

Nov. 2, 1954

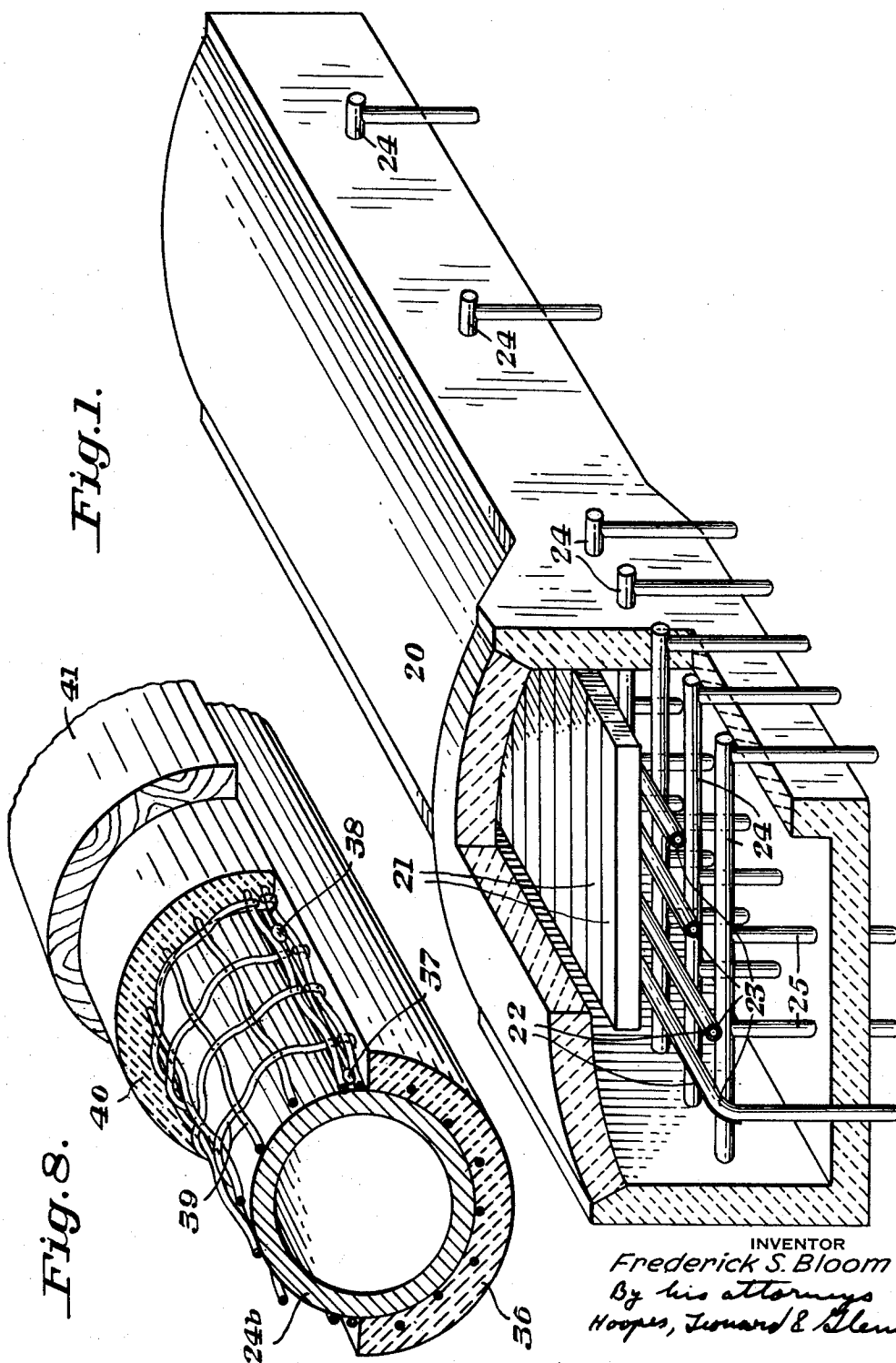
F. S. BLOOM

2,693,352

FURNACE INSULATION SYSTEM

Filed Aug. 14, 1950

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Fig. 2.

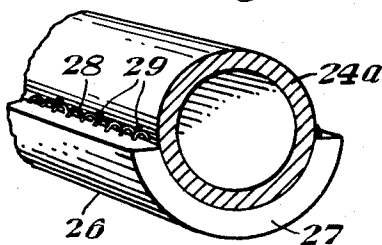


Fig. 3.

