(No Model.)

P. H. JACKSON.

2 Sheets—Sheet 1.

BUILDING AND BRIDGE CONSTRUCTION.

No. 371,843. Patented Oct. 18, 1887.

Fig. 1.

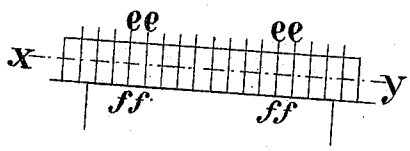


Fig. 2.

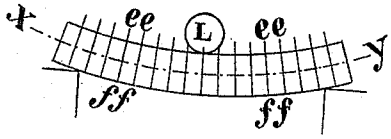




Fig. 4.

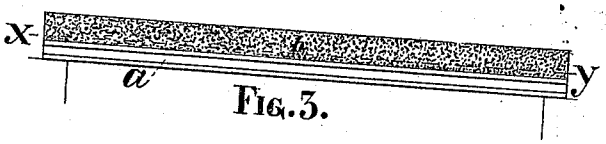


Fig. 3.



Fig. 5.



Fig. 7.

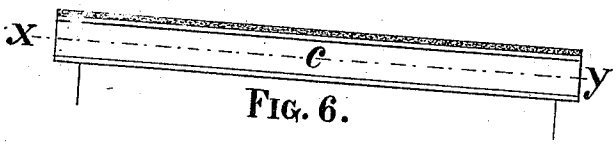


Fig. 6.

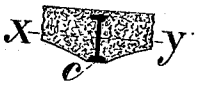


Fig. 7a.

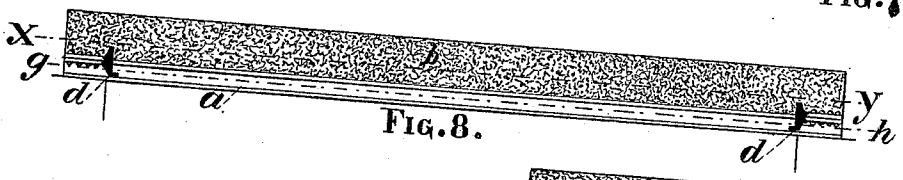


Fig. 8.

Fig. 8a.

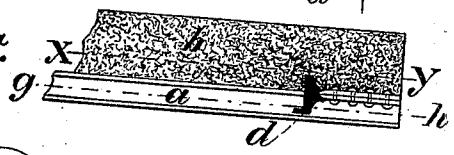


Fig. 9.

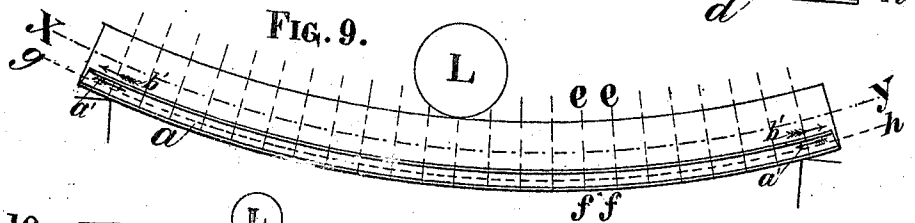
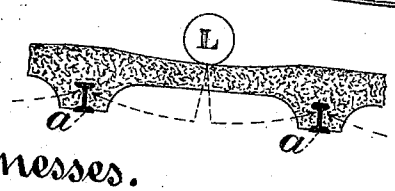


Fig. 10.



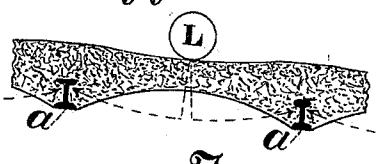


Fig. 11.

Witnesses.

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(No Model.) 2 Sheets—Sheet 2.

P. H. JACKSON.

BUILDING AND BRIDGE CONSTRUCTION.

No. 371,843. Patented Oct. 18, 1887.

Fig. 12.

