(No Model.) 2 Sheets—Sheet 1.

W. W. RENWICK.

ROOF.

No. 418,296. Patented Dec. 31, 1889.

Fig. 1

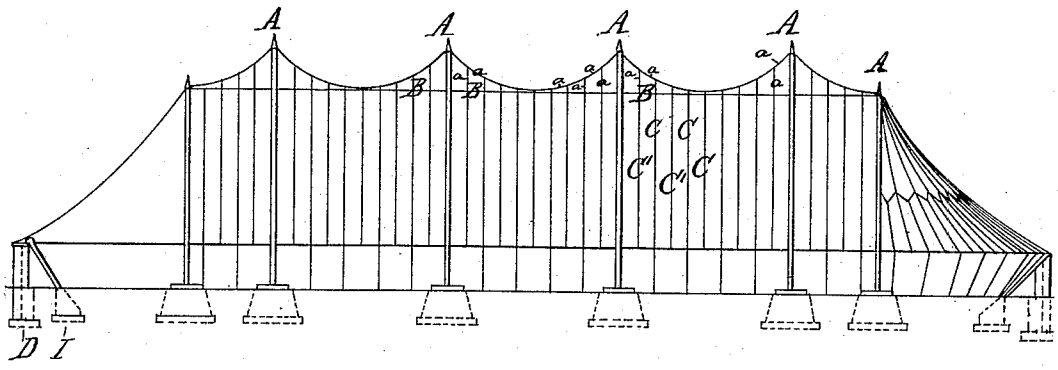


Fig. 2

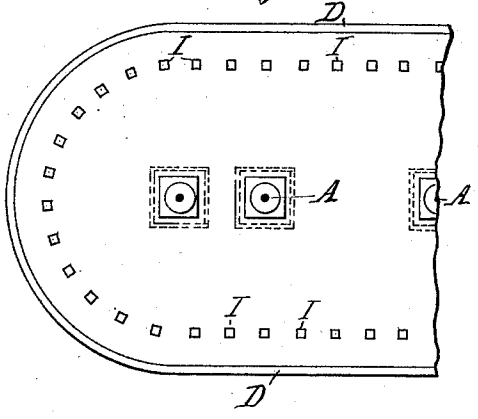


Fig. 3

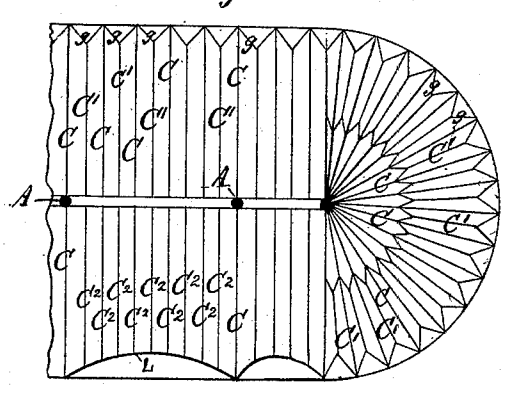
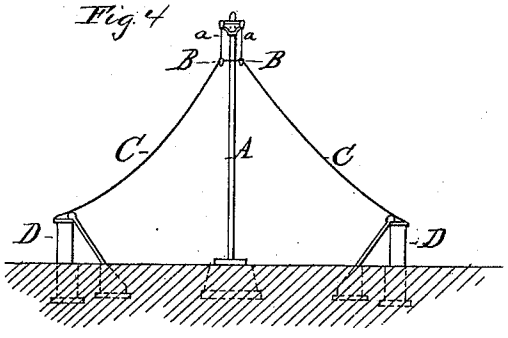


Fig. 4



Witnesses
W. L. Bennem
Jas. E. Warner

Inventor
William Whetten Renwick

N. PETERS. Photo-Lithographer, Washington, D. C.

(No Model.) 2 Sheets—Sheet 2.

W. W. RENWICK.

ROOF.

No. 418,296. Patented Dec. 31, 1889.

