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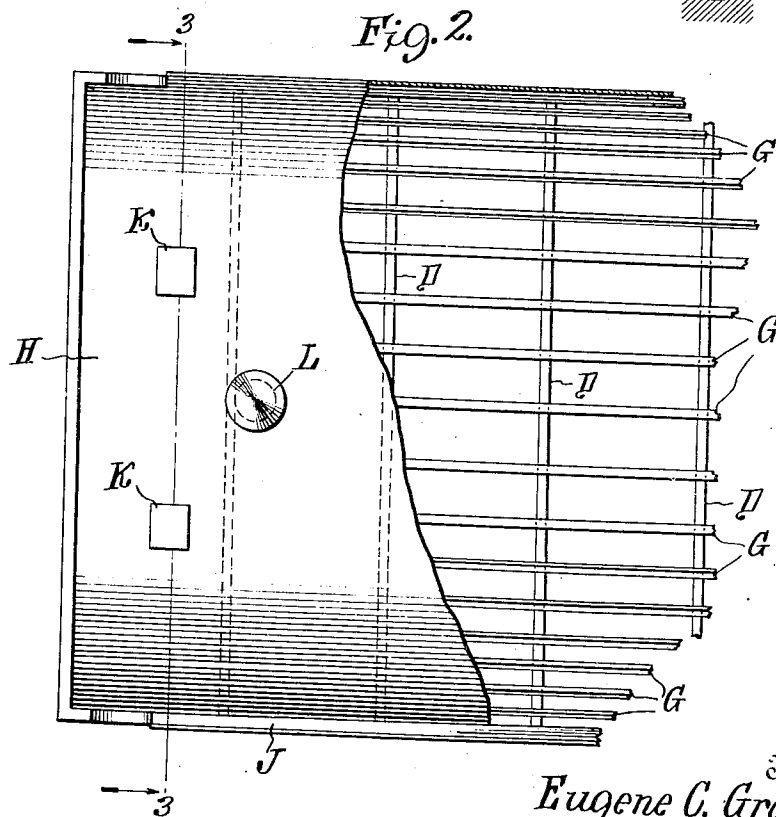
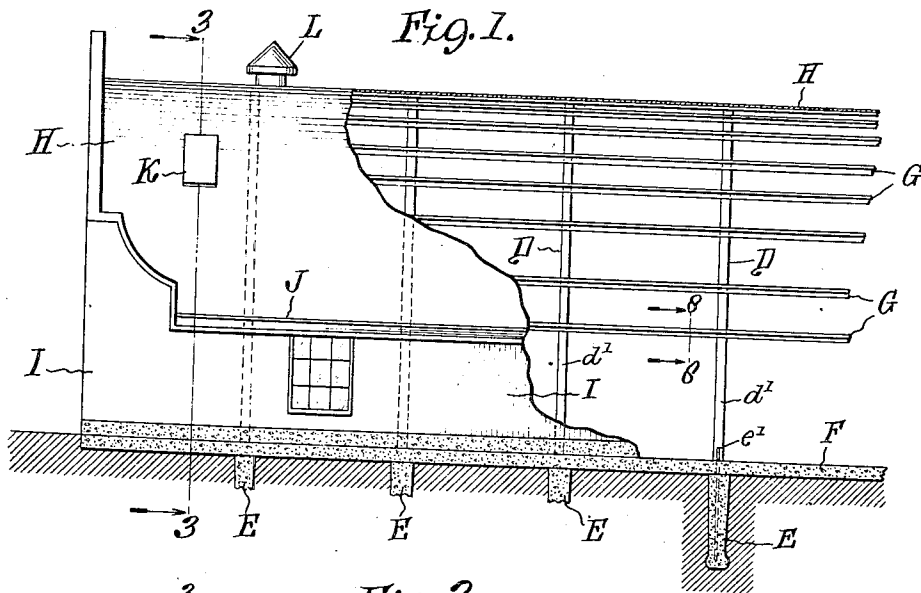
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ARCH CONSTRUCTION

