(No Model.)

3 Sheets—Sheet 1.

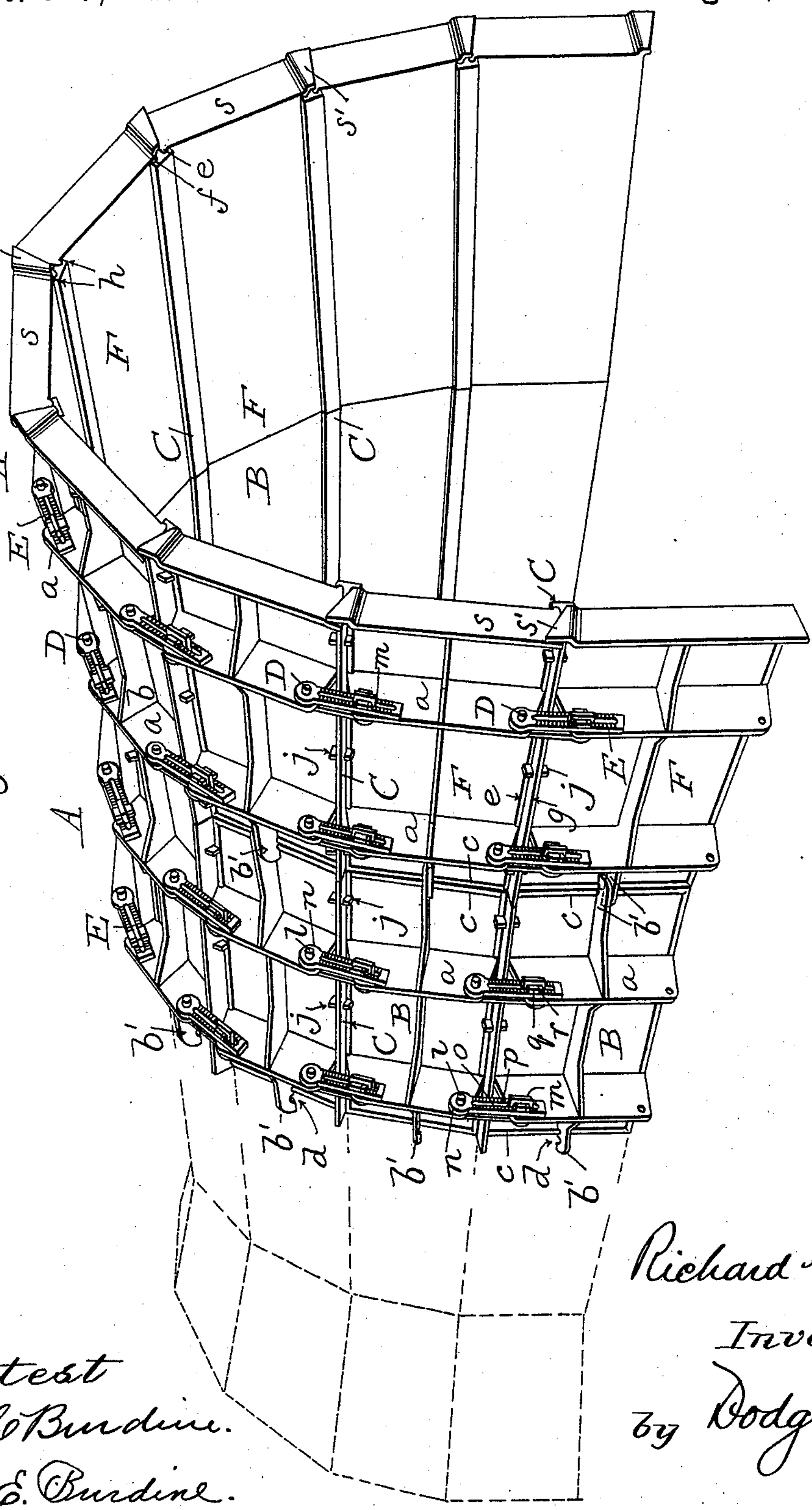
R. GRAY.

METAL ARCH FOR CULVERTS.

No. 587,392.

Patented Aug. 3, 1897.

Fig. 1.



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Richard Gray
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R. GRAY.

METAL ARCH FOR CULVERTS.

No. 587,392. Patented Aug. 3, 1897.

Fig. 2.