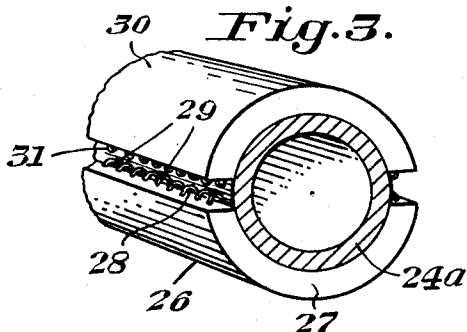


Fig. 4.

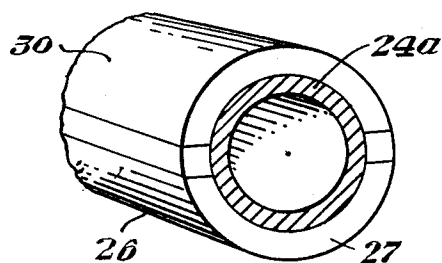


Fig. 5.

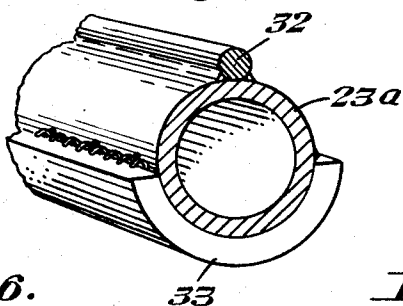


Fig. 6.

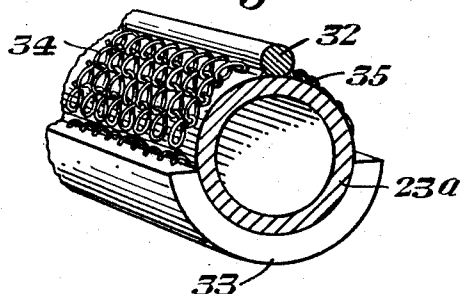
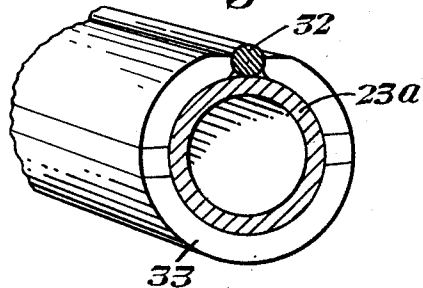


Fig. 7.



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Fig. 9.

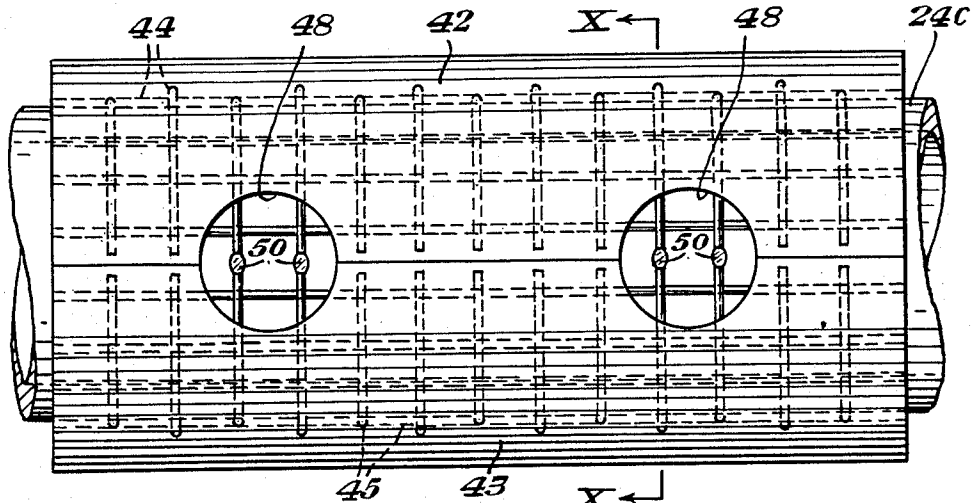


Fig. 10.

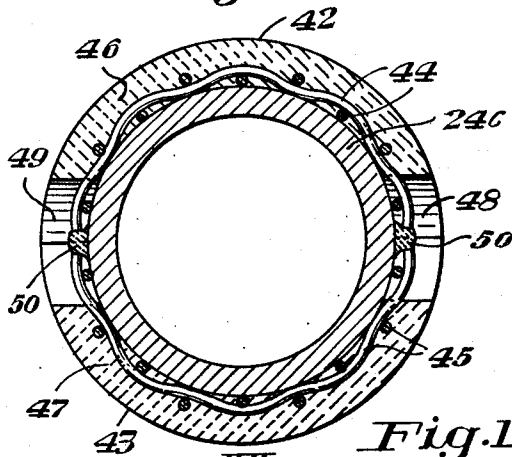


Fig. 11.

