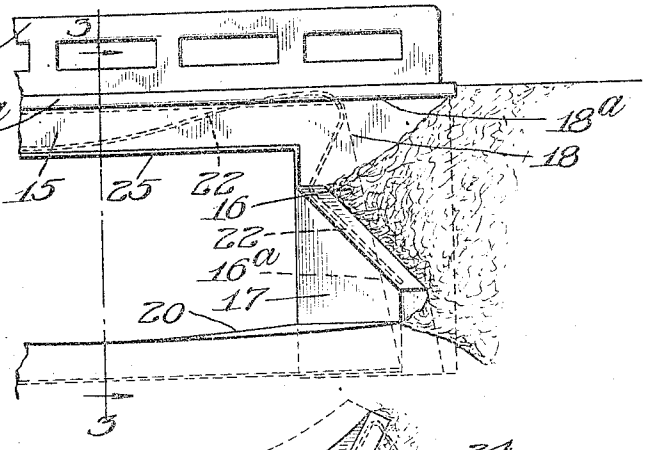


Fig. 2.

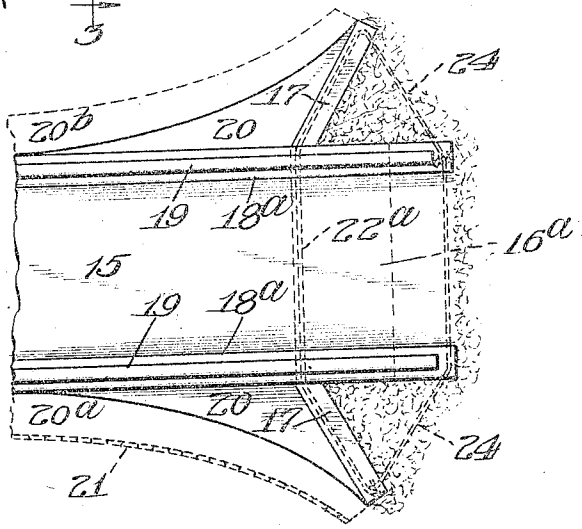
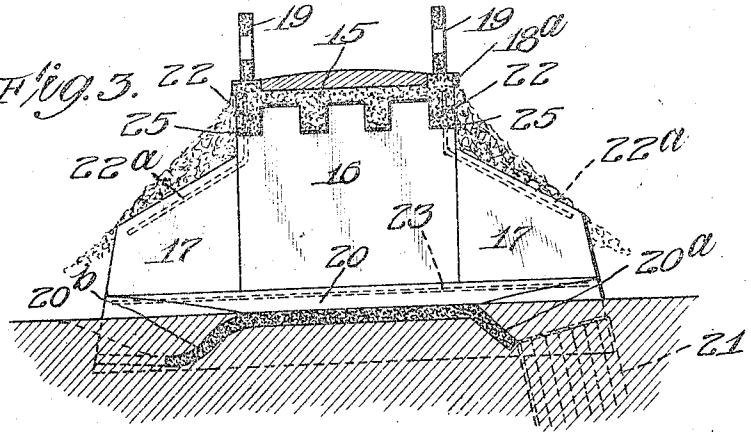


Fig. 3.



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3 SHEETS—SHEET 2.

Fig. 4.

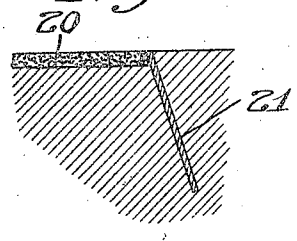


Fig. 5.

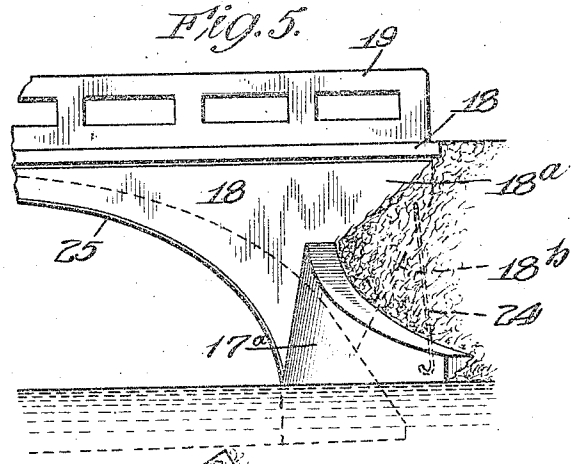


Fig. 6.