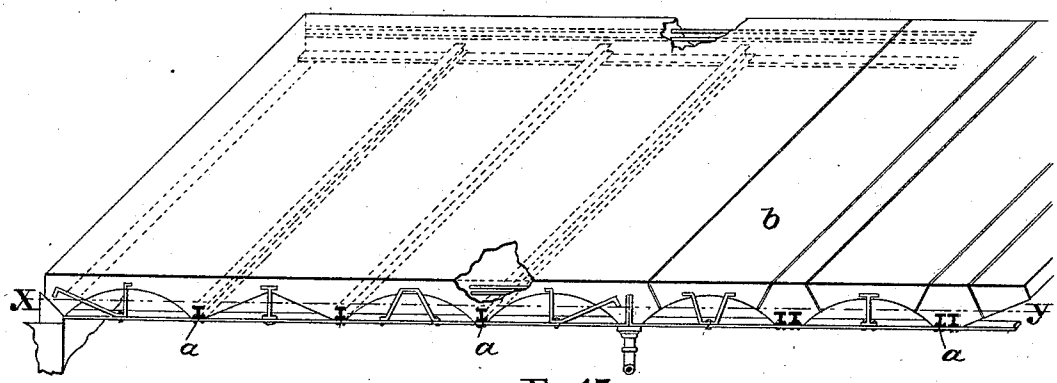


Fig. 13.

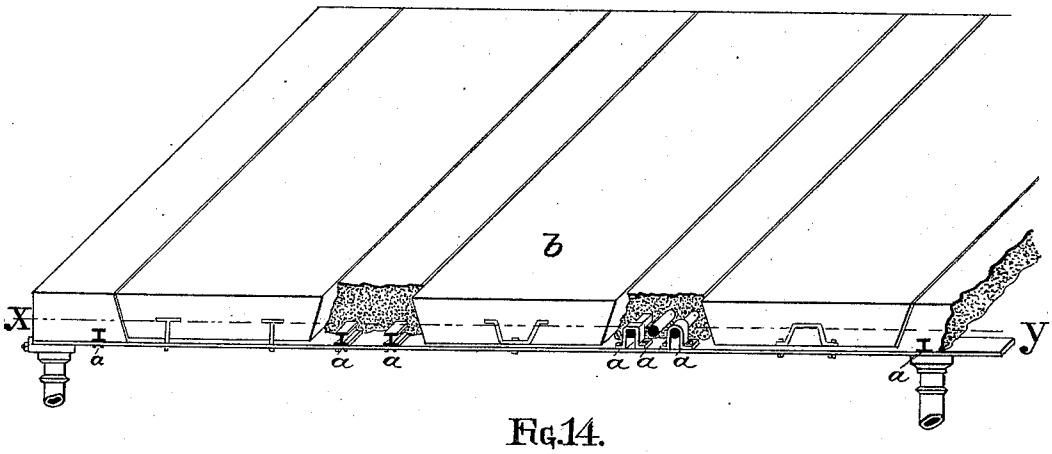
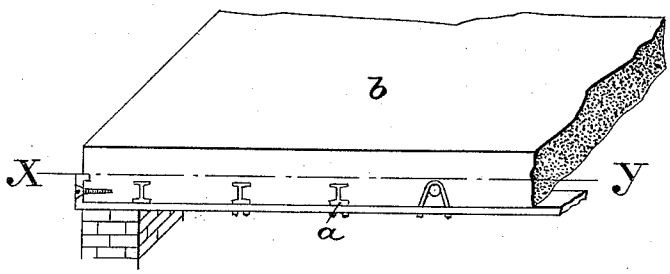


Fig. 14.



Witnesses:

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UNITED STATES PATENT OFFICE.

PETER H. JACKSON, OF SAN FRANCISCO, CALIFORNIA.

BUILDING AND BRIDGE CONSTRUCTION.

SPECIFICATION forming part of Letters Patent No. 371,843, dated October 18, 1887.

Application filed January 7, 1886. Serial No. 187,930. (No model.)

To all whom it may concern:

Be it known that I, PETER H. JACKSON, of the city and county of San Francisco, and State of California, have invented an Improvement in Building and Bridge Construction; and I hereby declare the following to be a full, clear, and exact description thereof, sufficient to enable any person skilled in the art to which my invention belongs to make and use the same, reference being had to the accompanying drawings, forming part of this specification.

This invention relates to girders, bridges, buildings, sidewalks having vaults or chambers beneath them, &c.

The object is to strengthen bridges, buildings, &c., in the construction of which concrete, artificial stone, brick, and cement or mortar, or similar materials, are largely employed, and at the same time employ a proportionally small quantity of metal, dispensing with the large and costly metal beams and girders now employed, and thus decreasing materially the cost of construction, while increasing the strength and security of the structure.

