F. ORTH.

ARCH CONSTRUCTION FOR FURNACES.

APPLICATION FILED DEC. 26, 1912.

1,095,920.

Patented May 5, 1914

3 SHEETS—SHEET 1

Fig. 1.

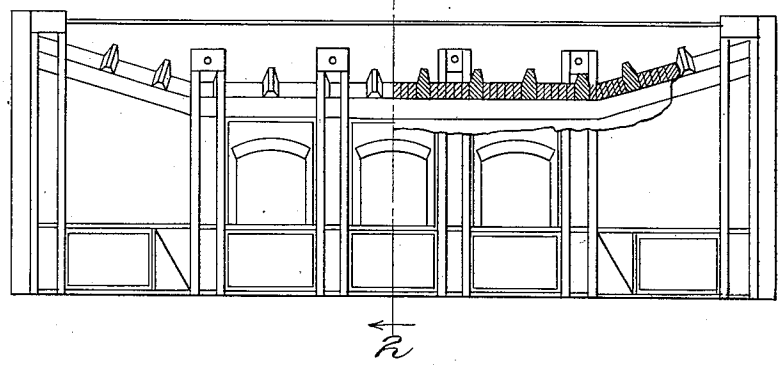
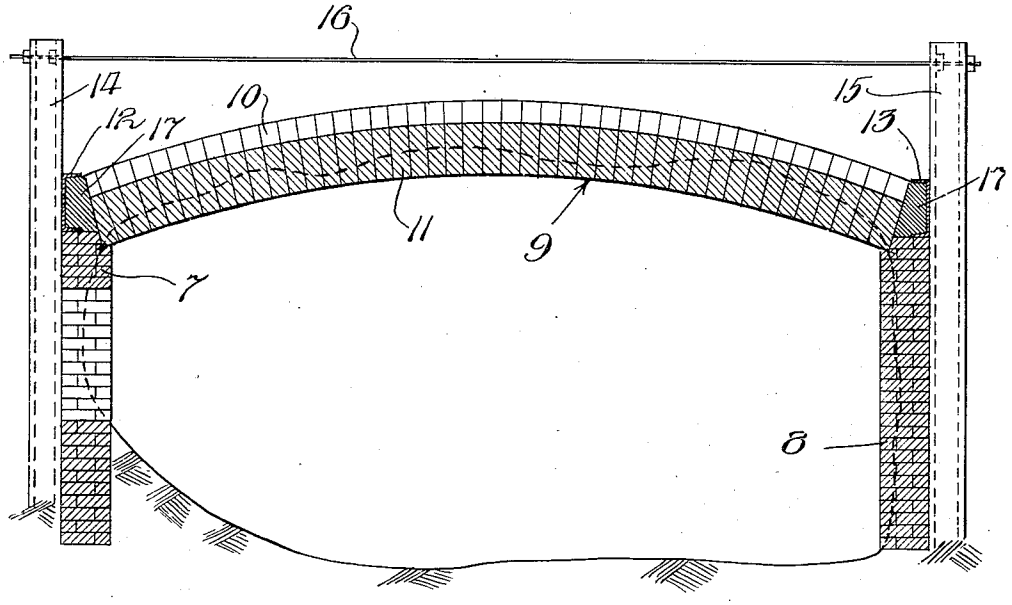


Fig. 2.