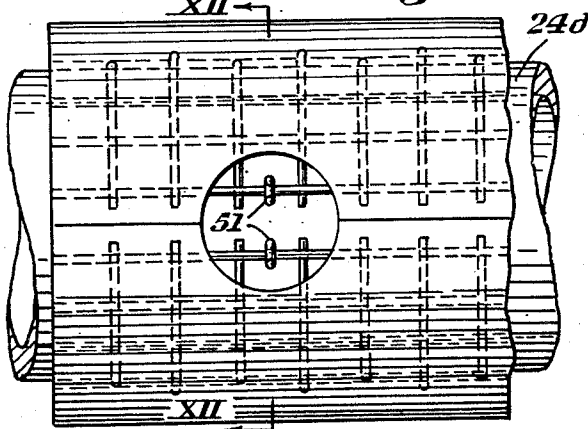
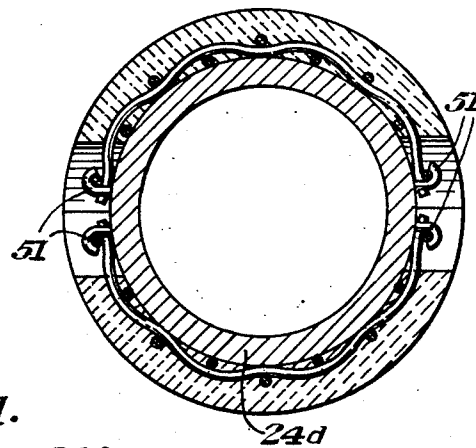


Fig. 12.



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Fig.13.

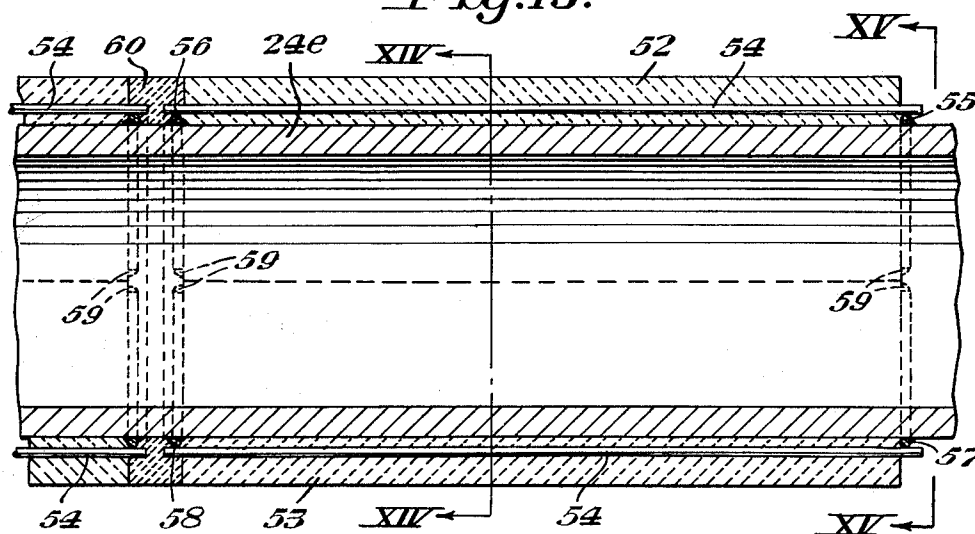


Fig.14.

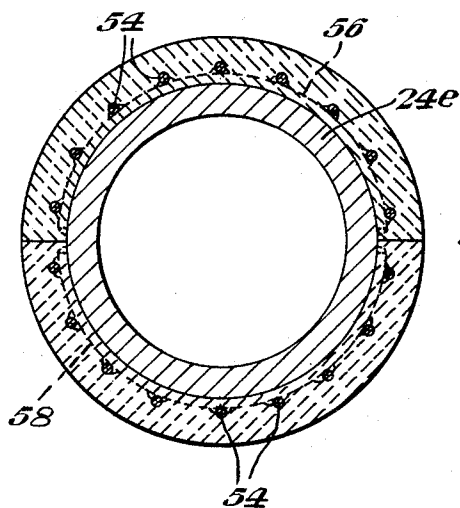
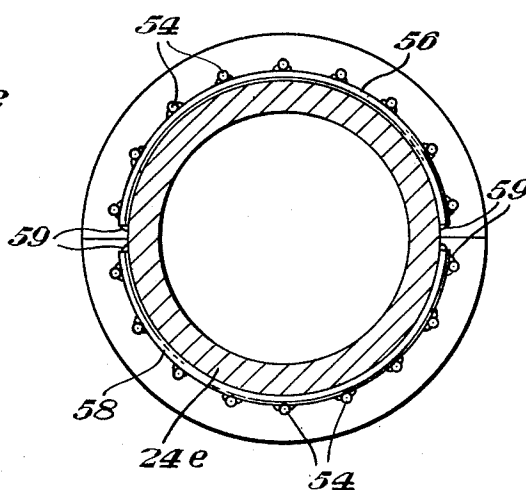


Fig.15.



