

May 5, 1959

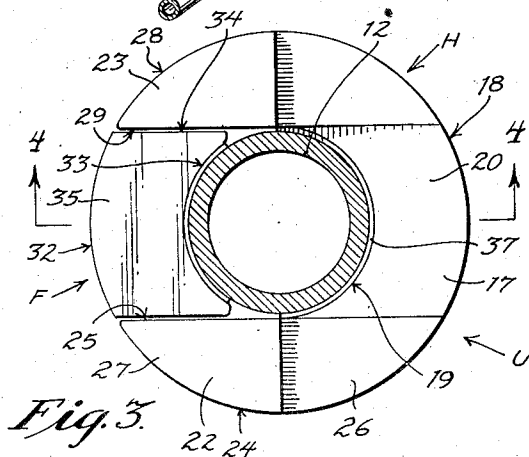
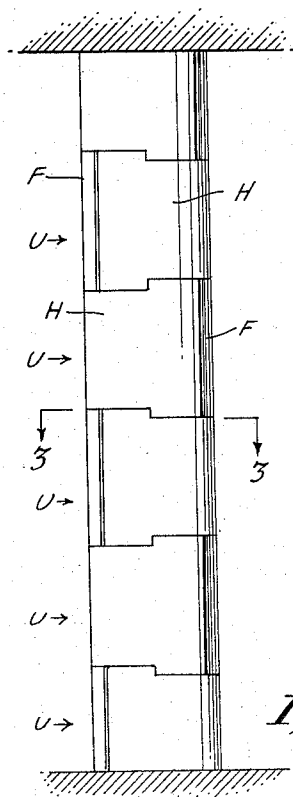
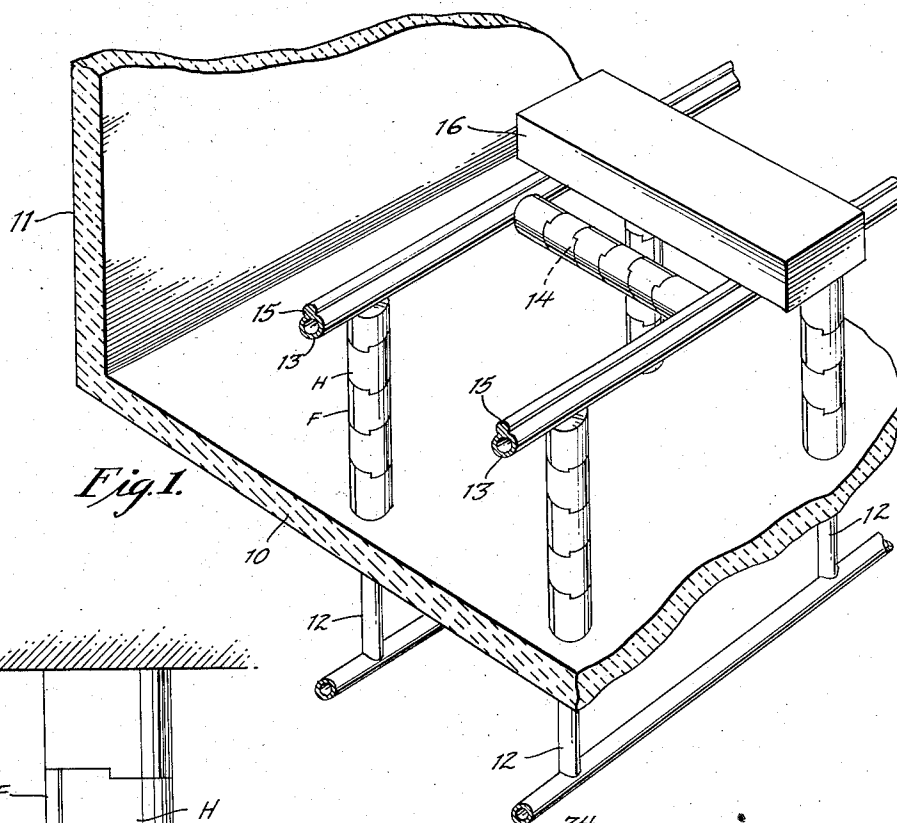
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2,884,879