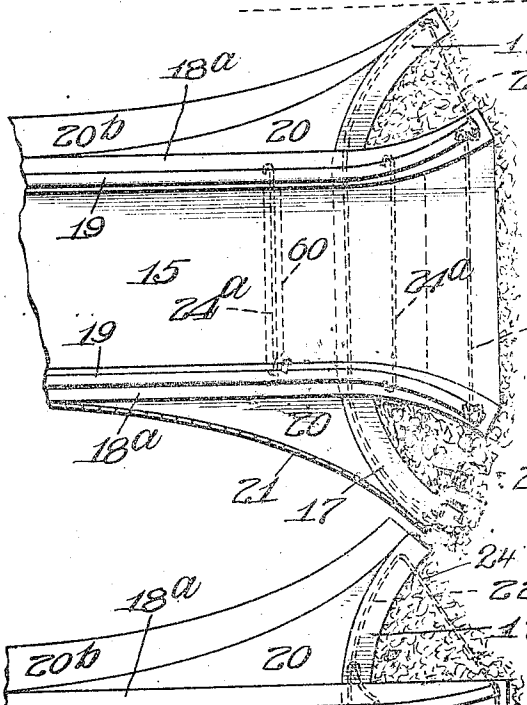
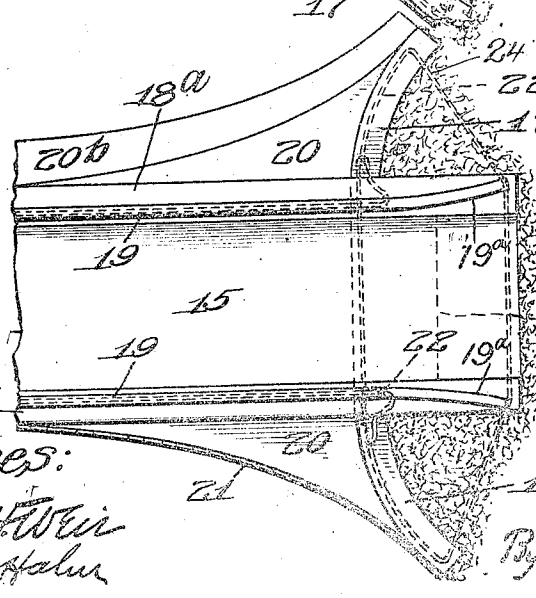


Fig. 7.



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3 SHEETS—SHEET 3.

Fig. 8.

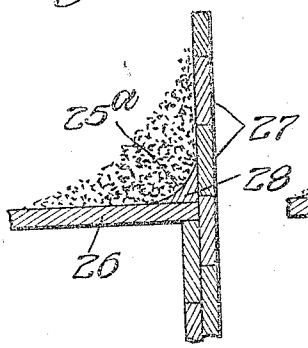


Fig. 9.

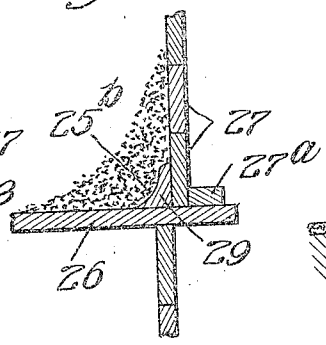


Fig. 10.

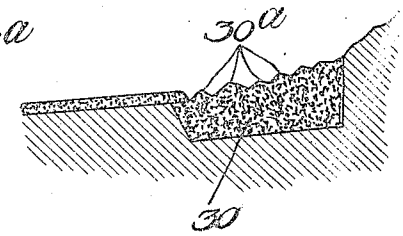


Fig. 11.