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FURNACE INSULATION SYSTEM

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Application August 14, 1950, Serial No. 179,105

10 Claims. (Cl. 263-6)

This invention relates to means and method for insulating members mounted within high temperature furnace chambers, particularly water-cooled pipes in the supporting structure for workpieces in heat-treating furnaces such as those described in my copending application Serial No. 694,734, filed September 4, 1946, now Patent No. 2,523,644.

A supporting structure within a furnace chamber where temperatures may be in the order of 2000° F. must be compact in order to leave sufficient combustion space in the chamber, must be strong enough to support heavy metal workpieces being treated in the furnace, and must be protected against injury by the high temperatures within the furnace while at the same time not seriously interfering with the efficiency and maximum temperatures of the furnace. A combination of small size with high strength dictates the use of metal in these supports, and the necessity for cooling the metal dictates the use of hollow metal pipes through which cool water is circulated. If water-cooled pipes with bare outer surfaces are used, however, the adsorption of heat through the metal to the cooling fluid is so great that much more fuel is wasted in heating the cooling fluid than in heating the higher temperature workpieces; for example, a furnace having bare metal supports in its lower zone requires about three times as much fuel to heat the lower zone of the furnace as the upper zone of the furnace, and no matter how much fuel is supplied to the lower zone it still remains distinctly cooler than the upper zone. In order to correct this condition refractory insulating material is often placed around water-cooled supporting pipes, but the refractory tends to crack away after some use, principally because of the difference in thermal expansion of the inner and outer layers of the refractory material and because of the difference in the thermal expansion characteristics of the refractory material and the metal pipe which it encloses. In order to overcome this difficulty various expedients have been tried. In some cases, such as shown by Schmidt Patent No. 2,436,452, the refractory material is spaced from the metal pipe. This I have found to be disadvantageous because the air space acts as an insulator and consequently the refractory material is insufficiently cooled by the fluid within the metal pipe and the working life of the refractory material is reduced. In other cases, such as shown by Corriston Patent No. 2,022,649, the refractory material is applied directly to the water-cooled metal pipe so that it is adequately cooled by the pipe, and a large number of radially-extending metal studs are welded to the pipe to hold the refractory material in place. This helps to retain the refractory but this system is expensive because of the large number of studs which must be welded to the pipe, and precludes any possibility of precasting the refractory before it is placed around the pipe. Moreover, the studs of Corriston extend entirely through the refractory and conduct an excessive amount of furnace heat to the cooling fluid in the pipe.

In accordance with my invention I overcome these difficulties and achieve a more practical and efficient insulation of a furnace support, especially in the case of a water-cooled metal supporting pipe, by securing a reticulated metal structure such as a plurality of wires around the pipe and imbedding refractory material in the wires to cover the wires and pipe and to extend solidly from the outer surface of the pipe without any air space between the refractory and the pipe. The outer layer of the refractory overlies any metal which might

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conduct excessive heat to the core of the insulated structure, and at the same time the reticulated metal structure acts as a firm anchor for the refractory and prevents the refractory from falling away when it develops cracks after a period of exposure to furnace temperatures. The reticulated metal structure is readily welded or otherwise fastened to the metal pipe and can be made up of any desired number of sections. These sections may have refractory material cast thereon before being secured to a supporting pipe in a furnace chamber. This saves time and expense and is more convenient than casting the refractory in the furnace. Moreover, the time available for replacing refractory after prolonged use in a furnace is so limited that it is conventional to use wooden molds for casting the refractory in the furnace and to fire up the furnace before the refractory has hardened sufficiently to permit the molds to be removed and saved. The use of precast sections in accordance with my invention eliminates this waste of molds without loss of time and without sacrificing any of the strength and durability of the completed refractory covering. In short, one object and effect of my invention is to permit the welding of prefabricated refractory cover pieces to metal supports in furnace chambers.

I have further discovered that the reticulated metal structure can be quickly fastened to the metal supporting structure by bending a portion of the reticulated metal around a small stud welded to the pipe and entirely covered by the outer layer of insulating material, or by bending the welded stud around the reticulated metal structure. This slightly increases the time of applying the insulation initially but when sections of insulation have to be replaced it is sometimes quicker and easier to bend small pieces of reticulated metal in the bases of the insulating sections around studs already in place on the metal support, or vice-versa, than it is to bring welding equipment into the furnace chamber in order to weld the insulating sections in place.