Fig. 5

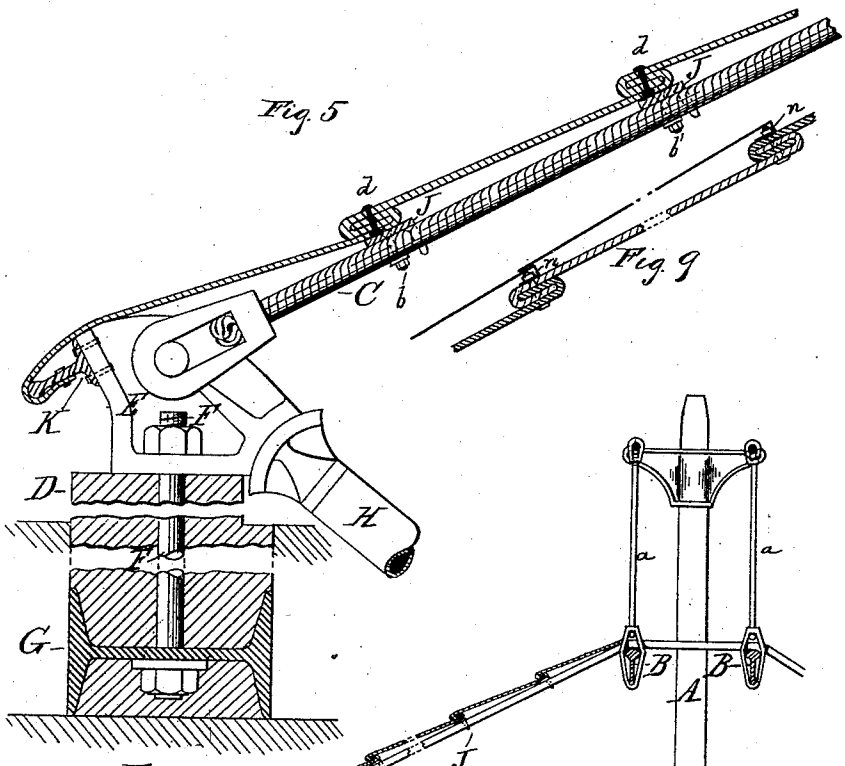


Fig. 9

Fig. 6

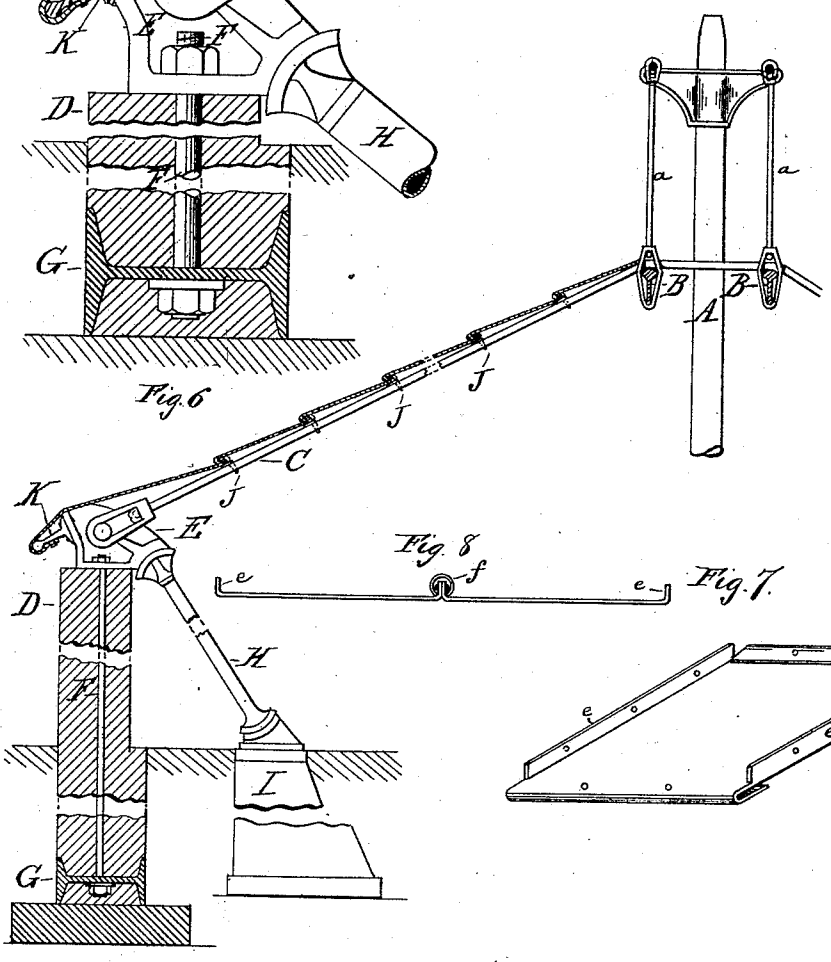


Fig. 8

Fig. 7.

Witnesses
W. L. Bennett
Jas. E. Warner

Inventor
William Whetten Renwick

N. PETERS. Photo-Lithographer, Washington, D. C.

UNITED STATES PATENT OFFICE.

WILLIAM WHETTEN RENWICK, OF MILLBURN, NEW JERSEY.

ROOF.

SPECIFICATION forming part of Letters Patent No. 418,296, dated December 31, 1889.

Application filed November 8, 1889. Serial No. 329,652. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM WHETTEN RENWICK, of Millburn, in the county of Essex and State of New Jersey, have made a new and useful invention of certain Improvements in Roofs for Buildings; and I do hereby declare that the following, in connection with the accompanying drawings, is a full, clear, and exact description and specification of the same.