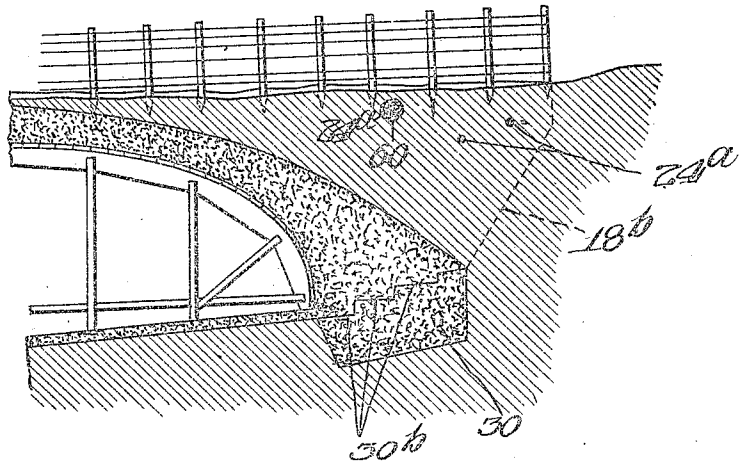
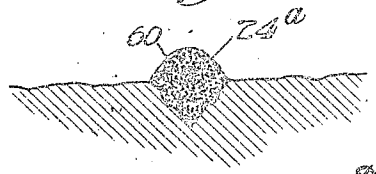


Fig. 12.



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UNITED STATES PATENT OFFICE.

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BRIDGE OF CONCRETE OR OTHER ANALOGOUS MATERIAL.

No. 852,970. Specification of Letters Patent. Patented May 7, 1907.

Application filed February 13, 1905. Serial No. 245,365.

To all whom it may concern:

Be it known that I, DANIEL B. LUTEN, a citizen of the United States, residing at Indianapolis, Indiana, have invented certain new and useful Improvements in Bridges or Arches of Concrete or other Analogous Material, of which the following is a specification.

This invention relates to girder bridges and to arch bridges which are made of concrete or other suitable material and to methods of erecting the same, and has for its general object to provide an improved structure of the class referred to which shall combine a maximum of strength and efficiency with increased economy of construction as compared with similar bridges at present in use.

The improvements to which my invention is directed pertain to various features of a bridge of this class, some of them having reference to improvements in the pavement usually employed where the bridge constitutes a viaduct across a stream, others having reference to improvements in the wings also customarily applied to such bridges, and still others having reference to improvements in the spandrel walls.

My invention will be readily understood upon reference to the accompanying drawings illustrating the same in the preferred forms and constructions of its several features, wherein—

Figure 1 is a side elevational view of substantially a longitudinal half of a bridge built in accordance with my invention; Fig. 2 is a top plan view of the same; Fig. 3 is a cross sectional view on the line 3—3 of Fig. 1; Fig. 4 shows a modification of a part of Fig. 3; Figs. 5 and 6 are views similar to Figs. 1 and 2, showing a bridge of the arch form provided with curved wings convex toward the stream and also with extended outwardly curved spandrel walls; Fig. 7 is a view similar to Fig. 6, showing straight extended spandrels with outwardly curved railings thereon; Figs. 8 and 9 are detail views illustrating the means and method of forming a molded corner designed to prevent ice and debris from breaking away the structure; Figs. 10 and 11 illustrate certain novel steps in the process of constructing the bridge; and Fig. 12 illustrates a means for protecting a tie-rod against rust and for tightening same when passed through an earth fill.

Referring to Figs. 1, 2 and 3, which show a bridge of the flat arch or girder type, and first briefly specifying the structural elements of the bridge, 15 designates the arch or girder or span over which the roadway extends, 16 designates the end wall or abutment herein shown as vertical but with a sloping back 16^a, 17 designates the wings, 18 designates the spandrel and 18^a the coping; 19 designates a concrete rail mounted on the coping, and 20 designates a pavement extending across the stream from abutment to abutment beneath the bridge.

Describing first those features of improvement which pertain to the pavement, it will be observed by reference to Fig. 3 that the pavement at the upstream end is turned downwardly at an oblique angle to form an apron as shown at 20^a, and is protected from undermining by a sheeting of piling or other suitable material indicated at 21, the upper edges of said piling slightly overlapping the lower edge of the apron. This sheeting may also be employed without the apron, the sheet piling overlapping the edge of the pavement, with the concrete apron omitted as in Fig. 4. In view of the well known indestructibility when continuously submerged, the wooden piling form of such sheeting is preferred on account of its comparative cheapness, where such piling is continuously under water. Of course, in situations where water is not present or only partially or intermittently present, galvanized iron sheeting or reinforced concrete or other piling will be employed. The opposite or down stream end of the pavement is also downwardly turned to form an apron which is preferably curved so as to present a concave upper surface, as shown at 20^b, such a form tending to deflect the current and prevent scour.