One suitable form of reticulated metal structure is woven wire having a network of strands crossing over and under one another, since a portion of this structure may be injured without weakening the adjacent portions of the structure. A more expensive and stronger form of reticulated metal structure is a wire fabric comprising interlocking coils of wire extending parallel to each other and to the pipe axis. However, it is not practical to prefire insulating sections having any form of woven or interlocking wire base because the wire would be exposed to high temperatures in order to prefire the inner surfaces as well as the outer surfaces of the refractory, and this would burn out the wire. I have found that this difficulty in prefiring can be overcome by using a plurality of separate wire strands which are not woven together and which, therefore, can be individually removed from the cast preformed insulating section while the insulating material is being prefired, and then may be replaced in the refractory before the resultant preformed section is placed on a furnace supporting pipe, where the ends of the wire strands protruding from the prefired refractory are readily welded or otherwise fastened to the pipe.

Other novel features, objects and advantages of the invention will become apparent from the following description and in the accompanying drawings. I have shown in the drawings, for purposes of illustration only, certain present preferred embodiments of my invention, in which

Figure 1 shows a heat-treating furnace partially broken away to show the interior structure;

Figures 2, 3 and 4 show three stages of applying preformed insulating sections to a riser or crossover pipe in the lower part of the furnace shown in Figure 1;

Figures 5, 6 and 7 show three successive stages of applying partially preformed insulating sections to a skid rail pipe in the lower part of the furnace shown in Figure 1;

Figure 8 shows a partially sectioned and broken away perspective view of a pipe like that shown in Figures 2-4, with a modified form of refractory covering;

Figure 9 shows a partially broken away side view of a riser or crossover pipe with a further modified form of refractory covering;

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Figure 10 is a section on line X—X in Figure 9;

Figure 11 corresponds to Figure 9 but shows a different means for attaching wire in a refractory covering to an underlying pipe;

Figure 12 is a section on line XII—XII in Figure 11;

Figure 13 is a sectional view through the axis of a riser or crossover pipe with a still further modified form of refractory covering;

Figure 14 is a section on line XIV—XIV in Figure 13; and

Figure 15 is a section on line XV—XV in Figure 13.

Referring now more particularly to the drawings, in Figure 1 there is shown a furnace 20 through which a series of metal billets 21 are passed on skid rails 22 extending along skid rail pipes 23 and resting on horizontal crossovers 24 supported on vertical risers 25. The skid rail pipes, crossovers and risers are all in the form of metal pipes having connected interior passages for passing cooling fluid such as water therethrough in accordance with conventional practice.

In Figures 2-4 a crossover pipe 24a is shown in successive stages of having refractory insulation applied to it. In Figure 2 the lower portion of the pipe 24a is shown covered with a preformed insulating section 26 comprising a semicylindrical refractory element 27 having wire fabric 28 imbedded therein closely adjacent its inner surface with portions of the wire protruding from the refractory material adjacent opposite sides of the pipe 24a. The section 26 is placed against the pipe 24a and the protruding portions of the wire are welded to the pipe at spaced intervals 29 on both sides of the pipe 24a. An identical insulating section 30 is placed against the upper portion of the pipe 24a and is similarly welded to the pipe 24a. Each of the sections 26 and 30 extends less than 180° around the pipe 24a so that the protruding portions of the wire base of the section 30 are spaced from the corresponding portions of the section 26 and are thereby exposed for welding to opposite sides of the pipe 24a as indicated at 31 in Figure 3. The gap between the sections 26 and 30 on opposite sides of the pipe 24a is closed after the welding operation by pasting plastic refractory material into these gaps, so that the pipe 24a is entirely surrounded by a coating of refractory material as indicated in Figure 4. Additional sections are added in abutting end-to-end relationship as required. It will be observed that preformed insulating sections of this kind are suitable for use on the vertical riser pipes 25 as well as on the horizontal crossover pipes 24 shown in Figure 1.

In Figures 5-7 a horizontal pipe 25a supporting a skid rail 32 along its upper surface is shown in successive stages of having a refractory covering applied thereto. In Figure 5 there is shown a preformed insulating section 33 identical with the section 26 shown in Figure 2 and welded to the pipe 25a in the same manner as the section 26 is welded to the pipe 24a in Figure 2. In Figure 6 pieces of wire fabric 34 and 35 are shown placed around the portions of the pipe 25a between the opposite sides of the skid rail 32 and corresponding edges of the insulating section 33. The wire fabric pieces 34 and 35 are welded at intervals to the pipe 25a and refractory material is then pasted against the wire pieces 34 and 35 and is molded therearound as shown in Figure 7 to form a solid layer of refractory material imbedded in the wire fabric pieces 34 and 35 with a thickness equal to that of the preformed lower section 33, so that a continuous layer of refractory material extends around the pipe 25a from the opposite sides of the skid rail 32, without covering the top working surface of the skid rail 32.