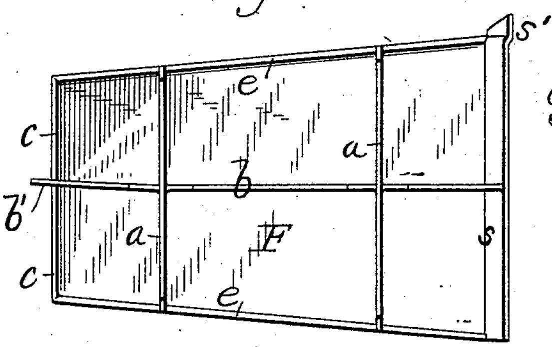


Fig. 3.

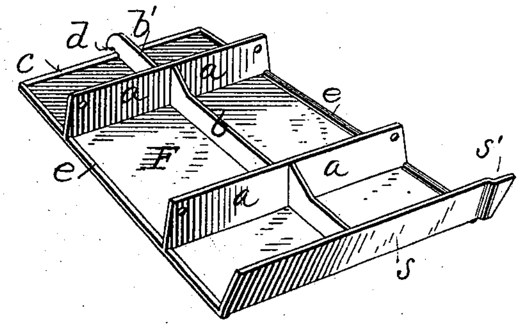


Fig. 4.

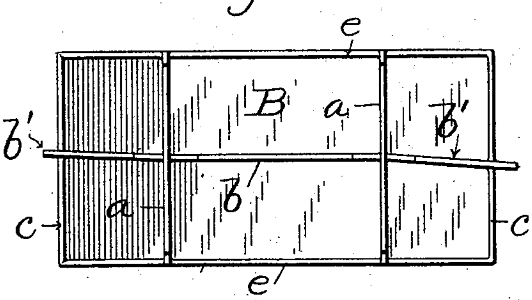


Fig. 5.

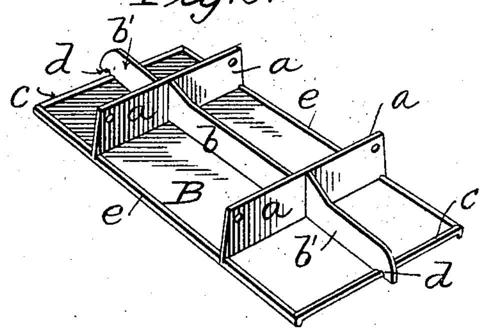


Fig. 6.

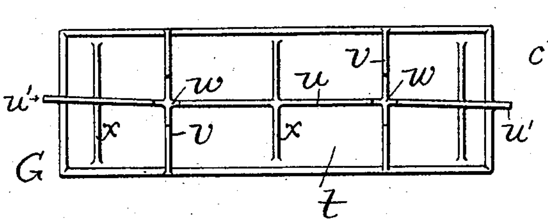


Fig. 7.

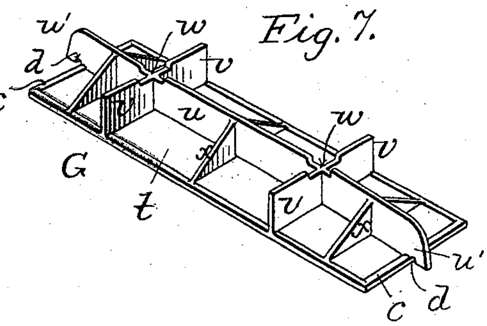


Fig. 8.

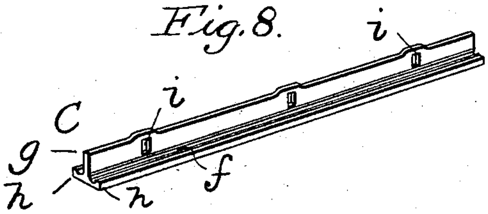
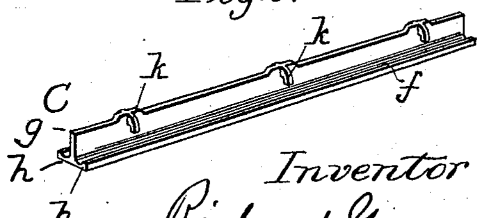


Fig. 9.



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(No Model.) 3 Sheets—Sheet 3.

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Fig. 10.

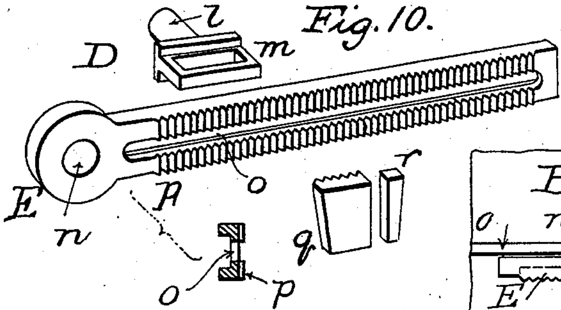


Fig. 11.