Filed Sept. 19, 1928

4 Sheets-Sheet 1



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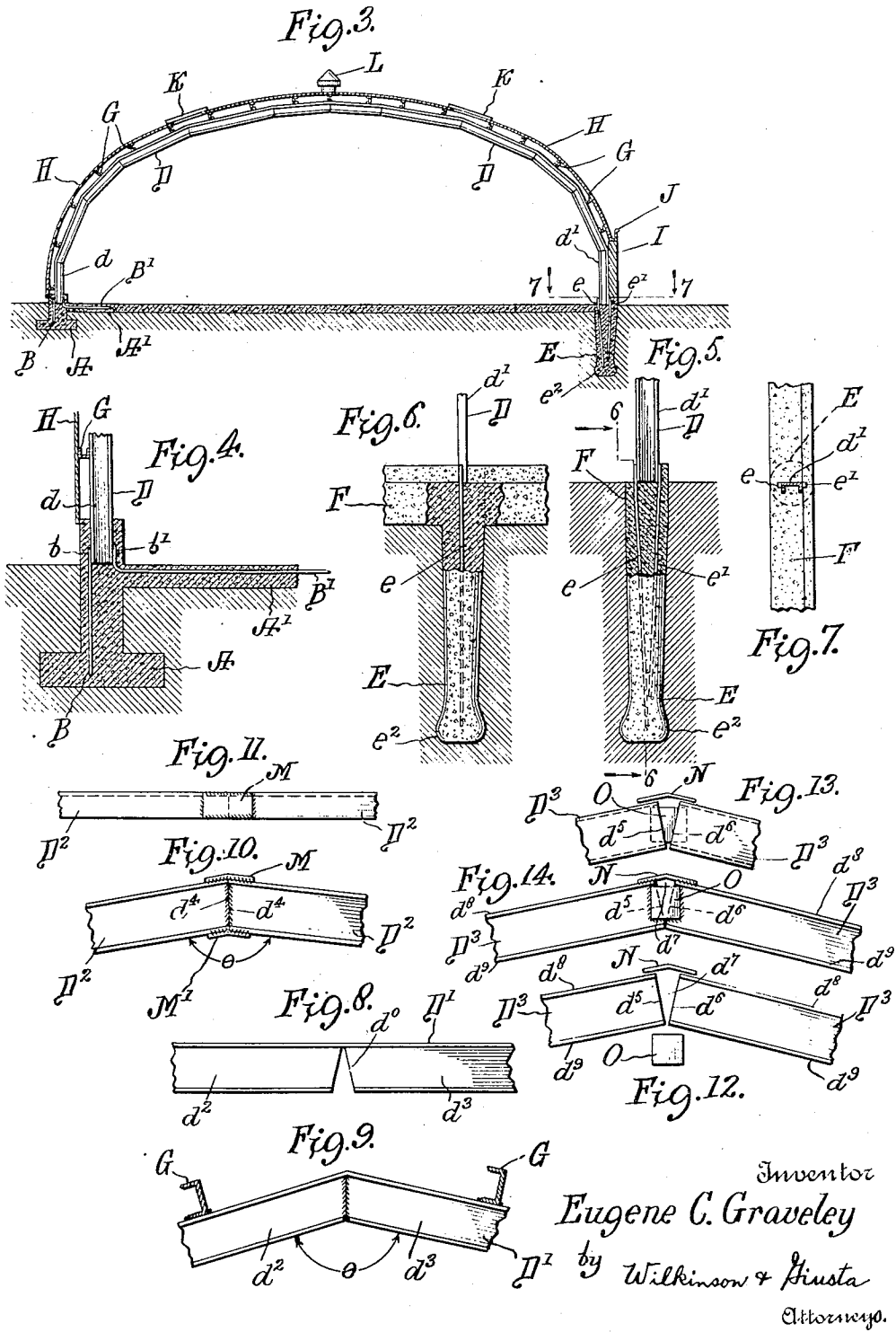
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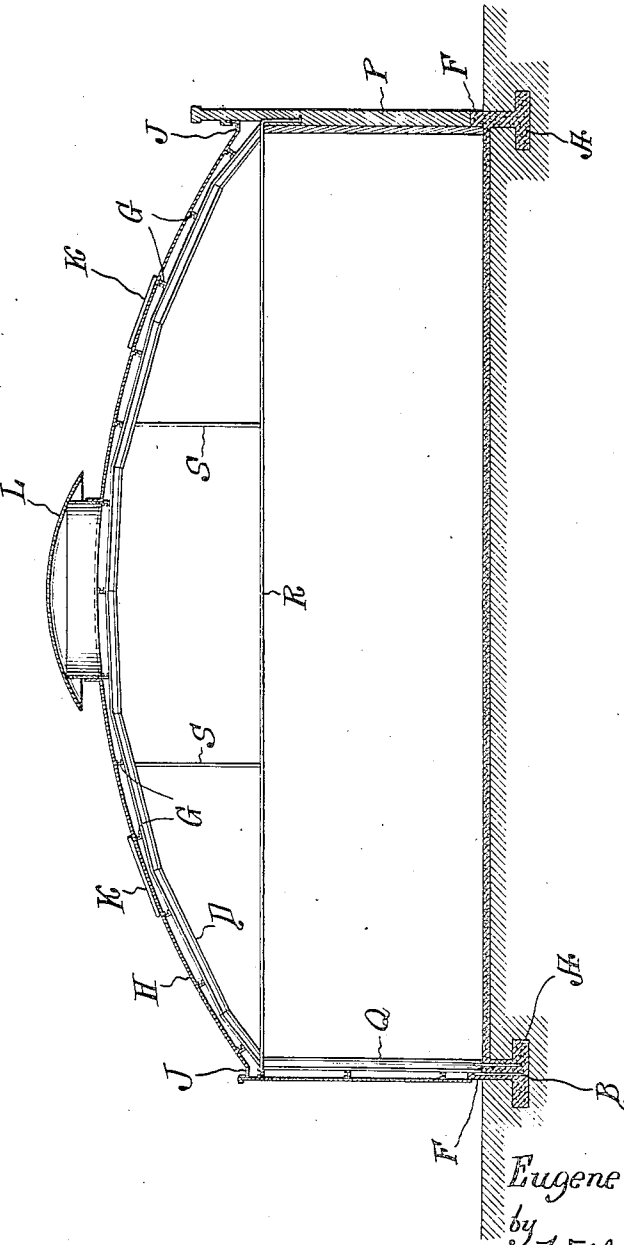
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Fig. 15.