The wire fabric pieces 34 and 35 shown in Figure 6 may take various forms but are illustrated in Figure 6 as comprising a plurality of interlocking coils of wire having helical axes parallel to each other and to the axis of the pipe 25a. This form of wire base is very strong, is very effective in holding the base of the refractory covering to the pipe, and is easy to lay around a pipe with all of the coils fitting closely against the pipe, without any presetting or bending of the wire before it is applied to the pipe.

A modified embodiment of the invention is shown in Figure 8, where a horizontal pipe 24b (similar to the pipe 24a in Figures 2-4) is shown with a covering of insulation comprising a preformed lower section 36 like that shown in Figure 2 extending along the lower por-

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tion of the pipe 24b and welded thereto at 37 and 38 on opposite sides of the pipe. A piece of wire fabric 39 is placed around the opposite upper portion of the pipe 24b and is welded to the pipe 24b adjacent the axially-extending edges of the preformed section 36, preferably with common welds. A layer of plastic refractory material 40 is then imbedded around the wire fabric 39 against the pipe 24b so that the layer of refractory material provided by the section 36 around the lower portion of the pipe 24b is continued around the upper portion thereof. A semicylindrical mold for applying the refractory material 40 to the upper portion of the pipe 24b is indicated in Figure 8 at 41. In some instances this may be more convenient than the system illustrated in Figures 2-4, since the preformed sections are primarily useful in applying a refractory covering to the lower portion of a horizontal pipe or to any portion of a vertical pipe, where it is difficult to hold unhardened plastic refractory material in place. The upper portion of a horizontal pipe, on the other hand, can retain unhardened plastic refractory material without the necessity of holding a mold against the material while it hardens. It should also be observed in Figure 8 that the wire fabric 39 is of conventional woven type. Such a woven fabric provides less anchoring structure for the refractory material than the interlocking coil fabric illustrated in Figure 6 and described in more detail above in connection with that figure. Also, one set of the cross-strands of woven wire must either be preformed into a semicylindrical shape or else must be forcibly bent and held around the pipe during the welding operation. On the other hand, woven fabric such as that shown at 39 in Figure 8 contains less wire and is less expensive than interlocking coiled wire, and is therefore advantageous where its lower first cost offsets higher maintenance cost.

Figures 9 and 10 illustrate a modified system of forming and securing preformed insulating sections. A pair of semicylindrical preformed insulating sections 42 and 43 are shown covering a pipe 24c like the pipe 24a shown in Figures 2-4. These sections have respective wire bases 44 and 45 of woven wire similar to that shown in Figure 8, and have refractory material 46 and 47 cast around and imbedded in the respective wire bases 44 and 45 before the sections are placed on the pipe 24c. The refractory coverings 46 and 47 each extend 180° around the pipe 24c so that their adjacent coaxially-extending edges on opposite sides of the pipe are in closely abutting relationship. The refractory material is omitted at spaced intervals as shown at 48 on one side of the pipe and at 49 on the other side of the pipe, to expose the underlying wire bases 44 and 45 so that they may be welded to the pipe 24c as shown at 50. After the welds 50 have been completed refractory material in plastic form is pasted over the openings 48 and 49 along the abutting edges of the sections 42 and 43 to complete the refractory covering. Additional preformed sections are applied to the pipe 24c in the same way in abutting end-to-end relationship to extend the covering as required.

In Figures 11 and 12 a different system of attaching a wire base to a supporting pipe is shown, using preformed insulating sections like those shown in Figure 9 around a similar pipe 24d. Instead of welding the wire bases of the sections to the pipe 24d metal studs 51 are welded to the pipe 24d before the insulating sections are placed on the pipe, and then the insulating sections are put in place and the studs 51 are bent around the wire bases of the sections to anchor them to the pipe 24d, as best shown in Figure 12. This system of anchoring the metal base is applicable to any of the disclosed embodiments of my invention and makes it possible to weld anchoring studs to supporting pipes before the pipes are placed in a furnace and then to fasten insulation to the pipes after the pipes are installed in the furnace without the necessity of bringing cumbersome welding equipment into the limited space inside the furnace.