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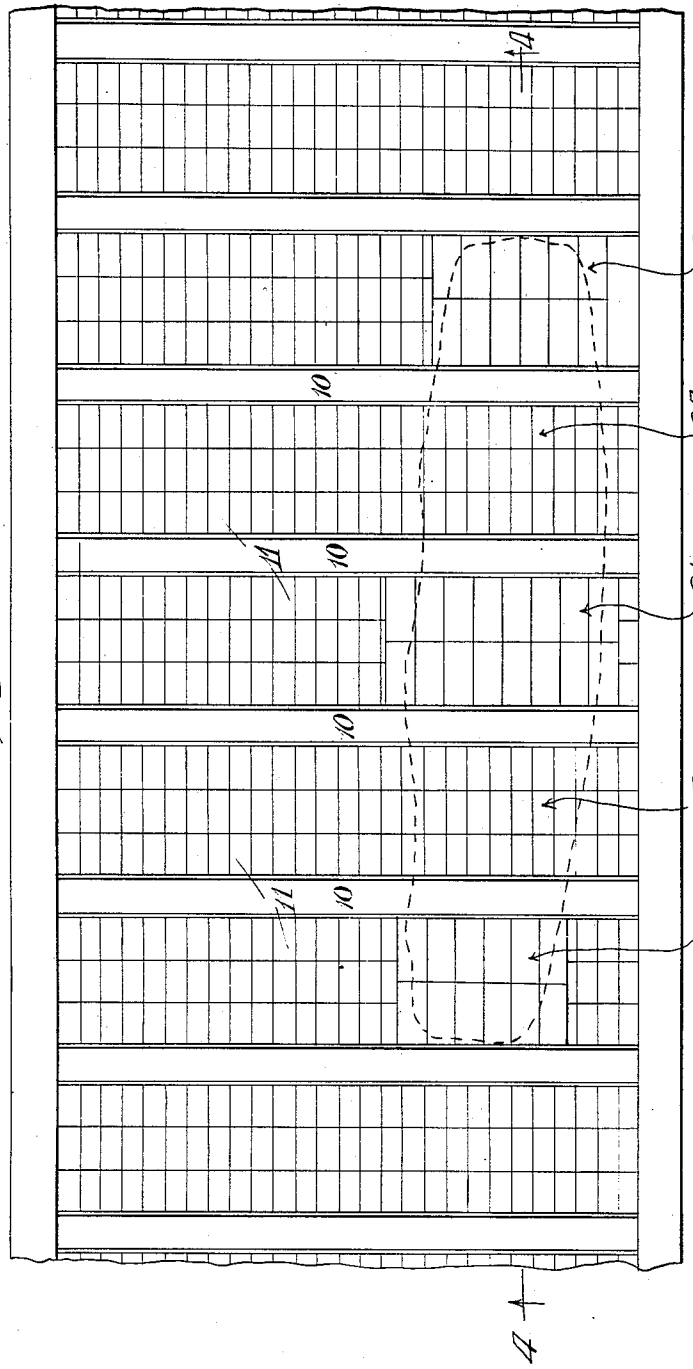


Fig. 5.

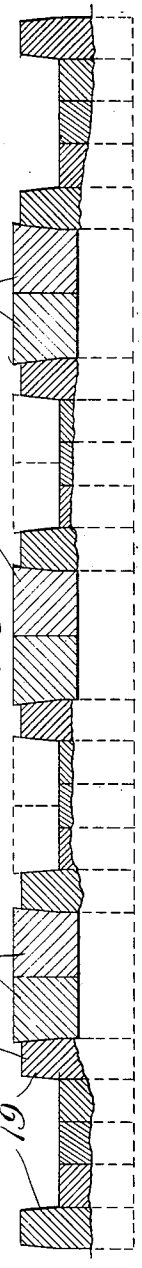


Fig. 4.

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3 SHEETS—SHEET 3.

Fig. 7.

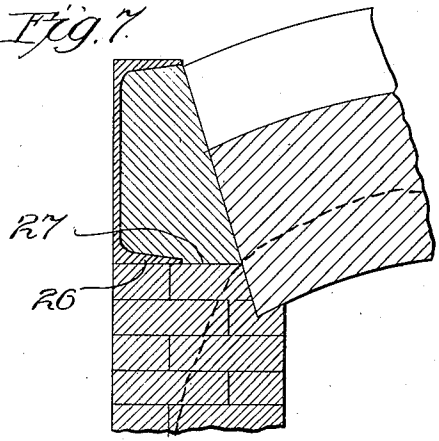


Fig. 8.

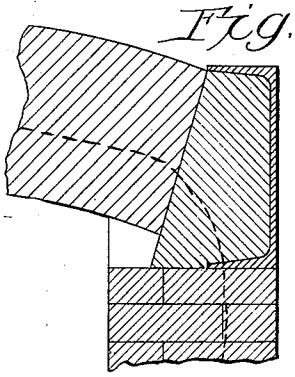


Fig. 6.