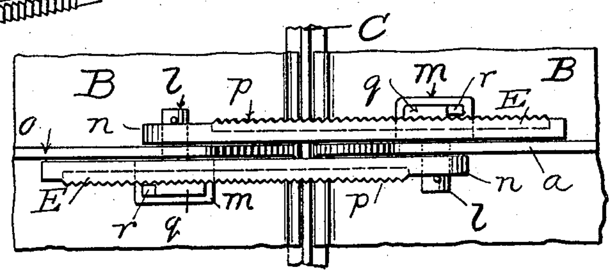


Fig. 12.

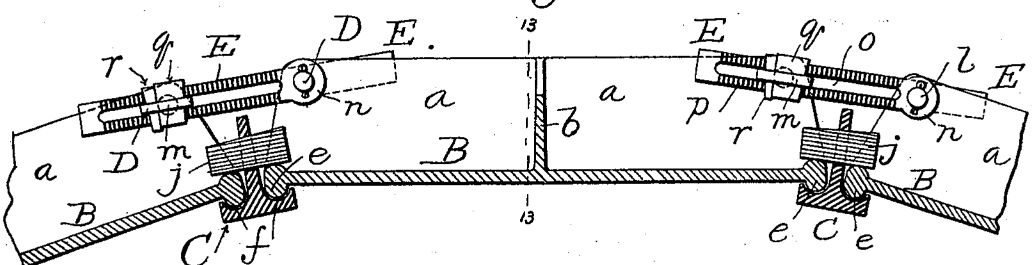


Fig. 13.

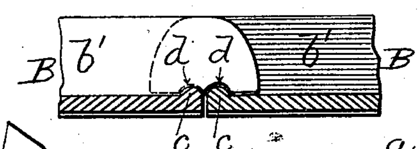


Fig. 14.

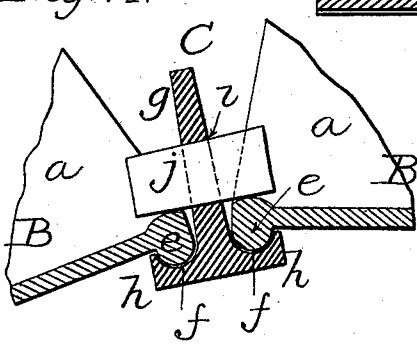
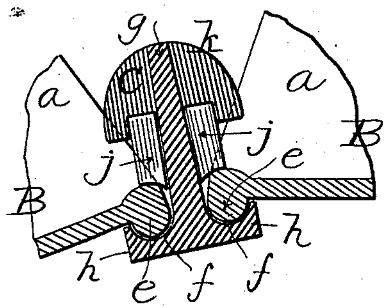


Fig. 15.



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Inventor

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Attys.

UNITED STATES PATENT OFFICE.

RICHARD GRAY, OF BLOOMINGTON, ILLINOIS.

METAL ARCH FOR CULVERTS.

SPECIFICATION forming part of Letters Patent No. 587,392, dated August 3, 1897.

Application filed May 10, 1897. Serial No. 635,871. (No model.)

To all whom it may concern:

Be it known that I, RICHARD GRAY, a citizen of the United States, residing at Bloomington, in the county of McLean and State of Illinois, have invented certain new and useful Improvements in Metal Arches for Culverts, of which the following is a specification.

My invention relates to metal arches designed for culverts and the like; and it consists in various features hereinafter set forth and claimed.

Arches in general may be divided into two classes, masonry and metallic, and the former, usually of brick or stone, is made of many pieces fitted together, not otherwise fastened to one another except by the small adhesive force of the cement between them.

Metallic arches are either hinged or elastic, the former comprising two pieces hinged at three points, the latter composed of one piece. Now the effect of a uniform load upon an arch is a uniform compression strain in all its pieces and there is consequently no tendency to distortion or change in shape. On the other hand a concentrated load tends to change the shape and give rise to bending strains, the bending being positive or downward immediately under the load and negative or upward at the unloaded point. It is clear that these changes in shape or form are mutually dependent—that is to say, if the arch cannot bend down at any point it will not bend up at any other point, and vice versa—and hence when provision is made for one it is also made for the other.

In the masonry arch the positive strain tends to open the joints between the voussoirs at the intrados, while the negative strain tends to open the joints at the extrados. It is plain, therefore, that if the voussoirs are firmly united, so as to prevent sliding or opening at the joints, the stability of the arch will be increased.

Of course a metallic arch is subjected to the same strains as a masonry arch; but by reason of the construction I have devised I produce an arch which may be either elastic or hinged and which overcomes the theoretical objections above pointed out. It is a fact well understood that the discharge capacity of a pipe may be materially increased by making the ends of the pipe flaring or conically divergent, and I take advantage of this law or principle in the construction of my metallic arch or culvert and cause the ends thereof to flare outward or diverge.