The object of this invention is to enable roofs of large spans to be made of light weight and at a reduced cost.

Previous to this invention the common plan of constructing roofs has been to support the roof-covering by rafters or frames, the material of which is subjected mainly to transverse strains or to compressing strains, and consequently the rafters or roof-frames must necessarily be large enough transversely to sustain such strains.

The principle upon which the present invention is based is that articles of wrought-iron and steel will sustain tensile strains operating in the direction of the lengths of the articles far in excess of the strains applied transversely to the same articles, and also in excess of compressing strains; and the improvements consist of certain combinations of members forming the roof in which this principle is embodied for practical use. These combinations are set forth in the claims at the close of this description. In order that they may be fully understood, I have represented in the accompanying drawings and will proceed to describe an example of a structure embodying all my improvements in the best form thus far devised by me, it being understood that the details of construction may be varied as the exigencies of any particular case or the views of different constructers may render expedient.

Figure 1 of said drawings represents a vertical central longitudinal section of a part of the supporting-frame of the roof of a building constructed according to my invention. Fig. 2 represents a ground plan of a part of the building. Fig. 3 represents a top view of part of the roof-frame with variations. Fig. 4 represents a transverse section of the building. Fig. 5 represents in detail a transverse view of the means of securing the roof-cables and other members. Fig. 6 represents an enlarged partial cross-section of parts of the building. Fig. 7 represents a perspective view of one of the covering-plates of the roof. Fig. 8 represents a transverse view of connected covering-plates. Fig. 9 represents modifications hereinafter described.

The invention is more particularly applicable to roofs of great span—such, for example, as those of exhibition-buildings and large railroad-depots. The central part of such a roof may be sustained by a series of columns or masts A A, arranged in a row along its central line, and the columns are connected by ridge-tree sections B B, which extend between the columns, and are preferably duplex, as shown at Fig. 6, and are stayed against the downward strains by suspension ropes or rods *a a a a*, Figs. 1, 4, and 6, whose lower edges are made fast to the ridge-tree section, and whose upper ends are connected securely with the portions of the columns A, between which the section of the ridge-tree extends.

When my entire invention is used, the strains upon the roof are sustained in whole or in part by lateral cables C C C, which are extended in a downward-sloping direction from the ridge-tree sections B to the side walls D of the building, these lateral cables being secured at their upper ends to the ridge-tree, and being secured at their lower ends to plates or shoes E, supported either by the side walls of the building or by side columns located at the sides of the building. The lateral cables C extend in catenary curves from the ridge-tree to the side walls, and the strains at their lower ends are sustained by anchor-rods F, Figs. 5 and 6, which extend from the shoes E to the bottoms of the side walls or the foundations thereof, and are secured to anchor-plates G, so that more or less of the weight of the side walls or their foundations is utilized to hold the roof from sagging below the normal curve. I prefer to combine the lateral cables with the anchor-rods through the intervention of shoes, such as E; but the cables may, if preferred, be secured directly to the upper ends of the anchor-rods. In order that the side walls may not be drawn in by the strain of the roof, diagonal struts H are provided. These are preferably tubular

and extend inward and downward from the shoes E at the outer ends of the roof-cables C to foundations I within the building.

The roof is covered, preferably, with metal sheets, such as are represented at Figs. 5, 6, and 7. These sheets may be laid directly upon the lateral roof-cables or upon purlins J, Figs. 5 and 6, extended between the roof-cables crosswise of their lengths, and in the latter case I prefer to construct the purlins of angle-iron (the web of which is notched to permit the lateral cable to pass through the web) and to make the purlin fast to the lateral cable by bolts *b*. The metal roof-sheets are connected at their ends, preferably by folding the ends of the sheets and hooking the folded ends together, as represented at Figs. 5 and 6, so that the rows of connected sheets extending from the ridge-tree to the side walls will sustain tensile strains. In order that the folds of the sheets may not pull apart by unbending, they may be secured by rivets or bolts *d*, Fig. 5, after the ends of the sheets are hooked together. The sides of the sheets are preferably connected by flanges *e*, which are turned upward. These flanges may be covered and secured together by split tubes *f*, Fig. 8, or may be riveted together before the split tube is applied to them. If desired, the sheet-metal covering may be laid upon a board sheathing, which is made fast to the purlins, and in case the sheet-metal covering is not subjected to much tensile strain it may be thin and the ends of the sheets may be secured to each other by soldering; but I prefer to use the tensile strength of the sheet-metal covering to sustain more or less of the strain upon the roof, and in such cases the ends of the sheets must be connected together by folding and riveting, as previously described, (or by one or other of these modes of connection,) and the uppermost sheet of each row must be secured to the ridge-tree B, while the lowermost sheet of each row must be made fast to a wall-plate K or its substitute, firmly secured to the anchor-rods F, before described, the mode of securing the wall-plate K to the anchor-rods which I prefer being through the intervention of the shoe E, Figs. 5 and 6.