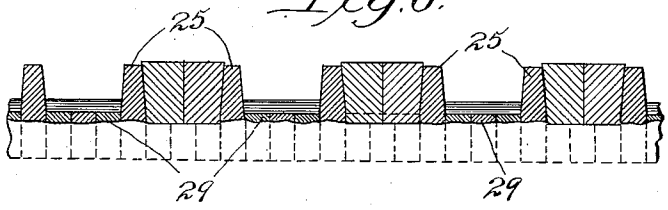
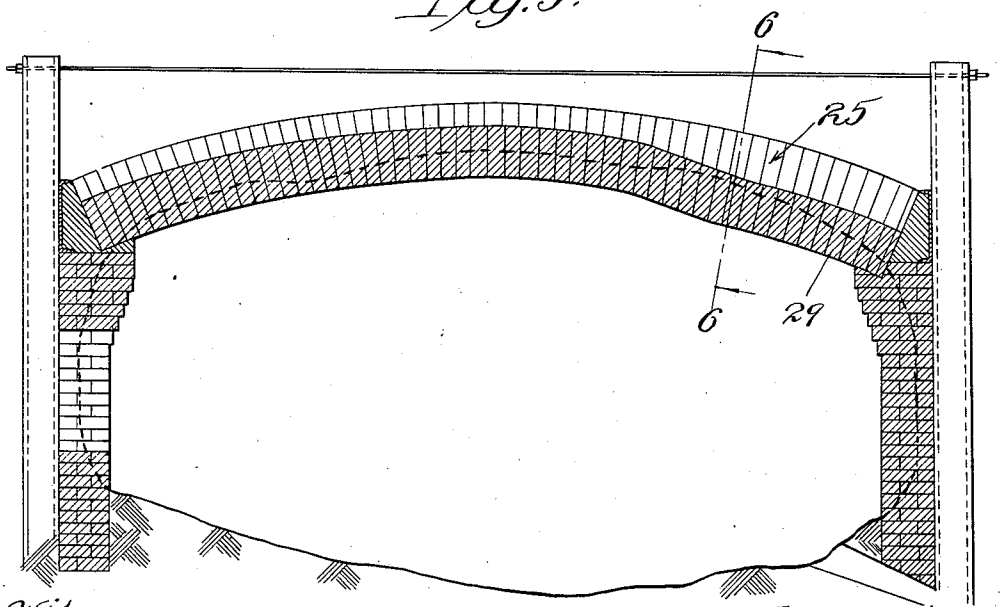


Fig. 5.



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UNITED STATES PATENT OFFICE.

FRANK ORTH, OF INDIANA HARBOR, INDIANA.

ARCH CONSTRUCTION FOR FURNACES.

1,095,920. Specification of Letters Patent. Patented May 5, 1914.

Application filed December 26, 1912. Serial No. 738,643.

To all whom it may concern:

Be it known that I, FRANK ORTH, a citizen of the United States, residing at Indiana Harbor, in the county of Lake and State of Indiana, have invented certain new and useful Improvements in Arch Constructions for Furnaces, of which the following is a specification.

The present invention relates to that class of arch construction for furnaces in which use is made of a series of transverse ribs extending across the furnace and adapted to support intermediate sections of the brick or tile from which the roof is constructed.

The present invention relates particularly to the above described construction as used in open hearth furnaces such as are employed in the manufacture of steel, glass, and the like. On account of the intense heat existing in these furnaces, it is found that the fire brick or tile of the roof burns away so that eventually the roof would cave in and thus interrupt the operation of the furnace. Where the roof is originally made of uniform thickness, and is entirely self-sustained, in other words, where it is not reinforced by some other element such as a series of ribs, it is found impossible to allow more than a predetermined percentage of the thickness to burn away before it is necessary to replace substantially the entire roof. This result follows largely from the fact that the burning away does not take place uniformly throughout the entire area of the roof, but concentrates in spots, which spots or portions burn away much more rapidly than the remainder of the roof. As a general rule, the portions of the roof which are most subjected to this rapid burning are those portions opposite the doors of the furnace. For example, it is generally found that the portion of roof just in advance of the rear wall generally burns away much more rapidly than any other portion. It is a well known fact in roof design that in order to insure stability and to insure against buckling, the line of thrust, as it is called, must be kept within the material of the roof or arch at every point. If the line of thrust is allowed to pass out from the material at any point in the arch, there will be a tendency for the roof to buckle at such point, to resist which tendency the tensile strength of the brick and cement would have to be brought into play.