INSULATED WATER-COOLED FURNACE MEMBERS

Filed Nov. 9, 1955

2 Sheets-Sheet 1



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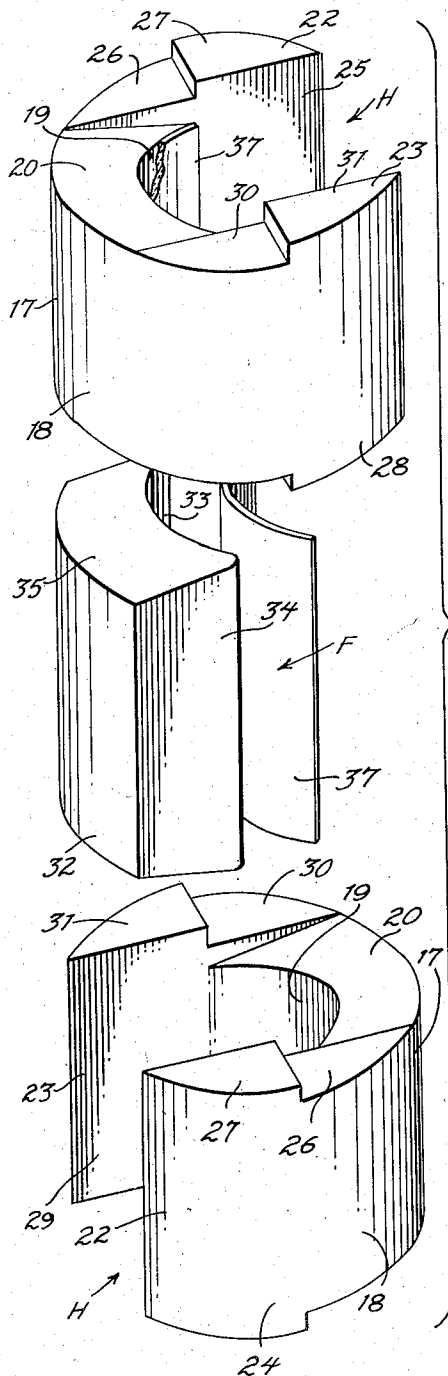


Fig. 5.

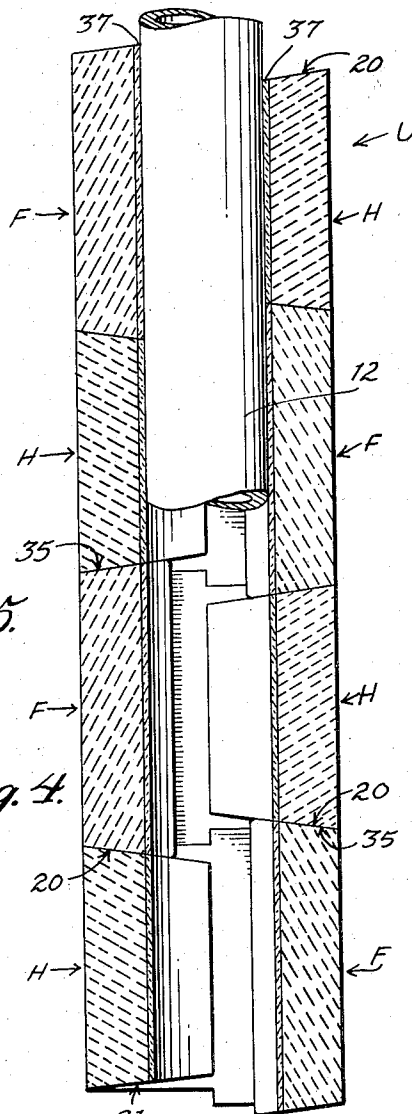


Fig. 4.