With these objects in view my invention consists, broadly, in building into the lower part of the body of cement, artificial stone, or similar material, the part below the "neutral" line, which is subjected to tensile strain when the bridge, floor, or structure is loaded, a small metallic **I**-shaped beam or beams, cemented to the surrounding material, which beam makes up the deficient tensile strength of the body in which it is embedded.

Furthermore, the invention consists in employing the materials of the construction or body to aid in its own support; furthermore, in means for sustaining the ends of the structures, as in bridges, floors, sidewalks, roofs, and the like platforms of these materials, whether constructed in whole or in divisions or sections, in flat sections or in arches, employing the material of the platform or body to resist compressive force and the longitudinal supporting tie or ties resisting the tensile strain.

Furthermore, the invention consists in arranging the flanged metal ties in the lower part of the floor, bridges, &c., below its neutral line, parallel with one another and in the same horizontal plane, so that when a load rests on the body between two parallel flanged beams and the arch is thereby deflected the direction of thrust of the material will be against the facing sides of the said beams at an upward angle, (as indicated by the dotted lines and arrows in Figs. 10 and 11,) compared to the direction before deflection took place, and the upper flanges of the beams, beneath which the material rests, operate to hold the material between the beams and prevent it from slipping over or being forced over them; and, finally, in securing to the small beams or to a flat bar near each of its ends and above its neutral line upright resistance-plates, which, when the beam is embedded in the structure below the neutral line thereof, will resist the extension of the surrounding material.

Bridges, floors, sidewalks, girders, and the like made of cement, artificial stone, concrete, or similar material possess the property of great resistance to compression or crushing, but are comparatively very weak in resisting tension or a force tending to separate or destroy the cohesion of the particles; and to furnish the required strength of this weak part to equalize the great compressive resisting property of the material above the neutral axis, I employ these small metallic flanged beams, built in the weak part of the body, so that the structure may be of uniform strength in resisting tension and compression.

All structures—such as sidewalks with vaults beneath them, floors with chambers below them, beams and girders, bridges, and the like—are subjected to transverse strain, caused by loads or weight on their tops, and have to resist compression on their upper parts above the neutral line and tension below their neutral line, the line where these two forces of diametrically-opposite character meet and neutralize each other lying half-way between the top and bottom of the body, and being herein denominated the "neutral" line.

In the accompanying drawings, in which like letters of reference indicate corresponding parts, Figures 1 and 2 are longitudinal vertical

sectional views illustrating the action of forces, and adapted in that respect to a bridge, sidewalk, floor, beam, girder, or any such structure, resting on end supports and adapted to be loaded and subjected to transverse strain, Fig. 1 representing the structure when there is no load upon it, and Fig. 2 representing it deflected under the weight of the load L, the vertical imaginary lines *e f e f* in Fig. 1 being changed when the structure is deflected into radial lines, as shown in Fig. 2, *x y* in both views representing the neutral line, where the compressive and tensile forces neutralize each other. Fig. 3 is a longitudinal vertical sectional view of a bridge, sidewalk, girder, or like structure, resting on end supports, with a small metallic flanged beam built in longitudinally and cemented to the surrounding material below its neutral axis, acting as a resistant to the tensile strain. Fig. 4 is a cross-sectional view of a structure similar to that shown in Fig. 3, showing the small metallic flanged beams embedded and cemented in a flat body of the cement or concrete or like material. Fig. 5 is a cross-sectional view showing the small flanged metallic beam embedded at the foot of an arch and cemented to the surrounding material. Fig. 6 is a longitudinal vertical sectional view of a bridge, sidewalk, girder, or such structure, resting on end supports and constructed in the usual manner, with a large metallic beam built in the material and adapted to carry the entire load by resisting both the compressive force and tensile strain. Fig. 7 is a cross-sectional view of a structure similar to that shown in Fig. 6, showing the large beam inclosed in a flat body of the surrounding material. Fig. 7ª is a cross-sectional view showing the large beam inclosed at the foot of an arch which it supports. Fig. 8 is a longitudinal vertical sectional view of a bridge or like structure, showing a small beam or flat bar embedded therein beneath the neutral line of the structure, having fastened to it near each of its ends and above its neutral line a resistance-plate, *d*. Fig. 8ª is an enlarged view of the right-hand portion of Fig. 8, showing more plainly one of the resistance-plates and the position and manner in which it is attached upon the beam or bar. Fig. 9 is a longitudinal vertical sectional view of a bridge or like structure of cement, artificial stone, or similar material, in which my small flanged beam is embedded below the neutral line *x y*, but not cemented to the surrounding material, the bridge being shown considerably deflected under the heavy load L, so that the beam *a* is shortened above its neutral line *g h*, shortening to the greatest extent at its top, while the structure is lengthened below its neutral line *x y*, this view illustrating the action of the two forces without the restraint of unity between the beam and structure. Figs. 10 and 11 are vertical cross-sectional views of a bridge or other structure having my small metallic flanged beams embedded and cemented in the footings of the arches, below the neutral lines of the arches and parallel to one another, the arches being shown deflected by the weight of loads L, and the direction of thrust against the facing sides of the beams of the arch on which the weight is resting being then at a slightly-upward angle, as indicated by the dotted lines and arrows, compared to the direction before deflection took place. Fig. 12 is a perspective view of a bridge, sidewalk, or like structure, resting on end supports and covering a chamber or open space beneath, and constructed with arches or bays, showing the longitudinal end ties supporting and having bolted to them the ends of the small flanged beams, which are embedded in the footings of the arches, and showing a part of the structure made solid, while the remainder is made in sections. Fig. 13 is a perspective view of a bridge, sidewalk, or like structure, resting on end supports and covering an open space or chamber, and consisting of flat sectional arches having flanged metallic beams embedded in the supporting-sections below their neutral line, and supported at their ends by longitudinal non-embedded ties. Fig. 14 is a perspective view of a bridge, sidewalk, or like structure, resting on end supports and covering an open space beneath, and consisting of a body of cement, artificial stone, or the like, having a flat upper and flat lower surface, having small flanged metallic beams embedded in it below its neutral line, the ends of these embedded beams being supported on and secured to longitudinal non-embedded ties.