A roof constructed as above described I term a "suspension" roof, and from the foregoing description it is evident that the strains upon the roof incident to its own weight and to the stress of wind and snow are sustained by the tensile strength of the material extended from the ridge to the side walls, and consequently the roof members which sustain the strains may be only of the comparatively small cross-sections required for this purpose. Moreover, the interior of the roof is free of all cross frame-work which would obstruct the view. The same system of roof may be applied to the semicircular ends of long buildings. An example of this application is shown in the drawings at Figs. 1, 2, and 3, and it is evident that two such semicircular ends put together with a central column or mast will form a circular roof, the upper ends of the cables being in this case secured to the central column, preferably through the intervention of a hub, to which the upper ends of the cables are secured. When the space between two adjacent anchor-rods F is so broad as to require purlins of too large transverse dimensions, intermediate lateral cables C′, Figs. 1 and 3, may be inserted, and their lower ends may be forked, as at *g*, so that each intermediate cable is connected with the two adjacent anchor-rods, or, if the space between two adjacent anchor-rods be broad enough to include a number of intermediate cables $C^2 C^2 C^2$, Fig. 3, may be connected with the anchor-rods through the intervention of reversed curved bars or cables L, Fig. 3, which are preferably curved in catenary form.

When the span is not too great—say not exceeding three hundred feet—the tensile strength of the sheet-metal covering-sheets alone will be sufficient to sustain the roof strains, and in such cases the lateral cables may be dispensed with, the upper ends of the rows of covering-sheets being sustained by the ridge-tree, and their lower ends being made fast to the wall-plates K, held by the anchor-rods and anchor-plates, as previously described. In this case the ends of the metal sheets must of necessity be firmly secured together, so as to withstand the tensile strain, and the mode of securement which I then prefer to use is by hooking the folded ends of the sheets together and riveting them, as before described, and as illustrated in Figs. 5, 6, and 7. The wall-plates then transmit to the anchor-rods F the roof strains of the rows of metal covering-sheets, and consequently the wall-plates may be replaced by their equivalents for that purpose—such as curved or diagonal bars—to which the lower portions of the rows of covering-sheets are secured, and which in turn are secured to the anchor-rods. It is further evident that in place of lateral wire cables lateral cables made of bars linked together may be employed, and in such case the bars may be linked in the manner previously described with reference to the covering-sheets—that is, by hooking their ends together, as shown at Fig. 9, and securing them by through rivets or bolts. The purlins may then be secured by the same rivets or bolts; or, if no separate purlins are used, one end of the metal covering-sheets may be turned downward to form a flange *n*, Fig. 9, which will rest upon the joints of the link-bars and will stiffen the roof longitudinally or crosswise of the slope.

The roof may be lighted by inserting sheets of glass in openings formed in the metal sheets.

When a semicircular or circular roof is constructed as before described, the central column sustains the same kind of strain as several central columns of a long rectangular roof, and the hub secured to the upper

end of the central column sustains the diverging lateral cables and roof-plates as the ridge-tree does in a rectangular building.

I claim as my invention—

1. The combination of the central columns, the ridge-tree, the wall-plates secured by anchor-rods and anchor-plates, and the sheet-metal covering composed of metal sheets whose adjacent ends are connected to sustain tensile strains, substantially as before set forth.

2. The combination, substantially as before set forth, of the central columns, the ridge-tree, the anchor-rods and anchor-plates, and the lateral cables extended laterally from the ridge-tree and secured at their lower ends to the anchor-rods.

3. The combination, substantially as before set forth, of the central columns, the ridge-tree, the lateral cables secured at their lower ends to anchor-rods and anchor-plates, and the internal diagonal struts.

4. The combination, substantially as before set forth, of the central columns, the ridge-tree, the lateral cables secured at their lower ends by anchor-rods and anchor-plates, and the side wall resting upon said anchor-plates, whereby the weight of the side wall is utilized to sustain the roof strains.

5. The combination, substantially as before set forth, of the central columns, the ridge-tree, the wall-plates, the sheet-metal covering composed of sheets whose adjacent ends are connected to withstand tensile strains, the anchor-rods and anchor-plates, and the side wall resting upon said anchor-plates.

6. The combination, substantially as before set forth, of the central columns, the ridge-tree, the wall-plates secured by anchor-rods and anchor-plates, the lateral cables, and the sheet-metal covering composed of metal sheets whose ends are connected to sustain tensile strains.

In witness whereof I have hereto set my hand this 6th day of November, A. D. 1889.

WILLIAM WHETTEN RENWICK.

Witnesses:
W. L. BENNEM,
JAS. E. WARNER.