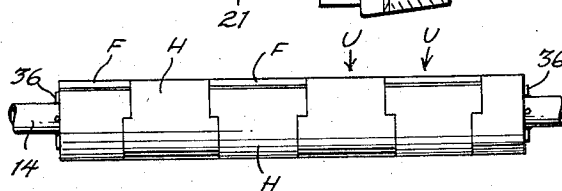


Fig. 6.

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INSULATED WATER-COOLED FURNACE MEMBERS

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2 Claims. (Cl. 110—98)

The present invention relates to heating furnaces such as are commonly employed in the metallurgical industries, and is concerned primarily with the water-cooled pipes which function as skidrails or stock supports in such furnaces.

In metallurgical furnaces of the type with which this invention is concerned, temperatures in the nature of 3,000° F. are often achieved; moreover, any pipe, insulated or otherwise, is exposed to flame action. Thus, any insulation which is provided for the water-cooled pipes must be capable of accommodating these factors. Moreover, from the practical viewpoint, it is highly important that any insulation provided have a long service life so as to reduce to a minimum shutdown periods which are required for replacement. Then again, if insulation is to be replaced, it should be of such a nature that this operation can be quickly performed.

At the present time, it is common practice in the steel and other metal industries to move stock in the forms of billets, slabs, and the like through a furnace for heat treatment purposes. Skidrails and stock supports are ordinarily provided for the purpose of supporting the work as it is moved through the furnace. Due to the high temperatures which obtain in such furnaces, it is now the substantially universal practice to employ water-cooled tubes as the work-supporting elements. Moreover, during recent years, because of high fuel and repair costs, it has been recognized as desirable to insulate these tubes or pipes by applying a lining or covering of refractory material thereover. In the patent to J. W. Corriston, No. 2,022,649, dated December 3, 1935, there is illustrated and described an arrangement whereby a plastic refractory is applied and held in position on such water-cooled pipes by studs which are full welded directly to the pipe and outstand therefrom. In addition, the covering of high heat-and-slag-resistant insulation acts to protect the surface of the pipe from deterioration from the hot and corrosive gases of the furnace.

As above outlined, installations have been made in which the studs are welded directly to the piping. In other installations, the studs are carried by collars or curved plates which are in turn welded to the piping. In both of these types of installations, the studs function not only to support the plastic refractory in position, but also as heat conductors which cool the refractory and prolong its service life. Another type of installation involving the use of plastic refractory has also been employed. In this latter type, stainless steel coils are embedded in the refractory and welded to the pipe. When this form is employed, the cooling effect is lost, and the refractory covering quickly deteriorates because of the exposure to high temperatures and flame actions.

It has been found that while both the welded stud and wire coil types of pipe insulation are fairly satisfactory when a new furnace is built, the subsequent maintenance of the insulation involves such a high time consumption as to be undesirable, particularly when continuous pro-

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duction of steel tonnage is of prime importance. It is to be remembered that with every repair job thousands of studs have to be welded onto the pipe and the plastic refractory applied by hand. This, of necessity, requires stoppage of the furnace for periods running into several days. Thus, while great fuel saving is obtained during furnace operation by the insulation, this is greatly offset by the loss during the shutdown periods.

With the foregoing conditions in mind, the present invention has in view as its foremost objective the provision of a new and improved refractory lining or covering for furnace pipes of the character aforesaid which, from its very nature, has a service life much greater than any of the refractory linings now being employed; and further, because of its structural features, may be quickly applied to the pipes either in new furnace constructions or for repair purposes with a degree of facility far beyond anything that is possible with the now-known arrangements provided for this purpose. More in detail, the invention has as an object the provision of a refractory covering or lining for furnace pipes of the character indicated which consists essentially of interlocking blocks having inner curved surfaces conforming to the contour of a pipe to which they are to be applied, with the curved surfaces being lined with a material having higher heat-insulating properties than the blocks proper. By utilizing blocks, it is possible to employ many of the modern "super refractories." Among such materials might be noted fused types of alumina oxide, fused and stabilized zirconia, alumina-silicate combinations, mullite, sillimanite, Carborundum, as well as chrome ore. These super refractories are capable of withstanding the high temperatures and flame action which are present in steel and other metal furnaces. Under such conditions they will exhibit a longer service life as compared to the plastic refractories heretofore employed, since they may be kiln fired to develop a ceramic bond.