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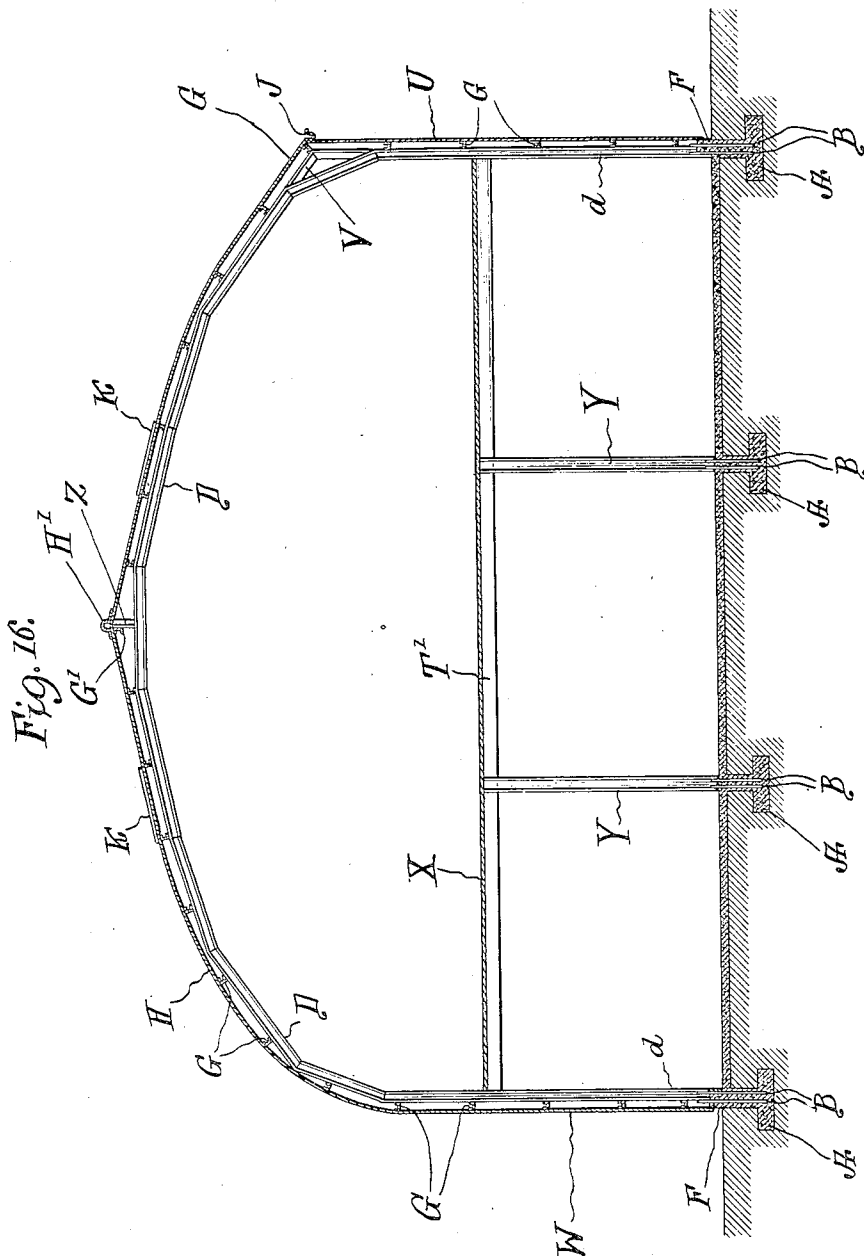
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ARCH CONSTRUCTION