Referring next to the wings 17, which may be either straight, as shown in Figs. 1, 2 and 3, or curved as shown in Figs. 5 and 6, an important feature of improvement therein to which my present invention pertains resides in the reinforcing of said wings with steel rods 22 embedded therein, which rods are preferably, and as mor particularly shown in Fig. 3, extended upwardly into the spandrel walls, whereby the wing is not only reinforced against cracking longitudinally and transversely of its own length but is also securely joined to the body of the bridge proper. These reinforcing rods 22 may, if preferred, instead of being anchored in the spandrel walls, extend across the span in the form of a single continuous rod 22^a as shown in Fig. 2.

As an additional reinforcement and bond between the wings and the abutments or end walls a substantially horizontal rod or rods indicated at 23 in Fig. 3 may be employed, said rod or rods extending through the lower portions of the wings and an intermediate abutment somewhat above the level of the stream. A still further reinforcement for the wings is shown at 24 as consisting of a tension member preferably in the form of a steel tie anchored at one end in the wing preferably near its outer end and at its other end anchored in the spandrel wall or in the abutment, whereby the thrust against the wings created by the filling or embankment is largely taken up by said tension member, thus permitting the use of wings of less thickness and effecting an economy in the amount of material required and consequently in the cost of the structure. A modification of this device occurs where the rods 24 form integral parts of a continuous tie 22 from the end of one wing through the spandrel walls to the end of the other wing (Fig. 7).

Another feature of my invention is shown at 24^a, (Fig. 6), representing a tie rod from spandrel wall to spandrel wall to support the two walls against the thrust of the earth filling. In cases where no wings are used as with spandrels extended to hold the earth embankments, or where the spandrel walls are extended across a pier in bridges of more than one span, this tie from spandrel wall to spandrel wall accomplishes a great saving of the material that would otherwise be required in the spandrel walls to resist the thrust of the earth-filling. To prevent rust of these ties I sometimes embed them in a layer of cement mortar or concrete 60 just sufficient to thoroughly protect them, before covering with the earth fill, as shown in Figs. 6 and 12. Another feature of my invention relates to the use of tie rods to support spandrel or wing walls where the rods are to be buried in an earth fill. In such a case I embed the rod such as 24^a in a layer or beam of concrete 60 such that settlement of the earth fill will cause a sag in the embedded rod thus causing it to become taut to resist the pressure against the wall, as shown in Fig. 6. To accomplish this purpose I first place the tie in position without any covering and anchored at its ends so as to support the wall, then build the earth fill up to the level of the rod, and excavate a trench lengthwise of the rod in the earth fill. I then fill this trench with concrete covering 60, embedding the rod therein as shown in Fig. 12. The fill is then completed and settlement of the earth above the rod presses the surrounding concrete downward inducing a sag in the rod and concrete tending to lengthen the rod and hold it taut and in tension between its anchorages (Fig. 6).

Figs. 5 and 6 illustrate a modification in the form or contour of the wings, wherein said wings designated by 17^a, are formed with surfaces rounding or convex toward the stream, said wings being also provided with the same reinforcing members already described.

Heretofore, so far as I am aware, in the construction of bridges of this type the wings have been built up to meet the ends of the spandrel walls at the end of the bridge span. Another feature of my improved bridge which is shown in both the forms illustrated in Figs. 1 to 3 and Figs. 5 and 6 consists in extending the spandrels, as shown at 18^a, primarily for the purpose of a guard railing for the roadway; such a construction permitting a saving of material through the use of wings of decreased height, since in such a construction the earth embankment slopes from the end of the spandrel down to the top of the wing on each side at a reduced angle. As is well known, a wing being a retaining wall requires great mass for any considerable height; and by decreasing this height in the manner described through the extension of the spandrel walls, enough is saved in the wings to build the extended spandrels, and the roadway has the added protection of the latter. These extended spandrels may be supported by extending the wall down to the same foundation bed as the abutment, or they may be supported on the abutment itself as shown at 18^b in Figs. 5 and 11, in which case the weight of the extended spandrel acts as a cantaliver relieving the arch of part of its horizontal thrust against the abutment. It will also be observed in Fig. 6 that the ends of the extended spandrels are curved outwardly away from the roadway, such a form affording an easier entrance to the span, and presenting a more graceful appearance. A curved spandrel is, however, more difficult and expensive to construct than a straight spandrel; and consequently, where the cost does not permit a curvature of both the spandrel and the superposed railing the spandrel walls may be continued rearwardly in a straight parallel form, the railings being outwardly curved thereon, as shown at 19^a in Fig. 7.