In providing a pipe covering in the form of interlocking blocks, it is possible to provide for a small space between the outer surface of the pipe and the inner surface of the covering. Another highly important object of this invention is to provide a pipe covering of the character indicated in which this space is filled by another type of high heat-insulating material such as asbestos or superior synthetic fiber products in the form of a wrapping material. This insulating lining may be carried by the inner surface of the covering blocks.

While all the super refractories mentioned above have good heat-insulating properties, there are other materials such as asbestos and some of the synthetic fiber products now on the market which are better heat insulators and are also of a more soft or cushioning nature. With a lining of such a high insulating material applied to the inner curved surfaces of the blocks, many important advantages are obtained. Among these might be noted the maintenance of a comparatively low heat differential between the outer and inner surfaces of the blocks. This prolongs the service life of the blocks. Also, any discrepancies between the meeting curved surfaces of the blocks and pipes are accommodated. Then again, any vibrations in the pipes are taken care of without danger of cracking the blocks; and should the pipes, whether vertical or horizontal, become distorted for any reason, the higher heat insulation will absorb the distortion without cracking the blocks.

Another object of the invention is to provide a pipe covering of the character indicated which consists essentially of a plurality of block units which are applied in succession along the pipe, with each unit interlocking with the next adjacent unit. Each of these units consists essentially of a horseshoe-shaped collar, together with a

piece for closing the open mouth of the horseshoe, and an inner lining of a high heat-insulating material on both parts.

Due to the fact that this collar and complemental piece are made from a refractory material, they are herein identified as tiles.

Another object of the invention is to provide a covering for furnace pipe of the character indicated which consists essentially of a plurality of horseshoe-shaped tiles which are alternately arranged along a pipe in interlocking engagement, together with complemental filler tiles which close the mouth of the horseshoe tiles and which interlock with the adjacent horseshoe tiles. Particular objects and advantages of the invention are associated with the particular shape and construction of these horseshoe and filler tiles which provide the interlocking structure.

A furnace of the type with which this invention is concerned ordinarily includes both vertical and horizontal pipes which must be protected by insulation. In the case of vertical pipes, the tiles may be applied by beginning at the bottom, with each tile being interlocked and held in position on the next adjacent tile by gravity action. When a horizontal pipe is to be covered, an appropriate anchorage or support must be provided at the starting end. Thus, a plurality of studs may be welded in ringlike fashion about one end of a horizontal pipe that is to be covered. The first unit is then pushed up against these studs and each successive unit applied to the unit previously positioned. At the finished end another ring of studs is welded to the pipe to maintain the assembled relation.

Various other more detailed objects and advantages of the invention such as arise in connection with carrying out the above-noted ideas in a practical embodiment will in part become apparent and in part be hereinafter stated as the description of the invention proceeds.

The invention therefore comprises a refractory lining or covering for the water-cooled pipes of metallurgical furnaces, and which lining consists essentially of a plurality of units that are applied in succession along the pipe in interlocking relation, with each unit comprising a horseshoe-shaped tile and a filler tile which are made from a super refractory, with the horseshoe-shaped tiles being alternately arranged and the filler tiles alternately arranged, together with a lining of high heat-insulating material on the inner curved surfaces of the tiles.

For a full and more complete understanding of the invention, reference may be had to the following description and accompanying drawings, wherein:

Figure 1 is a perspective view of a portion of a metallurgical furnace including water-cooled pipes which are protected by the refractory lining of this invention.

Figure 2 is a view in side elevation of one of the vertical pipes as covered.

Figure 3 is a horizontal cross section taken about on the planes represented by the lines 3—3 of Figure 2.

Figure 4 is a vertical section taken about on the planes represented by the line 4—4 of Figure 3.