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4 Sheets-Sheet 4



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ARCH CONSTRUCTION

Application filed September 19, 1928. Serial No. 303,947.

My present invention relates to improvements in the construction of buildings, especially adapted for use in the tropics, where severe wind storms are frequently experienced, and in which it is desirable to provide a roof having a comparatively small vertical area exposed to the force of the wind.

The invention is also especially intended to provide an extremely light, cheap, and efficient construction, which may be readily and quickly put up if desired.

The invention further is intended to provide a construction, in which there is an arched roof, of comparatively flat curvature, and which arch may be made of sufficient length to cover a wide floor space without the necessity of providing supporting pillars, which will interfere with the movement of bodies on the floor space, and without the necessity of providing interior truss work.

My invention is more particularly intended to provide a light roof, having the ribs formed of short straight lineal sections, forming a multi-sided polygon, the abutting ends being welded together, as will be hereinafter described.

My invention is especially intended to provide a roof structure, which may be used with or without side walls, or in which one end of the arch may lead directly to the floor, and the other end may be supported by a side wall.

My invention also includes other features of novelty and utility, which will be hereinafter more fully described.

My present invention is intended to provide certain improvements over my application filed Sept. 10, 1926, Serial No. 134,655, entitled Arched roof construction.

My invention will be more fully understood after reference to the accompanying drawings, in which like parts are indicated by similar reference symbols, throughout the several views, and in which,

Figure 1 shows a side elevation, partly broken away, of one end of a building constructed according to my invention.

Figure 2 shows a plan view of the structure shown in Figure 1 with the roof partly broken away.

Figure 3 shows a vertical transverse section along the line 3—3 of Figures 1 and 2, and looking in the direction of the arrows.

Figure 4 is an enlarged view, showing a section of footing provided to support one end of the arched roof shown in Figure 3.

Figure 5 shows an enlarged sectional view of one of the posts constituting a part of the footing adapted to support the opposite end of the arched roof, shown in Figure 3.

Figure 6 is a side elevation of Figure 5, looking in the direction of the arrows 6—6 of Figure 5.