The main object of this invention is to provide a ribbed roof construction of such form that an increased thickness of material is provided in those portions of the roof and ribs which are most subjected to burning. In this way when practically all of the roof material has been burned away in these portions, there will still remain sufficient rib material, and of proper contour to insure that the lines of thrust of the ribs will still remain in the material of them. Thus any danger of buckling the ribs in such portions of the roof will be obviated.

Another object of the invention is to so form the rib sections that replacements for repair purposes can be easily and quickly made, and so that the blocks or bricks, used in this repair work will be efficiently sustained and held against the possibility of dropping down. This feature of my invention also has for an object the construction of the roof in such a way that the repair of an extensive burned section may be made by replacing the burned brick in every other section, and afterward in the intermediate sections. In this way the expansion of the new brick which is suddenly subjected to a high degree of heat will be distributed and will not tend to push the ribs out of alinement and to accumulate toward one end of the furnace.

Another feature of my invention relates to the form of construction adopted for sustaining the end thrust which is exerted by the arch, and by the ribs which reinforce the same. It is customary in constructing open hearth furnaces to run channels or other suitably shaped steel sections lengthwise of the furnace along the upper portions of the walls of the same, placing vertical struts outside these channels, and then tying together the struts by crosswise extending tie-rods. The sides of the arch and the ends of the ribs are abutted against these channels, or against suitably formed blocks which are seated into these channels, so that the thrust throughout the entire length of the roof is taken up by the channels, which in turn are sustained against spreading by means of the crosswise extending tie-rods. Now, it has been attempted heretofore to protect the inturned flanges of these channels as well as possible by attempting to surround them with fire brick or tile so that they will not be burned by the intense heat existing within the furnace. However, it

has been found that in almost every instance the edges of the channel flanges are eventually burned away, because when the fire brick of the walls and roof is burned away the flanges are exposed to the intense heat. One reason why this result takes place is that the channels in the ordinary roof construction must be set low down in the walls in order to receive the thrust of the arch. Therefore, when the material of the walls and arch has been burned away to some extent the flanges of the channel are exposed to the heat. In the present feature of this invention I take advantage of the fact that the ribs extend above the intermediate sections of roof material, and inasmuch as the ribs take the thrust, or a large part of it, the channels can be set up as high as the ribs extend. By setting the channels up in this manner, by the time the walls and arch have been burned away as much as is safe, there still remains a considerable thickness of fire proof material surrounding the flanges of the channels to effectively protect the same against the intense heat of the furnace.

Other objects and uses of the present invention will appear from a detailed description of the same which consists in the features of construction and combination of parts hereinafter described and claimed.

In the drawings, Figure 1 shows an elevation of an open hearth furnace embodying the features of my construction, one-half being in full elevation, and the other half showing the roof in section; Fig. 2 shows an enlarged section taken on the line 2—2 of Fig. 1, looking in the direction of the arrows; Fig. 3 shows a plan view of a section of roof embodying the features of my invention showing the manner in which a thin section of roof may be easily and safely repaired by first replacing the thin portions of alternate sections; Fig. 4 shows a section taken on the line 4—4 of Fig. 3, looking in the direction of the arrows; Fig. 5 shows a cross-section through a modified form of roof in which those portions most subjected to burning are provided with ribs of excess thickness; Fig. 6 is a section taken on the line 6—6 of Fig. 5, looking in the direction of the arrows; Fig. 7 shows an enlarged detail of the upper corner of my improved roof construction showing how it is possible in the same to place the thrust receiving channels so high up that they will not be burned when the wall and roof material has been burned away as much as is safe; and Fig. 8 shows an enlarged detail similar to that of Fig. 7 with the exception that the channel is set down into the position which it occupies in previous forms of construction.