Figure 5 is a perspective view illustrating two of the horseshoe tiles and one of the filler tiles and a lining of high heat-insulating material in exploded relation; and

Figure 6 is a view in side elevation of one of the horizontal pipes as covered by the lining of this invention.

Referring now to the drawings, wherein like reference characters denote corresponding parts, and first more particularly to Figure 1, a portion of a heating furnace is therein illustrated. It is to be understood that this heating furnace is of the type commonly employed in the steel or comparable metallurgical industries for the purpose of heating stock in the form of billets or slabs whereby it is adapted to subsequent forming processes.

The furnace includes a horizontal wall 10 and a vertical wall 11. Extending upwardly through openings formed in the horizontal wall 10 is a plurality of vertical pipes 12 which project into the interior of the furnace. The upper ends of the pipes 12 support the pair of hori-

zontal pipes 13 which function as skidrails. The pipes 12 and 13 communicate with each other so that a cooling medium such as water may circulate therethrough. Between the pipes 13 are one or more cross members 14, which also are hollow pipes that are covered with a refractory lining.

As shown in Figure 1, each of the horizontal pipes 13 includes a top rib 15 which adapts it to the function of acting as a skidrail. A piece of work such as the billet shown at 16 is moved over these skidrails during the normal operation of the furnace.

Referring now more particularly to Figure 5, two horseshoe-shaped tiles are therein illustrated, and each is referred to in its entirety by the reference character H. These tiles H are substantially duplicates, and the construction of only one of them is herein described in detail because that is believed to be sufficient for the purposes of the specification. Each tile H comprises a curved main body portion 17 defined by an outer cylindrical surface 18, an inner cylindrical surface 19, and inwardly converging end surfaces 20 and 21 (see Figure 4).

Integrally joined to this main body portion 17 are side extensions 22 and 23. The side extension 22 has an outer cylindrical surface 24 of the same curvature as the cylindrical surface 18 of the main body portion 17 with which it merges. It also has a flat inner face 25 that merges in with the inner curved surface 19 of the main body portion 17. The side extension 22 has two end faces 26 and 27 at each end in stepped relation. Thus, the flat end faces 26 are disposed more closely adjacent to the main body portion 17, while the flat end faces 27 are at the free ends of the side extensions. These faces 26 and 27 are substantially normal to the axis defining the circular surfaces 17 and 19.

As shown in Figure 5, as well as the other views, the horseshoe-shaped tiles H are alternately arranged. Thus, the tile H at the bottom of Figure 5 opens to the left, while the tile H at the top opens to the right.

The side extension 23 has an outer curved surface 28 corresponding to the curved surface 24 of the side extension 22, an inner flat surface 29 corresponding to the flat surface 25, and flat end faces 30 and 31 which correspond to the flat end faces 26 and 27 of the side extension 22. A lining 37 of a high heat-insulating material is applied to the inner surface 19 and secured thereto in any preferred manner. This lining 37 may be asbestos or one of the synthetic fiber compositions that is now available and which has greater heat-insulating properties than the main body portion of the block and which is relatively soft as compared to the refractory employed.

A filler tile is referred to in its entirety by the reference character F. It is defined by an outer cylindrical surface 32 having a curvature corresponding to the surfaces 18, 24, and 28 with which it blends in when the filler F is assembled in the open mouth of the horseshoe tile H. The tile F also includes an inner cylindrical surface 33 having a curvature substantially the same as the cylindrical surface 19 of the tile H. The tile F also has flat side faces 34 which are in sliding engagement with the faces 25 and 29 of the tile H when the tiles are in assembled relation. It also has end faces 35 which converge outwardly, in contrast to the end faces 20 which converge inwardly. A lining 37 of high heat-insulating material is also applied to the curved surface 33.

The tiles F and H may be made from any of the super refractories now available to the public. Among the super refractories which are believed to be suitable for this purpose are such materials as fused types of alumina oxide, fused and stabilized zirconia, alumina-silicate combinations, mullite, sillimanite, Carborundum, and chrome ore. While Carborundum is often thought of as a high heat conductor compared to other refractories, it is still a good insulator as compared to metal. It may in fact be desirable to use several types of refractories in the

same furnace. Thus, a chrome-ore material might be used to cover the base of vertical support pipes when they are in contact with accumulated iron-oxide slag. Carborundum may be most effective for pipes exposed to direct flame blasts; 90%-alumina refractory or mullite may be best for average conditions.