Figure 7 shows a section along the line 7—7 of Figure 3 on an enlarged scale, and shows the grade beam with the concrete pile indicated in dotted lines below the same.

Figures 8 and 9 illustrate the preferred method of making the joint, in which Figure 8, shows a part of the beam designed to be used as a rib preparatory to bending and welding, and Figure 9 shows the joint after it has been bent and welded, and after the purlins have been applied.

Figures 10 and 11 show another method of making one of the joints of the complete polygonal arch, Figure 10 being a side elevation and Figure 11 a plan view of the joint shown in Figure 10.

Figures 12, 13 and 14 are diagrams illustrating another method of forming the joint between the polygonal segments of the arch.

Figure 15 shows a modification of the structure illustrated in Figures 1, 2 and 3, in which the lateral thrust is taken care of by tie rods, and both ends of the arch are provided with vertical supports. The section is similar to that shown in Figure 3, but on a larger scale.

Figure 16 shows in section another modification illustrating a two-story building with the lateral thrust taken care of by the second floor system, and this floor system is supported by columns, or any other suitable supports.

Reverting first to the construction shown in Figures 1, 2 and 3, A represents a reinforced concrete footing, which is formed, in the usual way, and earth afterwards filled in, if desired. This concrete footing is pro-

vided with a lateral concrete floor portion A', and with the anchors B and B', shown most clearly in Figure 4. These anchors B and B' are welded, as at *b* and *b'* to the end section *d* of one of the polygonal arches constituting the ribs D of the roof.

These ribs D are formed in segments welded together, as will be hereinafter more fully described, and the other end of the rib is supported as shown at the right of Figure 3, and in detail in Figures 5, 6, and 7.

In this construction, the end segment *d'* of the polygonal arch D is welded to the anchors *e* and *e'* in the concrete pile E, which is embedded in the earth, as shown, and is preferably provided with a bulbous bottom *e*², so as to anchor the same in the earth against the lifting effect of the wind.

Above these concrete piles E, I generally provide a grade beam F of reinforced concrete, which is also embedded in the earth, as shown, and thus the ends of the polygonal arches are securely fastened to the foundation.

Above these ribs D, the purlins G are attached, preferably by welding. These purlins run longitudinally of the roof, and above these purlins and on the upper edge of these purlins is the roofing H. This roofing may be of any suitable type of roofing, as corrugated iron, metal sheathing or wood sheathing, and I make no special claim to any particular kind of roofing material used.

In the construction shown in Figures 1, 2 and 3, I have shown the side wall I, such as is usually preferred for exposure on the street side of a building, but obviously the right hand end of the building shown may be the same as the left hand end. Above the wall I, a gutter J may be provided, if desired.

I have also shown skylights K and a ventilator L, which may be duplicated or multiplied when desired.

Having thus described, in a general way, the building construction, I will now describe the manner of manufacturing the ribs, which constitute the polygonal arches used in supporting the roof.

These ribs may be formed by welding in various ways, but the preferred method is shown in Figures 8 and 9, in which D' is a part of a straight structural member, preferably in the form of a channel or I beam, in which there are a series of V-shaped cuts *d*^o, the angle of the cuts being such that when the plate is bent to the final shape, as shown in Figure 9, there will be the proper obtuse angle between the adjacent segments *d*² and *d*³, which angle θ would ordinarily be in the neighborhood of 160°, more or less, depending upon the angle desired between the adjacent segments. In this case the angle of the cut *d*^o would be approximately 20°. This cut does not extend entirely through the beam, as shown in Figure 8, and when the beam is bent

to the closed position, the abutting faces of the segments are welded together in any convenient way, preferably by electric welding. Thus when the beam is bent, and the parts welded, as shown in Figure 9, a joint is formed whose strength, when used in an arch, is fully as great as that of the original metal.

If the building is too wide between the ends of the arches, two or more beams may be formed in the manner just described, and their ends connected together in any suitable way, as is well-known in the art.