All structures—such as sidewalks with vaults beneath them, floors with chambers below them, and bridges, and also girders employed in such structures—are subject to transverse strain caused by loads on their top, and have to resist compression of their upper halves above their central neutral line and tension or strain below their neutral line or plane, the neutral line, which lies in the central horizontal plane of the body or structure, being the dividing line between the two opposing forces. In order to illustrate the action of these two opposing forces, I have shown in Fig. 1 a longitudinal vertical sectional view of a bridge, sidewalk, or similar structure supported on end supports, as it appears before any weight or load is rested upon it; and in Fig. 2 I have shown the same structure deflected by the weight of a load, L, the imaginary vertical parallel lines *e f e f* in Fig. 1 being changed when the structure is deflected into radial lines, as shown in Fig. 2, *x y* in both views representing the neutral line, where the compressive and tensile forces neutralize each other. It will be seen from these views that the compressive and tensile forces neutralize each other at the central horizontal plane or neutral line of the body, the tensile strain causing the disturbed particles to extend the greatest at the bottom, this extension gradually diminishing up to the neutral axis *x y*, where it ceases, and from there the compressive force begins and

gradually increases until the top surface is reached, where the compression is the greatest. The bottom, measured over its length, has becomed lengthened and the top shortened. The cement, concrete, artificial stone, or similar material having great power of resisting compression, the part above the neutral line *x y* will strongly resist the weight of the load from lessening the distance between the imaginary lines *e e* at the top of the structure, and the material unaided will thus in its upper part resist a heavy load; but having comparatively little power of resisting strain or tension, and being thus weak below the neutral line *x y*, it is evident that if the distance between the imaginary lines *f f* is to be prevented from increasing under the weight of a load the strength of the structure should be computed in accord with its great power to resist compression.