In the drawings, the forward wall of the furnace is designated by the numeral 7 and the rear wall by the numeral 8. The arch roof is designated by the numeral 9. The same comprises a series of cross-wise extending arch ribs 10 each supporting intermediate sections of arch roof 11. Lengthwise extending channels or other suitable metal sections 12 and 13 abut against vertical struts 14 and 15 between which extend the tension bars 16. Suitably shaped blocks of fire proof material 17 are interposed between the ends of the arch sections and ribs and the channels. These sections 17 are for the purpose of insuring that the thrust from the arch sections and ribs will be evenly and uniformly delivered to the channels.

In Fig. 2 I have shown by means of the heavy dotted line approximately the line upon which the walls and roof of the furnace will be burned away. It will be seen that there is a tendency for the rear portion of the roof to burn away more rapidly than the front portion thereof, to meet which exigency I have provided the construction to be presently described.

On account of the tendency of the roof to burn away more rapidly in some spots than in others it is found necessary or desirable to make replacements or repairs in some portions of the roof before they are necessary in other portions. In Fig. 4 I have shown in enlarged detail a cross-section of a portion of the roof, with replacement sections inserted in every other span. It will be seen from this figure that the ribs have their upper portions 18 tapered inward so that the faces 19 of the upper portions of adjacent ribs approach each other from top to bottom. This construction is preferred for the reason that the repair sections can be more easily inserted and securely locked in place than would otherwise be possible.

In Fig. 3 I have shown by means of the dotted line substantially the contour of an unusually thin section of roof which it may be desirable to repair. When undertaking this repair work, the thin portions 20, 21 and 22 of the roof should first be removed and repair sections inserted in their place. Thereafter the intermediate sections 23 and 24 may be repaired so that eventually the entire section of thin roof will be replaced with material of such thickness as to considerably prolong the life of the roof.

It will be understood that in a furnace of this nature where the operating temperature is extremely high that a long interval of time would be consumed if the furnace were to be allowed to completely cool before undertaking the repair of a thin section of roof. In order therefore to reduce as much as possible the loss of time occasioned by having to await cooling, it is desirable to proceed with the repairing of the roof even while the furnace remains hot. For this reason if the entire section of the thin portion of the roof were to be repaired at once, commencing on the portion 20, and proceed-

ing successively through the portions 23, 21, and 24 to 22 the amount of expansion of the new material inserted in these several sections would be large, and would be cumulative, so that a considerable side thrust would be exerted on some of the ribs, and particularly those at the ends of the repaired section. Therefore these ribs might be displaced or even destroyed. Furthermore, the intermediate portions of roof which had not been repaired would probably have their seams opened up and become cracked. However, by making the repair as previously pointed out, repairing every other section first, and then coming back to repair the intermediate sections, the expansion of those sections first repaired can be taken care of, and then the intermediate sections, when they are inserted, will accommodate themselves to the slightly changed positions of the ribs occasioned by the expansion of the first repaired sections.

In Fig. 4 I have shown the preferred shape of the repair blocks. They are the blocks 28 and they have the upper portions of their outside faces tapered slightly to seat squarely against the rib faces 19, while their inner faces are untapered so that they seat squarely together. It will be seen that by the use of a block of this shape, when the blocks are set into position they will seat down only low enough to bring them firmly into contact with the side faces of the ribs, and to bring the adjacent faces of the blocks themselves firmly together. Therefore, when the intermediate sections are set into place they will seat down just low enough to accommodate themselves to any slightly changed positions of the ribs.

It was previously stated that one of the objects was to provide a roof construction in which the thickness of the ribs at the different points should be substantially accommodated to the amount of burning liable to take place at each point. In the construction shown in Fig. 5 this result is attained. In this figure the rear portion 25 of each rib section which in general is the portion which burns most rapidly is made of increased thickness or depth so that when the adjacent portions of the roof sections have been burned away there will still remain a sufficient depth of rib to insure that the line of thrust in the rib will remain within the material thereof, thus insuring stability and insuring against possible buckling.