The ideal pipe-insulating enclosure should have high resistance to thermal differentials, wherein one surface is next to the cold pipe and the other exposed to 3000° F. flame temperatures. It should also resist the attack of iron-oxide slags and have a very high melting point so that the extreme outer surface does not continuously erode away.

Referring now more particularly to Figures 2 and 4, the tiles F and H are therein illustrated as applied to one of the vertical pipes 12. For the purposes of this specification, each horseshoe tile H and a filler tile F make up a unit U. The first unit U is applied to the lowermost point where the pipe is to be covered. Thus, the horseshoe tile H and the filler tile F at the bottom are first positioned in the manner depicted in Figure 4. The next horseshoe tile H is then applied on top of this unit, with the inwardly converging end surface 20 of the tile H engaging the outwardly converging end face 35 of the filler tile F. The next filler tile F is then applied on top of the main body portion 17 of the first-applied tile H. This alternate application of the horseshoe tiles H and filler tiles F is then continued to the top of the vertical pipe, where a suitable end finish may be applied to fill any gap. It is evident that as this action is carried out the first unit U is held in position by its own weight, and this is equally true of each successive unit.

Figure 6 illustrates one arrangement which may be employed when a horizontal pipe 13 is being covered. At the point where the insulation is to begin, a ring of studs 36 is first applied about the horizontal pipe 13 by being welded thereto. A unit U made up of a horseshoe tile H and a filler tile F is then shoved against this ring of studs which acts as an abutment. Each unit U is then applied in succession, and after the last unit is applied, another ring of the studs is welded to the pipes to maintain the assembled relation. A plastic refractory may be applied over the studs 36 if it should be found to be necessary to protect these studs.

The lining 37 on the inner curved surfaces of the tiles H and F presents certain important advantages. In the first place, it reduces the thermal temperature gradient through the walls of the tiles. That is, it provides for a relatively low differential in the temperatures which obtain on the outer and inner walls of the tiles, respectively. This minimizes the tendency of the tiles to spall or crack.

This lining 37 also functions as a resilient cushion which eliminates or substantially reduces any tendency to crack due to vibration or thermal expansion and contraction. It also accommodates any minor imperfections in the pipes and makes it possible to install the tiles without the high degree of mechanical accuracy which ordinarily would be required.

Should the circulatory cooling system become impaired, the vertical pipes will become quite hot and exhibit a tendency to bend under the load on the skid-rails. This bending would, in the absence of the cushion lining 37, tend to crack the tiles. However, this cracking is avoided by the lining 37.

While a preferred specific embodiment of the invention is hereinbefore set forth, it is to be clearly understood that the invention is not to be limited to the exact materials, constructions, and designs illustrated and described, because various modifications of these details may be provided in putting the invention into practice within the purview of the appended claims.

What is claimed is:

1. In a refractory covering for a water-cooled furnace pipe, a unit comprising a horseshoe-shaped tile having a main body portion and side extensions, said main body portion having an outer cylindrical surface, an inner cylindrical surface, and inwardly converging end faces, said side extensions having outer curved faces, inner flat faces, and stepped end faces, and a filler tile having inner and outer cylindrical surfaces and outwardly converging end faces.

2. In a semi-heat-insulating refractory covering for a water-cooled furnace pipe, a unit comprising a horseshoe-shaped tile having a main body portion and side extensions, said main body portion having an outer cylindrical surface, an inner cylindrical surface, and inwardly converging end faces, said side extensions having outer curved faces, inner flat faces, and stepped end faces, and a filler tile having inner and outer cylindrical surfaces and outwardly converging end faces, there being a resilient high heat-insulating material on the inner cylindrical surfaces of said tiles.

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