A concrete footing at each end of the span, is indicated at 30 in Figs. 10 and 11, said footing having its upper surface inclined upward away from the span, as shown, to take the thrust of the arch. In the preferred form the upper surface of said footings, which constitute the foundations or feet of the abutments, is serrated as shown at 30^a in Fig. 10 or stepped as shown at 30^b in Fig. 11 to more effectually resist the outward thrust of the span transmitted through the abutment walls and prevent slipping of the latter on said footings.

The term "rod" in the claims is used in a generic sense and is intended to include all

forms of bars, plates, angles, webs, cables, built-up bars, or metal shapes of any kind adapted to the purpose described.

I claim:

1. A bridge or arch of concrete or other suitable material having a pavement in the bed of the stream, and a sheeting of piling or other suitable material to protect against undermining.

2. A bridge or arch of concrete or other suitable material, having a pavement in the bed of the stream with an apron and a sheeting of piling or other suitable material to protect against undermining.

3. A bridge or arch of concrete or other suitable material having wings, a pavement in the bed of the stream extending from wing to wing, and a sheeting of piling or other suitable material overlying the margin of said pavement.

4. A bridge or arch of concrete or other suitable material having wings, a pavement in the bed of the stream extending from wing to wing and provided with an apron, and a sheeting of piling or other suitable material overlying the margin of said apron to protect against undermining.

5. A bridge or arch of concrete or other suitable material having a pavement in the bed of the stream, said pavement having an apron with a depressed horizontal end.

6. A bridge or arch of concrete or other suitable material having a pavement in the bed of the stream, said pavement having an apron at its down-stream edge ending in a horizontal projection depressed below the level of the pavement.

7. A bridge or arch of concrete or other suitable material having spandrel walls and a wing or wings reinforced with embedded rods joining the wings to the spandrel walls.

8. A bridge or arch of concrete or other suitable material having a curved wing with exposed convex surface and reinforced with embedded rods.

9. A bridge or arch of concrete or other suitable material having a curved wing or wings reinforced with rods embedded near the convex outer surface of the wings.

10. A bridge or arch of concrete or other suitable material having a wing joined to the arch and spandrel by embedded rods near top and bottom.

11. A bridge or arch of concrete or other suitable material having spandrel walls and a wing or wings reinforced with rods embedded near the convex surface and extending into the adjacent spandrel

12. A bridge or arch of concrete or other suitable material having wings joined thereto by tie-rods embedded in said wings and passed through the body of the bridge or arch.

13. A bridge or arch of concrete or other suitable material having spandrel walls and wings, with tie-rods embedded in said wings and anchored in said spandrel walls, and other tie-rods embedded in said wings and passed through the body of the bridge or arch.

14. A bridge or arch of concrete or other suitable material having wings joined thereto by rods embedded in said wings and extending into the abutments.

15. A bridge or arch of concrete or other suitable material having wings joined thereto by rods embedded in said wings and extending into and through the abutments.

16. A bridge or arch of concrete or other suitable material having wings joined thereto by rods embedded in one of said wings and extending through the abutment into the opposite wing.

17. A bridge or arch of concrete or other suitable material, having a layer of concrete across the bed of the stream, and ending at its edge in an extension projecting downwardly into the bed of the stream.

18. A bridge or arch of concrete with a layer of concrete crossing the bed of the stream, and faced with sheet piling.

19. A bridge or arch having wings of concrete or similar material reinforced with embedded members and braced by a pavement or apron from wing to wing.

20. A bridge or arch having a wing of concrete or similar material reinforced with embedded tension members and braced by a transverse member near the outer end of the wing.