Girders, bridges, and similar structures are now constructed with large metallic beams extending in their vertical height nearly to the top of the girder or structure, and adapted to carry the entire load by resisting both the compressive force and the tensile strain. I greatly lessen the expense and at the same time add to the strength of the girder or structure by embedding in the lower part of the girder or structure *b*, below the neutral line thereof, a small I-shaped metallic beam or beams, *a*, of about one-half the height of the large beam now employed, and consequently only about one-half as expensive. This beam is cemented in the material in which it is embedded, (by any suitable cement, or by the material itself when the latter is cement, provided it is of great adhering quality, hydraulic cement being preferred,) which surrounds the beam and prevents the surrounding material slipping or sliding over it when the girder or structure is deflected by a weight, being thus practically integral with the body in which it is embedded. By this arrangement the small I-shaped beam strengthens the girder or structure most effectively against strain or tension, as it is entirely below the neutral line of the body, and therefore its entire strength is utilized to resist the tensile strain. At the same time that part of the material above its neutral plane or line serves effectively to resist the compressive force, my improved construction thus utilizing the material of the body or structure itself to resist the compressive force. A small metallic I-shaped beam, as I have applied it, has a large surface for the material to adhere to, and is of a form that with a comparatively small quantity of metal strongly resists bending to a far greater extent than a beam of square, round, or flat cross-section could possibly do, if containing only the same amount of metal. These beams may have two or more flanges; but when formed with only one this is always on top, so that the material of the body can extend under the flange on each side of the beam.

When desired, resistance-plates *d* may be bolted or otherwise rigidly secure positions to the beam, or to a flat b of its ends, as shown in Figs. 8 a sist in preventing the extension of the material *b* below its neut the beam was not cemented, or w without being cemented and wit sistance-plates, when the bridge was considerably deflected under a as L in Fig. 9, the beam would b above its neutral line *g h* to the tent at its top, while the structu ening below its neutral line *x y* wo the beam, as shown in Fig. 9, beam, instead of strengthening th would, in fact, tend rather to we will be seen that the resistance- when applied to a flangeless unce will strengthen the structure by the material from slipping over making the beam practically an i of the girder or structure.

When two or more of the smal embedded parallel to each other in ure below its neutral line, as sho 10, 11, 12, 13, and 14, and a weight the structure between any of the deflects that arch or part of the st direction of the thrust against the of the beams is changed to a sligh angle, as indicated by the dotted l rows in Figs. 10 and 11, thus th material under the upper flanges o which effectively prevents the ma slipping over the beams. The bea be placed parallel to one another integral or solid structure, as sho 10 and 11, the left-hand portion of Fig. 14, or may be embedded in t of the supporting-divisions of structure, as shown in the right-ha of Figs. 12 and 13.

When, as in Figs. 12, 13, and 14 flanged beams embedded in the structure are supported at their e longitudinal ties *d'*, to which the bolted, and the crowns of the arche structure is either whole or section nected and braced to the longitu by the struts or braces *b*, *c*, T, and form the subject-matter of a separa tion, and which I will not, therefo here at length,) the tensile strain both in direct and cross directio cement, concrete, artificial stone, cement or mortar, or other like above the neutral line, resist the c force also both in direct and cross

Having thus described my inve I claim, and desire to secure by Let is—

1. The combination, with a gird floor, or other body of cement, con ficial stone, or similar material, metallic I-shaped beam or beams e the lower part of the body below t line thereof to resist the tensile s

tructure is deflected by the weight
nd the material thrust against the
nges of a beam, to prevent the slip-
he material, substantially as de-

ombination, with a girder, bridge,
her body of cement, concrete, arti-
, or similar material, of a small
haped beam or beams embedded and
n the lower part of the body below
line thereof to resist the tensile
, when the structure is deflected by
of a load and the material thrust
web and the flanges of a beam, to
e slippage of the material, substan-
scribed.

ombination, with a girder, bridge,
her body of cement, concrete, arti-
, or similar material, of a flanged
am or beams or flanged bar or bars
upright resistance-plate secured to
1 of its ends and embedded in the
of the body below the neutral line

ombination, with a bridge, floor, or
ucture built in arches and composed
concrete, artificial stone, or similar
f small flanged metallic beams em-
bedded and cemented in the footings of the structure below the neutral line thereof parallel to one another and in the same horizontal plane.

5. The combination, with a bridge, floor, or like structure of concrete, cement, or similar material, of the small flanged metallic ties or bars having end resistance-plates embedded and cemented in the structure below the neutral line thereof and parallel to one another in a horizontal plane, and longitudinal non-embedded ties supporting and having secured to them the ends of said embedded ties.

6. The combination, with a bridge, sidewalk, floor, or like structure composed of cement, concrete, or like material, and constructed in flat or arched sections or divisions, of small flanged metallic beams or bars having end resistance-plates embedded and cemented in the supporting-sections below the neutral line thereof, and the longitudinal non-embedded ties supporting and having secured to them the ends of said embedded ties.

PETER H. JACKSON.

Witnesses:
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HENRY HAUSTEIN.