Figures 13-15 show a different form of preformed insulating section which is adapted to be preformed before being placed in a furnace without injury to the wire base, and which has the further advantage of permitting the use of a series of separate wires for forming the metal anchoring structure for the insulating sections so that the amount of wire in the base and consequently the cost of the wire base is reduced to a minimum. The illustrated embodiment of this modification comprises a pair of full 180° semicylindrical refractory pieces 52 and

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53 adapted to fit closely around a metal pipe 24e which is like the pipe 24a in Figures 2-4. The axially-extending edges of the pieces 52 and 53 are adapted to fit closely together in abutting relationship without any spacing therebetween such as shown in Figure 3 and without any relieved portions such as shown at 48 and 49 in Figure 9. The pieces 52 and 53 are precast separately in suitable molds with a series of axially-extending pieces of straight wire 54 extending therethrough adjacent the inner surfaces thereof. The pieces of wire 54 are left in the molded pieces 52 and 53 if the molded pieces are not to be prefired. However, prefiring improves the strength and durability of the refractory material and the wires 54 are therefore preferably withdrawn after the molded pieces 52 and 53 have hardened sufficiently, and the molded pieces are then prefired in a furnace suitable for that purpose. The use of straight wires makes it possible to remove the wires 54 to protect them from the unrelieved heat in the prefiring furnace, and after prefiring to replace the wires in the pieces 52 and 53, with the ends of the wires protruding from the opposite ends of the molded pieces. The protruding ends of the wires can be separately secured to the pipe 24e to anchor the pieces 52 and 53 thereon but preferably semicircular lengths of wire 55 and 56 are welded to the ends of the wires 54 protruding from the respective opposite ends of the piece 52, and like semicircular lengths of wire 57 and 58 are welded to the corresponding protruding ends of the wires 54 in the piece 53. The resultant prefabricated insulating sections can then be secured to the pipe 24c in a convenient manner by welding the opposite ends of the various wires 55-58 to the pipe 24e, as indicated at 59 in Figure 15. For purposes of illustration the welds 59 at the ends of the wires 55 and 57 are shown separately in Figure 15 but in practice it is preferable to weld the adjacent ends of these wires in a single welding operation, so that only four welds are necessary to anchor two opposite insulating sections of the kind in question to a supporting pipe. Additional insulating sections of the same kind are added in the same way in spaced end-to-end relationship, and the spaces between the adjacent ends are filled with plastic refractory material after the welding operation has been completed, as indicated at 60 in Figure 13. Anchoring studs like those shown at 51 in Figures 11 and 12 may be used instead of the welds 59 to anchor the wires 55-58.

The differences between the various forms of construction described above are of importance principally from the point of view of installation and maintenance. The thermal effects of the different forms of construction in their completed form are generally the same, although the shape and amount of wire in the anchoring base will have some slight effect on thermal conductivity. In all cases the refractory covers its wire base and the underlying metal pipe without any air gap in between, and as the result the rate of thermal adsorption of the pipe is sufficient to lower the temperature of the refractory material to safe limits, even near the outer surface of relatively thick pieces of refractory material, and also to lower the temperature of the wire anchoring base, which is close to the pipe and in occasional metal-to-metal contact with it, to even lower temperature limits safe for heat resistant metal. For example, with a woven wire base similar to that shown in Figure 8 welded to a 1 1/4" water-cooled pipe and with a 3/4" thick layer of refractory material around the pipe, I have found that with a furnace temperature just over 2700° F. the temperature of the outer surface of the refractory reaches just under 2600° F., the temperature of the refractory 1/16" below its outer surface reaches less than 1700° F., the wire temperature reaches about 1200° F., and the pipe surface temperature reaches about 250° F., with a pipe surface heat adsorption of about 28,000 B. t. u. per square foot of pipe surface per hour. These figures are illustrative of the fact that insulation in accordance with my invention is highly successful in holding down temperatures in the interior portions of a refractory covering for a pipe in a high temperature furnace, while at the same time holding down the heat loss to the cooling fluid in the pipe.

While I have illustrated and described certain present preferred embodiments of the invention and methods of practicing the same it will be realized that the invention is not limited thereto but may be otherwise variously

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embodied and practiced within the scope of the following claims.

I claim:

1. In a furnace, an elongated heat absorptive member, an interconnected reticulated metal structure fastened to said member and extending closely around and partly against said member, and refractory material imbedded in and solidly covering the reticulated metal structure and the underlying member with substantially no air space therebetween, whereby the anchoring structure is protected against the furnace heat by its close association with the heat-absorptive member and by the overlying refractory material, and the refractory material is protected from excessive temperature by transfer of its heat through the anchoring structure to the heat-absorptive member.