In Fig. 6 I have shown how repairs may be made in the construction of Fig. 5 in a manner similar to that illustrated in Fig. 4. In this case the intermediate roof sections are designated by the numeral 29. The main point with respect to the construction of Figs. 5 and 6 however is that the depth of the rib sections is substantially accommodated to the probable amount of burning so that the line of thrust will always remain within the rib sections, and particularly after the repairs have been made.

In Fig. 7 I have shown more in detail how the rib construction of roof is admirably adapted to the placing of the thrust channels in such position as to best protect them against burning. It was previously stated that the rib sections take the main portion of the thrust of the arch roof. For this reason it is possible where the ribs project above the roof sections to place the channels up higher than would be possible where the main portion of the thrust was on the intermediate sections. For example, in the construction shown in Fig. 7 the lower flange 26 of the channel is so high up that when the material of the wall and roof has burned away as far as it is safe to allow, there will still be such a thickness 27 of fire proof material protecting said flange that the latter will be in no danger of burning. On the other hand, in Fig. 8 I have shown for purposes of contrast the construction in which the rib sections are not used. In this case on account of the fact that the entire thrust is within the roof material itself the channel must be set down so low that its lower flange will ultimately be reached when the material is burned away, so that said flange will be burned and the strength of the channel will be greatly reduced. In this connection I wish to point out particularly the fact that there is a peculiar relationship or interdependency between the positions of the thrust channels and the rib sections. In other words, by the provision of the rib sections themselves I have made it possible to raise the thrust channels high enough up to effectively protect them against the intense heat of the furnace, even when the walls and roof of the furnace have been burned away as much as it is safe to allow. This is a very important matter for the reason that a very slight movement of any portion of the thrust channels is liable to allow a section of roof to cave in. The ratio between the lift of the central portion of the roof and the span, is so small that a very slight spreading of the channels will allow a considerable lowering of the central portion of the roof. When it is considered that the outer edges of the channel flanges are subjected to the maximum compressing force, it will be seen that a very slight burning on the edges of said flanges will very materially decrease the strength of the thrust channels and thus allow the slight spreading of the channels necessary to permit the roof to lower materially.

I claim:

1. In a furnace of the class described, the combination of a plurality of crosswise extending thrust ribs, intermediate roof sections between the adjacent ribs, and means

for sustaining the ends of the ribs to receive the thrust therefrom, the depths of the different portions of the several ribs being proportioned according to the probable amount of burning at each section of roof, and the upper portions of the several ribs extending above the adjacent roof sections, substantially as described.

2. In a furnace of the class described, the combination of a plurality of thrust ribs, intermediate roof sections between the adjacent ribs, and means for sustaining the ends of the several ribs to receive the thrusts therefrom, the depths of the different portions of the ribs being proportioned according to the probable amount of burning at each section of the roof, and the roof sections being mounted between the lower portions of adjacent ribs, whereby the upper portions of the several ribs extend above the adjacent roof section to provide supports for the reception of repair blocks, substantially as described.

3. In a furnace of the class described, the combination of a plurality of crosswise extending arched thrust ribs, means for sustaining the ends of said ribs against spreading, and intermediate roof sections between the lower portions of adjacent ribs, the upper portions of the several ribs tapering in thickness from the line of junction of each roof section with its rib, whereby replacement blocks may be inserted between the upper portions of adjacent ribs and supported by the tapered faces thereof, substantially as described.

4. In a furnace of the class described, the combination of a plurality of crosswise extending thrust ribs, the depths of the several portions of each rib being proportioned according to the probable amount of burning at each portion, means for sustaining the ends of the ribs to receive the thrusts therefrom, and intermediate roof sections between the adjacent ribs, the lower surfaces of such roof sections alining with the lower edges of the adjacent ribs, whereby a substantially flush inner surface of the roof is produced.

5. In a furnace of the class described, a roof having a plurality of crosswise extending thrust portions having the depths of their various sections proportioned according to the probable amount of burning at such sections, and intermediate roof sections between said thrust portions, the lower surfaces of the roof sections alining with the lower edges of the thrust portions to provide a substantially smooth and continuous inner surface at all points of the roof.

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Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."