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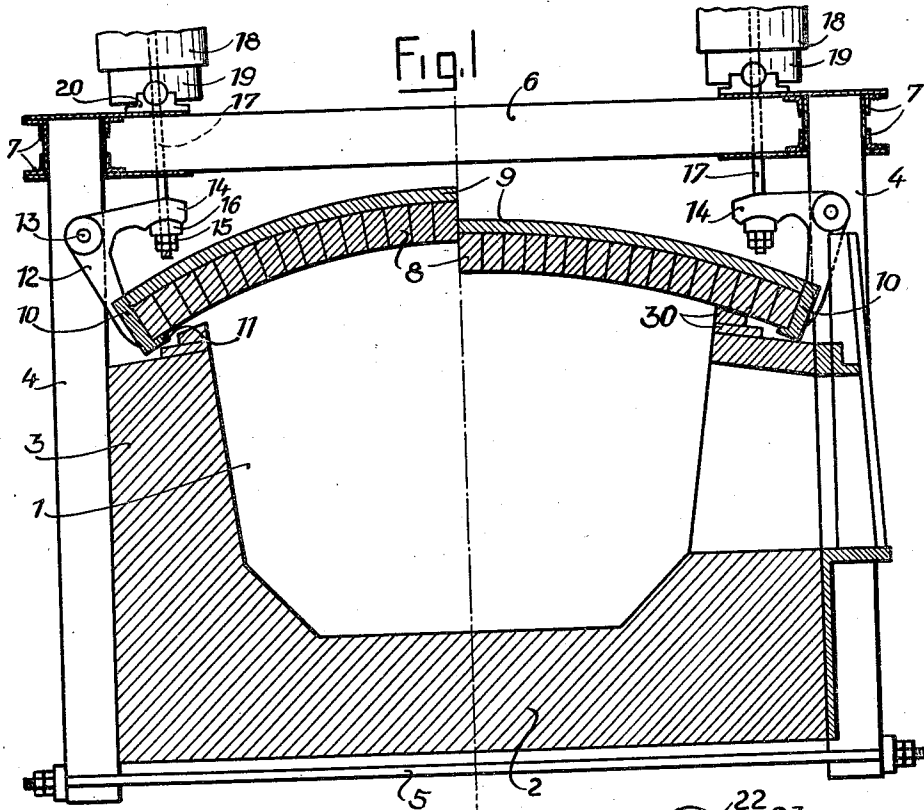
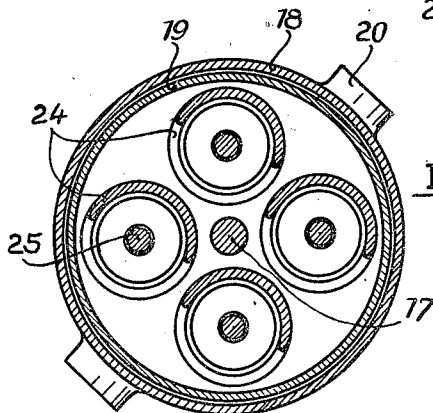
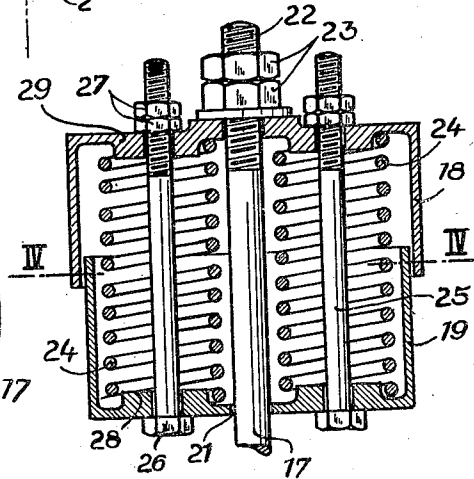
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2,146,751