I will now point out briefly some objections existing against culverts as usually constructed as shown by practical experience.

Stone culverts are too expensive for general use, especially where stone of the requisite quality does not abound. Brick culverts have been found wanting in permanency, the multiplicity of joints rendering necessary a large proportion of cement, which does not well resist the combined action of water and frost. The vitrified-pipe culvert is too limited in capacity, while the steel-pipe culvert is expensive and rusts rapidly. The cast-iron-pipe culvert is limited in capacity (five feet diameter) and is difficult to transport and erect, especially where it is necessary to transport the heavy weight (seven and one-half tons) by wagons over ordinary highways. Besides these objections the height of the grade will frequently preclude the use of a circular waterway. With these objections, theoretical and practical, existing it is particularly desirable to produce a culvert having the least cost combined with greatest strength and durability, and to this end I employ metal, preferably cast-iron, to the exclusion of wrought-iron or steel bolts or other parts, and so connect the voussoirs or pieces composing the arch that they may be secured to one another at most any desired angle. As a result of this the form in cross-section of the culvert may be varied without any change in the form or size of its several pieces, the area or capacity being regulated by the number and adjustment of the voussoirs and not by changing their form or dimensions. There are several important advantages in this construction. First, the cast-iron combines the greatest strength and durability when buried in earth or submerged in water; second, the pieces or sections are of such size and weight as to be readily handled and transported; third, the several parts are so designed and formed that they not only perform their functions as part of the structure, but are also easily molded, so that the castings will be true to pattern, thereby avoiding subsequent fitting and leaving the skin of the casting unbroken; fourth, I avoid a multiplicity of patterns, secure simplicity in erection, and extend the range of adaptation to varying circumstances by providing a possible adjustment to any curve, fixing and securing the voussoirs in such adjustment without changing the form or dimensions of any piece composing the arch, and, fifth, I adopt a form answering the requirements of economy according to a well-known fact or principle of hydraulics.

Bearing in mind the general facts and principles outlined above I will now describe in detail the construction of my improved arch or culvert in connection with the drawings, in which—

Figure 1 is a perspective view of a culvert constructed in accordance with my invention, a portion being represented in dotted lines; Figs. 2 and 3, respectively plan and perspective views of one of the end sections or plates; Figs. 4 and 5, respectively plan and perspective views of one of the sections or plates of the main body; Figs. 6 and 7, similar views of the footings or foot-pieces; Figs. 8 and 9, perspective views of two different forms of filling-pieces; Fig. 10, a perspective view of the parts of one of the plate-connecting devices or ties separated; Figs. 11 and 12, respectively plan and side elevation of the joint or connection between the plates or sections of each arch; Fig. 13 a sectional view on the line 13 13 of Fig. 12, showing how the arches are connected with each other; and Figs. 14 and 15, sectional views showing two different means for securing the filling-pieces.

The culvert comprises one or more arches A, whose walls are parallel, or one or more of such arches combined with one or more arches A′, whose walls are not parallel. In other words, the culvert may or may not have one or more of the flaring end sections.

Each arch A is made up of a series of plates B, which are duplicates of each other, said plates being flat on the inner face and provided on the back or outer face with transverse flanges a and a longitudinal flange b, Figs. 4 and 5. Of course the number of these flanges may be increased if it should be found that the requirements demand additional strength.

The ends b' of the flanges b are arranged at an angle to the main body portion thereof, as in Fig. 4, so that when two arches are brought side by side the end flanges b', which project beyond the ends of the plates, may overlap each other and engage a rib c, formed on the respective plates, as shown in Fig. 13, the said flanges being notched, as at d, to permit such engagement and thereby hold the arches together.

Each plate B is further provided on its longitudinal edges, preferably on both the front and back, with a bead or rib e, Figs. 5, 12, 14, and 15, which is designed to fit in curved seats f, formed in the ⊥-shaped filling-piece C. The filling-piece C has an upright web g, which projects up between the plates B, and lateral webs h, in which the curved seats f are formed, as shown in Figs. 8, 9, 12, 14, and 15. In the upright web g is a series of holes i, through which are driven keys j, by means of which the plates are connected to the piece C. Instead of this construction the piece C may be provided with lateral lugs k, Figs. 9 and 15, between which and the plates B keys j are inserted. While the plates are thus connected with the intermediate filling-piece they are capable of a motion upon the latter when it is desired to adjust the relative position of the plates. The flanges a on the back of each plate B are perforated to receive the eyebolts D, which latter project beyond each side face of the flange, as in Fig. 11. The stem l of the bolt is made cylindrical and extends beyond one side of the flange, while the open head or eye m, which is elongated laterally, projects beyond the opposite side.