Another mode of making the ribs is illustrated in Figures 10 and 11, in which separate segments D² are used, having their abutting ends *d*⁴ bevelled or mitered slightly, so as to form half the requisite angle θ between the adjacent segment of the finished rib, when the ends are welded together. In order to do this, one half the desired taper is cut off one segment, and the other half off the other segment, so that the two may fit tight in forming the arch. Bent splice plates in the form of flattened V's M and M' may be used for welding at the joint as indicated in Figure 10.

Another method of forming the joint in the beam constituting the polygonal arch is shown in Figures 12, 13 and 14, in which the rib is made up of a series of segments D³ in the form of channel irons, as shown. These are put together so that their edges *d*⁵ and *d*⁶ will abut, and then a flanged splice plate N is welded above the gap *d*⁷, and a web plate O is welded to the two adjacent segments D³ between the upper and lower flanges *d*⁸ and *d*⁹.

The final shape of the rib constituting the polygonal arch will depend upon the contour of the roof desired, which would ordinarily be of an elliptical or arc shaped construction, but if desired, the two sides of the arch may be made in the form of a Gothic arch.

When the desired number of ribs have been assembled in place, the purlins G are applied by welding, or in any other suitable or convenient way, and then the roofing is put on. These purlins should be so spaced apart as to supply the necessary lateral bracing to the various arched ribs.

I have shown in Figures 1, 2 and 3 one form of building construction, and in the modification shown in Figure 15, I have shown a roof having polygonal arched ribs, as hereinbefore described, but with a masonry wall P on one side, and a series of columns Q on the other. The columns Q are anchored to the concrete foundation A already described, and support one end of the arch, while the other end of the arch is anchored into the masonry of the wall P, and the two ends are tied together by tie rods R, suspended from the ribs by sag rods S. Thus the ends of the arch are prevented from spreading apart.

In this form of construction, I have shown

a ventilator L and skylights K. While only one column Q and tie rod R are shown in this drawing, of course, the necessary number of these would be supplied, but I only deem it necessary to show one of each for purposes of illustration.

In Figure 16, I have shown a two story structure, in which the ribs D supporting the roof are of polygonal arched construction, hereinbefore described, and in which the ribs are extended at both ends down to the foundation A, as shown at d, and connected to said foundation with anchors, as hereinbefore described. On one side, the structure may be carried up straight as on the street side of a building, as indicated at U, and braces V may be provided at this point. Instead of the roofing material, suitable sheathing material W may be used on one or both sides of the structure.

The thrust of the arched roof is taken care of by the floor beams T', on which suitable flooring X is mounted. These floor beams may be supported in any convenient way, as by means of columns Y. In this form of construction, I have shown the peak of the roof as provided with a ridge H', which is raised above the ribs D by means of filler blocks or posts Z supporting the top purlins G'.

The foregoing construction has been found, in practice, to require comparatively little metal in the frame-work, while supplying sufficient strength both to resist downward thrust or the pressure of the wind or storms.

It will be seen that by having the arch comparatively flat, a small vertical area is exposed to the wind pressure, and this feature is especially desirable where storms are apt to occur.

Thus it will be seen that I provide a welded steel arch with ends preferably securely fastened to their foundation, made more or less in an elliptical shape, made up of straight sections of structural shapes, usually channeled beams, so proportioned in length, and with the angles formed by the intersections of these sections, so proportioned in size that the outer flanges, surface or edges of the purlins, or joists, give the desired shape for forming the roofing; and with aforesaid purlins or joists so spaced that they fix the rib sections laterally at sufficiently close intervals that the slenderness ratio of the members forming the rib sections is maintained small enough that compressive stresses in these struts may be kept within the usually allowed amount without the use of excessive metal.

Electric welding is generally used, but oxy-acetylene or other forms may be used when better adapted to any particular part.

It may be further noted that the purlins or joists may be either wood or steel (but

preferably the latter) and while generally welded to the rib sections may be bolted or connected by other securing means to these structural supports.

It will be noted that no lateral or longitudinal wind bracing is required in these designs (though same may be provided if so desired) except in buildings of two stories or more in height, in which case the usual bracing is used on the lower stories.