2. In a furnace for heat-treating metal workpieces, an elongated hollow metal member, means for passing cooling fluid through the hollow interior of said member and extending closely around and partly against said member, a structure of connected wires fastened to said member, and refractory material imbedded in and solidly covering the wires and fitting against the underlying outer surface of the said member with substantially no air space therebetween, whereby the anchoring structure is protected against the furnace heat by its close association with the heat-absorptive member and by the overlying refractory material, and the refractory material is protected from excessive temperature by transfer of its heat through the anchoring structure to the heat-absorptive member.

3. In a furnace for heat-treating metal workpieces, an elongated hollow metal member, means for passing cooling fluid through the hollow interior of said member, a structure of connected wires fastened to said member and extending closely around and partly against said member, metal studs welded to said member and bent around wires of said structure to fasten them to the member, and refractory material imbedded in and solidly covering the interlocking wires and studs and fitting against the underlying outer surface of the said member with substantially no air space therebetween, whereby the anchoring structure is protected against the furnace heat by its close association with the heat-absorptive member and by the overlying refractory material, and the refractory material is protected from excessive temperature by transfer of its heat through the anchoring structure to the heat-absorptive member.

4. In a furnace for heat-treating metal workpieces, an elongated hollow metal member, means for passing cooling fluid through the hollow interior of said member, a structure of woven wires fastened at intervals to said member and extending closely around and partly against said member, and refractory material imbedded in and solidly covering the wires and the wire fastenings, and fitting against the underlying outer surface of said member with substantially no air space therebetween, whereby the anchoring structure is protected against the furnace heat by its close association with the heat-absorptive member and by the overlying refractory material, and the refractory material is protected from excessive temperature by transfer of its heat through the anchoring structure to the heat-absorptive member.

5. In a furnace for heat-treating metal workpieces, an elongated hollow cylindrical metal member, means for passing cooling fluid through the hollow interior of said member, a structure of interlocking wires fastened at intervals to said member and extending closely around and partly against said member, each wire being formed generally helically with its helical axis disposed parallel to the axis of said member, and refractory material imbedded in and solidly covering the wires and the wire fastenings, and fitting against the underlying outer surface of said member with substantially no air space therebetween, whereby the anchoring structure is protected against the furnace heat by its close association with the heat-absorptive member and by the overlying refractory material, and the refractory material is protected from excessive temperature by transfer of its heat through the anchoring structure to the heat-absorptive member.

6. A method of prefabricating a prefired, reinforced refractory cover for a support in a heat-treating furnace, comprising the steps of casting refractory material with wires imbedded therein, withdrawing the wires, prefiring

the cast refractory material without the wires, and replacing the wires.

7. A method of covering a metal pipe in a heat-treating furnace with a prefired, reinforced refractory cover, comprising the steps of casting a semicylindrical refractory section with separate straight wires extending axially therethrough adjacent its inner surface, said section being cast while separated from the pipe but adapted to fit closely therearound, withdrawing the wires after hardening of the refractory and prefiring the refractory, replacing the wires with their opposite ends projecting from the prefired piece, fastening a semicircular piece of wire to the adjacent projecting wire ends at each end of the prefired piece, placing the refractory in close fitting engagement around the pipe, and fastening each of the semicircular pieces of wire to the pipe.

8. In an insulated high temperature chamber, an elongated member therein and insulation covering the member, said insulation comprising a series of arcuate abutting sections each having a reticulated metal structure fastened closely around and partly against a portion of the member and having refractory material embedded in and solidly covering the reticulated metal structure and the underlying portion of the member with substantially no air space between the refractory material and the underlying portion of the member, said reticulated metal structure further extending over substantially the entire angular span of said arcuate sections and being secured to said member adjacent each longitudinally extending edge of said sections.

9. In an insulated high temperature chamber, an elongated member therein and insulation covering the member, said insulation comprising a series of arcuate abutting sections each having a wire structure extending closely around and partly against a portion of the member and having refractory material embedded in and solidly covering the wire and the underlying portion of the elongated member with substantially no air space between the refractory material and the underlying portion of the member, said member having studs secured thereto and bent around portions of the wire of the

respective insulation sections adjacent the longitudinally extending edges of said sections to facilitate attaching and detaching the sections, said wire structure further extending over substantially the entire angular span of said arcuate sections.

10. In a furnace, a tubular metal member therein to be thermally insulated, said tubular member being adapted to have a cooling fluid passed therethrough, a preformed insulating section having an arcuate inner surface fitting closely against the outside of said member, said section extending around a part of the circumference of said member, said section further comprising a block of refractory and a wire structure embedded in said block proximate to said surface, said block being bounded by edges at the ends and sides thereof, a plurality of portions of said wire structure projecting at least from opposite edges of said block adjacent said outside of said member, said projecting portions of said wire structure being substantially directly connected to said member to fasten said section to said member.

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