INDUSTRIAL FURNACE AND THE LIKE

Filed Dec. 16, 1936

3 Sheets-Sheet 1



Inventor:
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Feb. 14, 1939

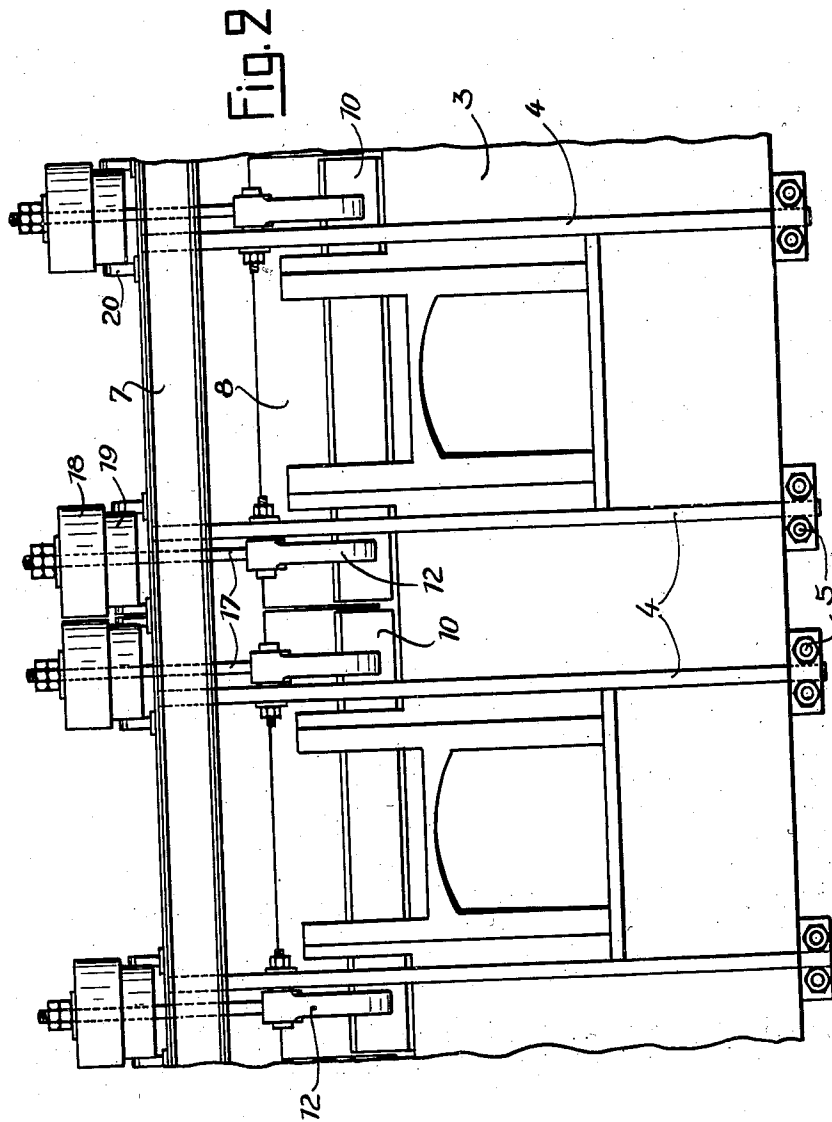
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3 Sheets-Sheet 2