These rib sections may be welded in halves in a shop and shipped knocked down to the place of erection, where the center joint, or other desired joints, may be welded, riveted, or bolted in the field.

Also rib sections can be strengthened, if so desired, at any part of the arch by use of heavier or larger sections, or by welding on additional metal in form of straps.

In the following claims, the welded construction is specified as specially adapted to be used for connecting the several sections of the ribs, not merely to define the simplicity and economy of this method of joinery, but to differentiate from former methods previously used, as this has been found to provide a continuity of beam action throughout the rib section which materially alters the entire stress relationship, and leads to marked economy of materials.

These V-ed-out joints at the desired points and of the required size and depth without cutting one flange provide that when the beam is bent, the cut portions of the rib contact throughout their length, and when welded provide a firm, rigid and strong joint which will withstand bending; but which carries no tension in the welds.

It will be seen that by the hereinbefore described construction, the segmental arched rib forms with the ground or floor below a continuous circuit, which does away with the necessity for roller bearings, hinges, or the like, now used in the art. This condition provides that the final static stress that exists in such a structure allows a marked saving in material, and produces smaller deflections and a more fire-proof as well as storm-proof type of structure.

Under actual test the buildings constructed hereinbefore have been found to withstand fire to a marked degree.

The anchor piles as a form of anchorage is not used merely as a means of support for foundation purposes, but provides a proper resisting moment, and the needed moment of inertia at the ground line; and further prevents lifting. It has been discovered that with the ordinary construction the wind does not "blow the roof down" but that it picks it up and carries it away.

While I have described the invention in its preferred forms, it will be obvious that various changes might be made in the construction, combination, and arrangement of parts,

which could be used without departing from the spirit of my invention, and I do not mean to limit the invention to such details, except as particularly pointed out in the claims.

5 Having thus described my invention what I claim and desire to secure by Letters Patent of the United States is:

1. A roof construction for buildings comprising a series of flanged ribs, each rib being formed of a plurality of straight segments integrally connected by their upper parts, and shaped to form a polygonal arch, the segments having their abutting ends welded together to form a continuous arched beam, said arches being adapted to bear the entire load unaided by web members.

2. A roof construction for buildings comprising a series of flanged ribs, each rib being formed of a plurality of straight segments integrally connected by their upper parts, and shaped to form a polygonal arch, the segments having their abutting ends welded together to form a continuous arched beam, with means for anchoring the ends of each rib, said arches being adapted to bear the entire load unaided by web members.

3. A roof construction for buildings comprising a series of flanged ribs, each rib being formed of a plurality of straight segments integrally connected by their upper parts, and shaped to form a polygonal arch, the segments having their abutting ends welded together to form an arched beam, with means for anchoring the ends of each rib, said means comprising reinforced concrete piles, having bulbous lower ends, with anchor strips embedded in said piles and projecting therefrom, said projecting portions being welded to the ends of said ribs, said arches being adapted to bear the entire load unaided by web members.

4. A roof construction for buildings comprising a series of flanged ribs, each rib being formed of a plurality of straight segments integrally connected by their upper parts, and shaped to form a polygonal arch, the segments having their abutting ends welded together to form a continuous arched beam, with means for anchoring the ends of each rib, said means comprising reinforced concrete piles, having bulbous lower ends, with anchor strips embedded in said piles and projecting therefrom, said projecting portions being welded to the ends of said ribs, said arches being adapted to bear the entire load unaided by web members.

5. A roof construction for buildings comprising a series of flanged ribs, each rib being formed of a plurality of straight segments integrally connected by their upper parts, and shaped to form a polygonal arch, and segments having their abutting ends welded together to form a continuous arched beam, with means for bracing the ribs against lateral deflection, said arches being adapted

to bear the entire load unaided by web members.

6. A roof construction for buildings comprising a series of flanged ribs, each rib being formed of a plurality of straight segments integrally connected by their upper parts, and shaped to form a polygonal arch, the segments having their abutting ends welded together to form a continuous arched beam, with metal purlins welded to said ribs for bracing the ribs against lateral deflections, said arches being adapted to bear the entire load unaided by web members.

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