E indicates a link or bar having at one end an eye n to fit upon the cylindrical stem l of one bolt and also provided with a longitudinal slot o to receive the head or eye m of the other bolt, as shown in Figs. 10, 11, and 12, the outer face of each bar or link being serrated, as at p, to afford a rigid locking engagement for a correspondingly-serrated wedge q.

After the bolts D are placed in the holes of the respective flanges one bar E is placed at one end on the cylindrical stem of one bolt and receives the head of the other bolt in its slot o. The other bar is applied to the same bolts, but in a reverse position. After the plates have been given the desired adjustment or inclination the wedges q are then put into the eyes m, where they engage the serrations on the bars, and then the plain wedges r are also placed in the eyes alongside the wedges q and driven in tight, thereby locking each bar at one end to the respective bolts. It will be noted, however, that at one end each bar or link E has a pivotal connection with one of the bolts—being journaled on the cylindrical stem—and that each bolt is free to turn in the flange a, by which it is carried, thereby permitting a slight amount of flexibility to the arch.

The end arches A′ are built up in a similar manner; but the plates F, instead of being rectangular, are made trapezoidal, as shown in Figs. 2 and 3, and have at the outer or wider end an upright flange s with an offset part s'. Aside from these differences and the further difference that the longitudinal flange b projects beyond the plate at one end only, these plates F are similar to the plates B and are connected with each other in the manner already described.

Each of the arches A or A′ rests upon a foot-piece G, Figs. 6 and 7, which latter comprises merely a flat plate t, with longitudinal and transverse flanges u and v. Where the flanges u and v intersect they are cut away at their upper edges, as at w, so that the lowermost plates of each arch which set down upon the foot-pieces may engage therewith. Additional webs x may be provided here or on any of the other plates when deemed necessary.

It will be noticed upon reference to Fig. 6 that the ends u' of the flanges u are arranged at an angle to the main body to permit overlapping, and that they are undercut, as at d, to engage the ribs d on the plates.

After the arch or culvert is built up, as shown in Fig. 1, it is covered with dirt.

Where desired, the filling-piece C may be made long enough to extend from one arch to the next.

What I claim is—

1. A culvert comprising one or more arches, made up of metallic plates adjustably connected with each other.

2. A culvert comprising a sectional metallic arch flaring at one or both ends.

3. A culvert comprising one or more arches, made up of unyielding metallic plates adjustably connected with each other.

4. A culvert comprising a body portion made up of one or more arches, each of which arches is composed of rectangular metallic plates suitably connected; and an end portion or arch made up of a series of metallic plates of trapezoidal form, also suitably connected to each other and to the plates of the body portion.

5. An arch made up of metallic plates connected adjustably with each other and having the interposed longitudinal filling-pieces.

6. An arch made up of metallic plates adjustably connected with each other on the outer face, and interposed ⊥-shaped longitudinal filling-pieces.

7. An arch made up of a series of metallic plates; and an adjustable connection between the plates on their outer faces, whereby any desired curvature may be given to the arch.

8. A culvert comprising a series of connected arches, each of which arches is made up of metallic plates adjustably connected with each other; the plates of similar arches being duplicates of each other.

9. An arch made up of a series of adjustably-connected metallic plates, and a metallic foot piece or base.

10. The section or plate provided with the longitudinal flange b having the ends b' thereof out of line.

11. The section or plate provided with a rib c and with undercut end b'.

12. An arch comprising a series of trapezoidal metallic plates connected with each other.

13. In combination with plates having the ribs e; the ⊥-shaped filling-piece C provided with seats f; and keys for uniting the piece C to the plates.

14. In combination with the plates or sections provided with perforate ribs a; bars or links connecting said ribs upon opposite sides thereof, the said bars being reversed in position; and bolts D, D, passing through said perforate ribs and holding the links in their adjusted position.

15. In combination with plates or sections; bolts D provided with stem l and eye m; bars E provided with slot o and eye n; and means for uniting the bars to the eyes n.

16. In combination with plates or sections; bolts D provided with stem l and eye m; bars E provided with eye n, and slot o, and wedges passing through the eyes m.

17. In combination with two plates or sections and bolts journaled therein; two bars or links each of which is journaled at one end upon the bolt and secured at the opposite end to the head of the bolt.

In witness whereof I hereunto set my hand in the presence of two witnesses.

RICHARD GRAY.

Witnesses:
S. R. GRIFFITH,
F. R. HILL.