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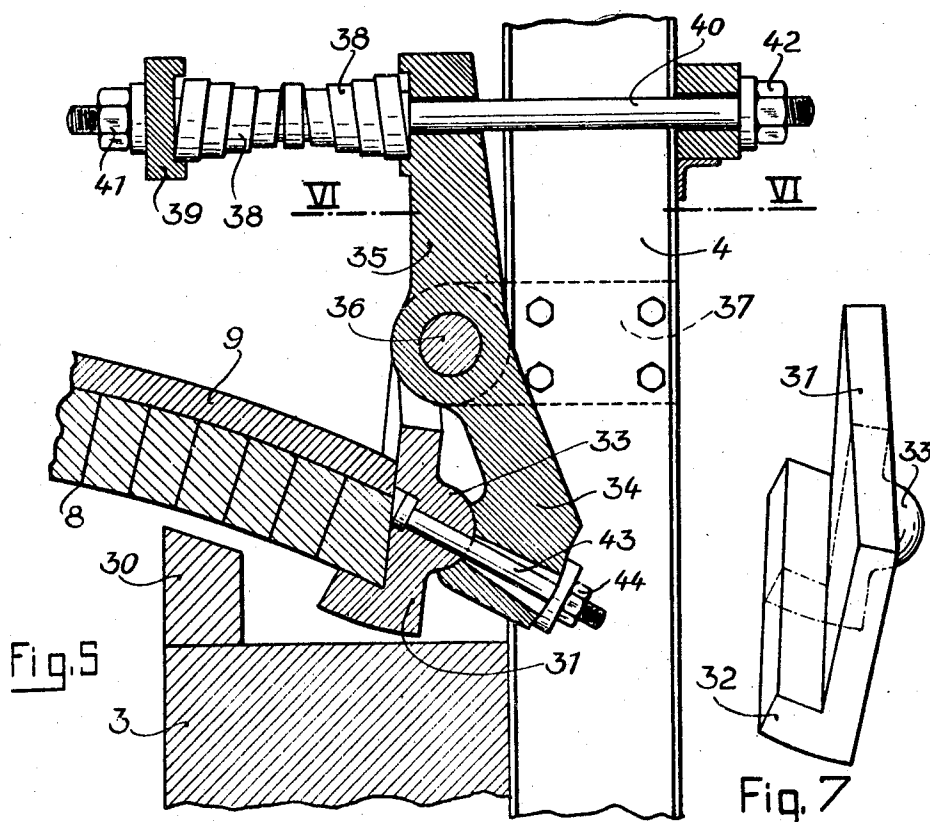
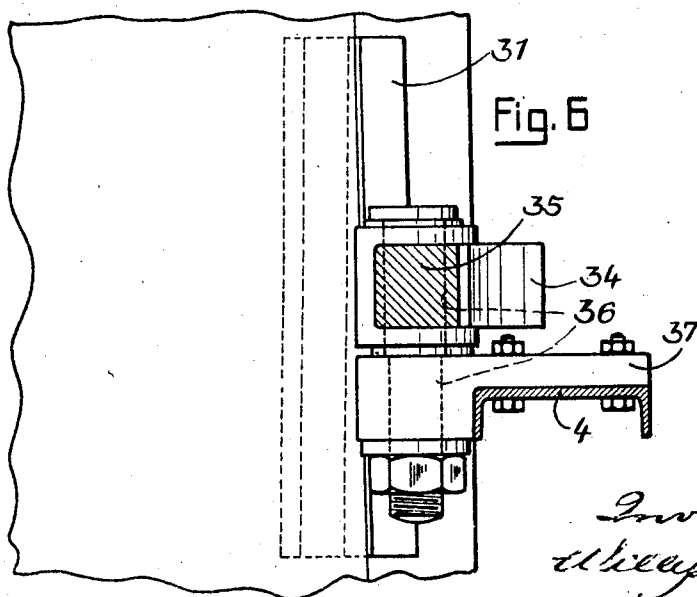
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INDUSTRIAL FURNACE AND THE LIKE

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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

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INDUSTRIAL FURNACE AND THE LIKE

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In Germany December 17, 1935

6 Claims. (Cl. 110—99)

My invention relates to industrial furnaces, operating on high temperatures, such as open-hearth furnaces, electrically heated furnaces or the like, and more particularly to those furnaces provided with an arch-like roof built of individual bricks made of refractory material, for instance magnesite bricks and chromium magnesite bricks, held together by an outer anchorage.

The main object of my invention consists in the provision of such improvements in said furnaces, by which the life and the resistance of the furnace roof is considerably increased.

It is well known that the arch-like roofs of open-hearth furnaces and similar furnaces soon show, after a comparatively short operating time, considerable damage, resulting from the expansion of the refractory material which takes place under heat when the oven brickwork is heated up to the operating temperature. On account of the heat expansion of the individual bricks, the top or roof as a whole tends to expand. Furthermore, as the oven roof is heated only from the underside, whilst the upper side is more or less cooled down by the comparatively cold atmosphere, the heat expansion in various zones of the roof brickwork will vary quite considerably. Therefore, the shape of the roof arch will alter, following the alteration of the angle of the center of the arch as well as the radius of the arch. On account of the heat expansion, the arch bricks between the abutments will be subjected to an increased pressure throughout the whole section or in individual zones, so that the bricks will crack or deform, resulting finally in a collapse of the arch.