21. A bridge or arch of concrete or other suitable material having extended spandrels cantilivered on the abutments as supports, and with their ends embedded in the earth fill of the embankments.

22. A bridge or arch of concrete or other suitable material having spandrel walls with extended ends overhanging the abutment, said spandrel walls being curved outwardly at their ends.

23. A bridge or arch of concrete or other suitable material having wings and extended spandrel walls, said wings and walls being curved toward each other at their outer ends.

24. A bridge or arch of concrete or other suitable material having spandrel walls extended at their ends along the roadway beyond the end of the span, said extended spandrel walls being surmounted by outwardly curved railings.

25. A bridge or arch of concrete or other suitable material provided with curved spandrels surmounted by more sharply curved railings.

26. A bridge or arch of concrete or other suitable material provided with spandrel walls surmounted by railings extending near one edge of the spandrel wall and curving across to the other edge of the spandrel wall.

27. A bridge or arch of concrete or other

suitable material having wings, and a tie-rod connecting said wings around the end of the body.

28. A bridge or arch of concrete or other suitable material having wings with tie-rods embedded in concrete joining the ends of the wings to the body of the arch.

29. A bridge or arch of concrete or other suitable material having wings and a rod or rods embedded in concrete joining the ends of said wings.

30. A bridge or arch of concrete or other suitable material having wings with their outer ends joined by rods passing through the earth embankment.

31. A bridge or arch of concrete or other suitable material having spandrel walls with a tie-rod extending from one wall to the other said tie rod being embedded in concrete.

32. A bridge or arch of concrete or other suitable material having spandrel walls confining earth filling and tie-rods extending through the filling between said walls, and anchored at their ends in the walls.

33. A bridge or arch of concrete or other suitable material with spandrel walls, tie-rods joining the walls and embedded in a concrete beam covered by the earth filling.

34. A bridge or arch of concrete or other suitable material having a wing below the level of the roadway and a light spandrel projection surmounted by a guard rail extending into an earth filling back of the wings.

35. A bridge or arch of concrete or other suitable material with low wings and spandrel walls extended back of the wings.

36. A bridge or arch of concrete or other suitable material with spandrel walls extended back of the wings, and wings of height sufficient to hold the earth fill that escapes the ends of the spandrels.

37. A bridge or arch of concrete or other suitable material with spandrel walls extended back of the wings, and curved wings at the foot of the slope of earth fill escaping from the ends of the spandrels.

38. A bridge having a wing of concrete or similar material backed by earth filling with tension members embedded in the wing transverse to the earth pressure inducing tension therein.

39. A bridge having a wing supported near its ends against the pressure of earth backing and a tension member embedded near its exposed face and oblique to its base.

40. A bridge having a wing with a tension member embedded extending in a direction from upper end toward diagonally opposite lower end.

41. A bridge having a wing with embedded diagonal tension members bonding the wing to the bridge.

42. A bridge having a wing of concrete or similar material, with tension members embedded in a direction oblique to its base.

43. A bridge having a wing of concrete or similar material, with tension members embedded near one face and in a direction oblique to its base.

44. A bridge or arch of concrete or similar material having a footing upwardly inclined away from the span.

45. A bridge or arch of concrete or similar material having a footing provided with a roughened upper surface upwardly inclined away from the span.

46. A bridge or arch of concrete or similar material having a footing provided with an upper surface upwardly stepped in a direction away from the span.

47. A bridge or arch of concrete or similar material having footings upwardly inclined away from the ends of the span and a pavement extending between and at its ends stepped on said footings.

48. A bridge or arch of concrete or other suitable material, having a tie joining spandrel to spandrel, and spandrel to end of wings, and passing through the earth embankment.

49. A bridge having a wing of concrete or similar material backed by earth filling, with reinforcing members embedded near the exposed face of the wing and oblique to its base.

50. A bridge having a wall of concrete or similar material, backed by earth filling with reinforcing members embedded in the wall in a direction substantially parallel to the slope of earth backing.

51. A bridge or arch of concrete having a wing with an anchor rod extending from near the outer end of the wing into the earth embankment and embedded in concrete.

Signed by me at Indianapolis county of Marion State of Indiana in the presence of two witnesses.

DANIEL B. LUTEN.

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