My present invention consists principally in suspending the arch roof between the abutments in such a manner, that the bricks can expand or contract freely without loosening their connection. For this purpose, I arrange to provide the said abutments so as to be moved transversely to the middle axis of the roof and also so as to be swung or movably turned in such a way, that the distance of the individual abutments, as well as the angle of the abutments to the horizontal, can be adjusted for every operating condition exactly according to the position of the end bricks of the arch. Another feature of my invention consists in that, under certain circumstances, the abutments are not only movable in one direction, but are arranged to be moved in all directions, thus for instance rendering it possible to support conical as distinguished from rectilinear arches in a most suitable way.

Furthermore, my invention provides for a new

design of abutments, in that the abutments are mounted on levers, which levers are supported for movement and have the abutments arranged at such a distance from the axis of the lever that, by swinging the levers, the distance of the abutments from each other and the inclination of the abutments may be set according to the angularity of the center as well as the length of the arch as a result of the alteration in the radius of curvature of the arch.

This feature may be adopted according to my invention especially to arches made of magnesite and chromium magnesite bricks, or bricks of other suitable material.

Finally, another important object of this invention consists in the provision for acting on the abutments by means of springs in such a way, that the position of the abutments will adjust itself automatically to the altered shape of the arch, with regard to the altered angularity of the center as well as also to the altered length of the arch as a result of the altering of the radius of curvature of the arch.

Further objects of my invention may be seen from the following description of a preferred embodiment of my invention.

Figure 1 of the drawings shows an industrial furnace designed according to my invention.

The left half of Figure 1 shows the arch roof in cold condition and the right half shows the arch roof in hot condition.

Figure 2 is a side view of one section of the furnace, according to Figure 1.

Figure 3 shows on an enlarged scale a vertical section through the abutment springs.

Figure 4 is a horizontal section of Fig. 3 on line IV—IV.

Figure 5 shows on an enlarged scale a vertical section through an abutment lever for a conical arch.

Figure 6 is a top view of the abutments of the arch according to Figure 5.

Figure 7 finally shows an abutment plate of the apparatus according to Figures 5 and 6.

The furnace according to Figures 1 and 2 consists of chamber 1, formed by the bottom 2 and side walls 3, both being made of refractory material. The bottom and side walls are held in position by an anchorage consisting of vertical buckstays 4, the lower tie rods 5 and the upper connecting bars 6. The vertical buckstays 4 are moreover interconnected by the horizontal girders 7.

The oven roof is formed by an arch 8, consisting of refractory bricks and covered outside

by a suitable heat insulating layer 9. The end bricks of the arch 8 are supported in abutments 10, whose lower projection 11 is provided in such a manner that the end bricks of the arch cannot slide from the plate-shaped abutment 10. The abutment plate 10 preferably extends over a multitude of arch bricks, as may be seen from Figure 2.

The abutment plate 10 is mounted on angle levers 12 arranged for movement on the vertical buckstays 4 in bearings 13. A tension rod 17 acts upon the lever arm 14 by means of set screws 15 and a ball-like pressure plate 16. Said tension rod 17 is pulled upwards by springs arranged in the casing walls 18 and 19.

Figure 3 shows the interior of the spring casing. The casing consists of two sections 18 and 19, which may be moved telescopically. The casing section 19, as shown in Figure 1, is movably supported on bearings 20, arranged on the connecting bars 6. The casing section 19 is provided with a central bore 21, through which extends the spring tension rod 17. The threaded end 22 of the tension rod 17 reaches outwards through a suitable bore of the casing section 18 and carries the set screws 23.

The portion of the spring tension rod 17 inside the casing is surrounded by a number of spiral springs 24. Concentrically to each spring is arranged a connecting pin 25, the head 26 of which fits against the bottom of the casing section 19. A nut 27 bolted on the upper threaded end of the pin 25 rests against the upper side of the casing 18. The springs 24 are held in position by the projections 28 and 29, provided in the lower casing section 19 and in the upper casing section 18. The final coils of the spiral springs surround these projections.

Figure 1 shows the arch as being arranged at a certain distance from the topmost layer of the oven sidewall 3. In order to protect the abutment 10, consisting of a suitable metal, against the influence of the oven heat, protection bricks 30 or a sand seal have been arranged on the topmost layer of the side walls. Said protection bricks are suitably movable, so that they may be adjusted corresponding to the resulting movement of the arch when the same is heated up to the operating temperature, whereby the space between the arch and the oven sidewalls is substantially closed.

The action of the oven anchorage, illustrated on the drawings, is essentially as follows:—

It may be assumed, that the arch is in cold condition, for instance after the erection, and therefore has the shape illustrated on the left side of Figure 1, and that the springs of the casings 18 and 19, acting upon the tension rod 17, and the abutment levers 12 thus tightened so that they will firmly hold together bricks of the arch in that position as indicated.

If the arch is heated from the oven side, the individual arch bricks will expand corresponding to the temperature drop existing in the arch roof from the oven side up to the upper side of the arch, and in accordance with the coefficient of heat expansion of the brick material used. The portion of the arch roof of the ovens exposed to high temperatures during the heating-up may be preferably made out of magnesite bricks or chromium magnesite bricks. The oven illustrated on the drawings for instance is designed for the use of magnesite bricks.

With the unequal heating of the bricks, the brickwork of the arch not only expands, but si-

multaneously the radius of curvature and the angle of inclination at the center of the arch are changed. Consequently, the arch at operating temperature tends to alter its shape, as illustrated on the right side of Figure 1.

To ensure that the individual bricks of the roof arch are firmly held together when the shape of the arch has been changed, the abutments 10 must give way in such a manner, that they are swung outwardly until they arrive at an angle, which corresponds to the altered angle of inclination of the center of the arch.

The abutment plate 10 has to be arranged at such a distance from the pivotal bearing 13, for the lever 12 that the abutment in moving under the tension of the spring 34 and under the action of turning of the lever outwards or inwards, as the case may be will perform that movement which corresponds to the alteration in the radius of curvature and the change in elevation of the center of the oven arch. The right side of Figure 1 shows the abutment plate 10 being moved in the correct manner, according to my invention.

To enable the abutment 10 to move in the manner indicated, it will be necessary to control the tension of the springs 24, by a proper adjustment of the set screws 23, in such a way that the levers will give way outwards under the increased pressure resulting from the expansion of the arch under heat, the weight of the arch itself, however, being fully taken up by the springs.

Furthermore, the springs 24 may be designed in such a manner, that their tension at varying rates of compression will be equal to the corresponding pressure of the arch roof.

Under certain circumstances, it may be advisable to arrange the abutment plates 10 for the conical rather than rectilinear arches not rigidly but movably to the levers 12. Such a mode of carrying out my invention is shown in Figures 5 and 7.

Figure 5 shows the buckstays 4 of the anchorage, the oven side walls 3 and the movable bricks 30 on the topmost layer of the side walls. The arch shown has been marked with 8 and 9.

The end brick of the arch rests in a plate shaped abutment 31. The abutment plate 31 is provided with a lower projection 32, which prevents the end brick of the arch from sliding from the abutment, said plate having on the back a ball-shaped projection 33. The end 34 of the lever 35 acts upon this ball-shaped projection 33, said lever being supported pivotally at 36 in a bearing 37 provided on the buckstays 4. The springs 38 placed between the end of the lever 35 and a pressure plate 39 are kept in position by a tension rod 40 and the nuts 41, and act upon the upper end of the lever 35. The tension rod 40 is supported by means of nuts 42 in a suitable manner at the vertical buckstays 4.

The springs 38 and lever 35 do substantially the same work as the abutment levers and the springs according to Figure 1. The arch 8 is held together by the force of the springs 38, which counteracts the weight of the arch, but the force of the springs gives way to the increased arch pressure resulting from the heat expansion of the bricks. Due to the fact, that the abutment lever 35 only acts loosely upon the ball-shaped projection 33 of the abutment plate 31, the abutment plate 31 can, moreover, perform a certain movement, relative to the abutment lever 34 in any desired direction. A screw 43 extends

through the projection 33 and through a bore in the end of the lever 34, and the nuts 44 ensure a solid connection of the abutments 31 to the lever ends 34, as soon as the arch has taken its final shape after the operating temperature has been arrived at.

A fixing of the abutment 31 is preferably done at this time, since with a free movement of the abutments of the arch, they may tilt over when the temperatures are varying, thus causing certain tensions in the arch, by which the arch would collapse.

Instead of connecting the abutments by means of set screws rigidly to the abutment levers, it is also possible to provide a yielding connection between the abutments and the abutment levers, which connection acts in such a way, that the abutments will partake of a certain movement relative to the abutment levers corresponding to the increased pressure of the arch, without however giving way to the weight of the arch itself.

I have now described my present invention on the lines of a preferred embodiment thereof, but my invention is not limited in all its aspects to the mode of carrying out as described and shown since the invention may be variously embodied within the scope of the following claims.

I claim:—

1. A furnace roof for high temperature industrial furnaces comprising: an arched roof formed of individual refractory bricks arranged in an arc and suspended to span the furnace side walls freely thereof; abutments at the margins of the roof for supporting the bricks in contiguous relationship with each other; and spring and lever mechanism mounted on an outside anchorage for the oven brickwork for yieldably clamping the abutments in clamping engagement with the bricks at the margins of the roof to clamp the bricks against each other and yet yield to accommodate expansion and contraction of the bricks under heat; and in which the bricks of the roof are free of suspensory means and otherwise unsupported other than by their clamped contiguity with each other for freedom of alteration of the shape, elevation and radius of curvature of the roof under expansion of operating heat, and in which the spring and lever mechanism also comprises the sole load carrying and supporting suspensory means for suspending the roof freely of the oven walls, with the levers mounted for movement in relation to the roof and designed and adapted for accommodating themselves to alteration in elevation as well as lineal movement of the roof as a result of alterations in radius of curvature of the roof during expansion and contraction under operating heats; and with the springs acting on the levers and designed and adapted to carry the entire weight of the roof as well as to adjust the levers to retraction and propulsion as the roof expands and contracts.

2. Apparatus as claimed in claim 1 and in which the levers comprise pivotally mounted upper and lower lever arms with the springs operatively connected with the upper arms and the roof suspended from the lower ends of the lower arms, and in which the pivotal axis is so cor-

related to the abutments as to cause the lower end of the lower arm to adjust itself to the alteration of the elevation of the roof arch as a whole during expansion and contraction of the roof arch as a whole.

3. Apparatus as claimed in claim 1 and in which the levers comprise pivotally mounted upper and lower lever arms with the springs operatively connected with the upper arms and the roof suspended from the lower ends of the lower arms, and in which the pivotal axis is so correlated to the abutments as to cause the lower end of the lower arm to adjust itself to the alteration of the elevation of the roof arch as a whole during expansion and contraction of the roof arch as a whole and in which the spring mechanism comprises telescoping upper and lower casing sections containing compressible inner springs and a connecting rod secured to the upper lever arm and extending through the casing sections and secured to the upper section, to draw the upper casing section down thereby compressing the inner springs upon retraction of the lower arm by expansion of the roof against the lower arm, and to be urged upwardly by the inner springs and thus draw up the upper arm and propel the lower arm towards the roof upon contraction thereof.

4. Apparatus as claimed in claim 1 and in which the clamping connection between the levers and the abutments comprises a yieldable connection permitting relative movement between the abutments and their levers at the juncture of the two to adjust them to each other during their movement under expansion and contraction of the roof arch.

5. Apparatus as claimed in claim 1 and in which the connection between the abutments and their levers comprise a spherical projection on the abutment and a correspondingly curved co-operating socket on the lever, a screw extending through the spherical projection and through a bore in the lever and the socket for the spherical projection with the bore of larger diameter than the screw and the screw fastened to the lever for adjustment of the spherical projection in the socket.

6. Apparatus as claimed in claim 1 and in which the levers comprise pivotally mounted upper and lower lever arms with the springs operatively connected with the upper arms and the roof suspended from the lower ends of the lower arms, and in which the pivotal axis is so correlated to the abutments as to cause the lower end of the lower arm to adjust itself to the alteration of the elevation of the roof arch as a whole during expansion and contraction of the roof arch as a whole and in which the spring mechanism comprises a volute spring encircling a horizontal adjusting rod which extends through the upper arm of the lever and has a pressure plate with the volute spring compressible on the rod between the pressure plate and the upper arm of the lever.

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