Nov. 2, 1943. J. F. PETERS 2,333,439

METHOD OF AND MEANS FOR COOLING HIGH TEMPERATURE STRUCTURES

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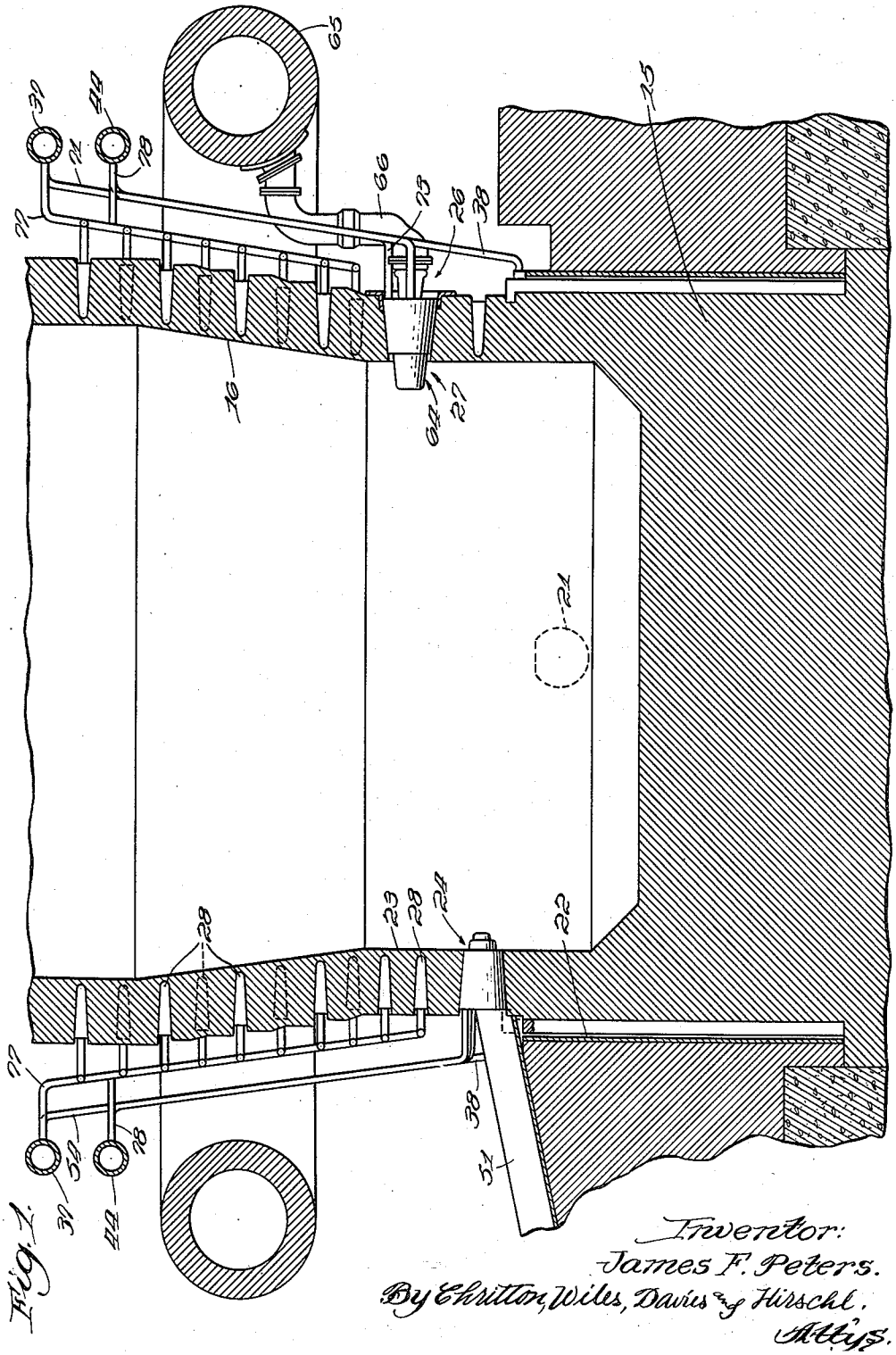


Fig. 1.

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Fig. 2.

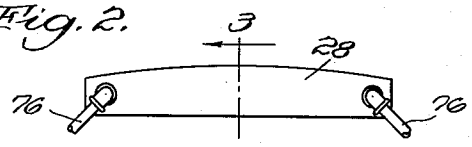


Fig. 3.

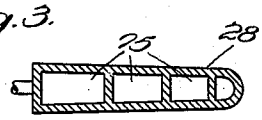


Fig. 4.

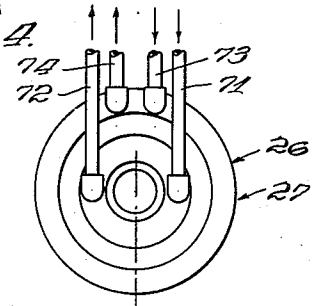


Fig. 5.

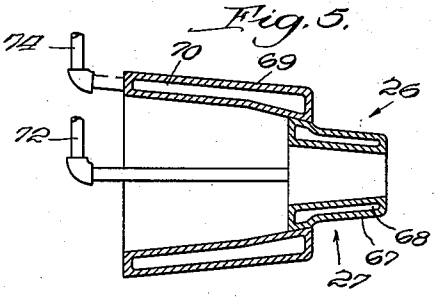


Fig. 6.

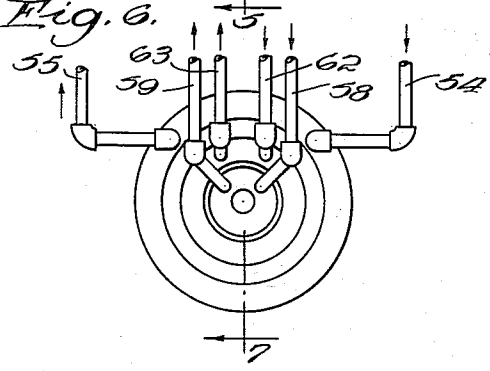


Fig. 7.

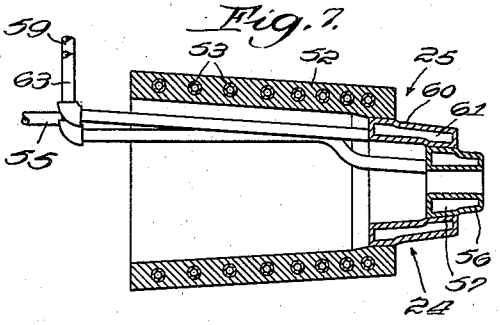


Fig. 8.

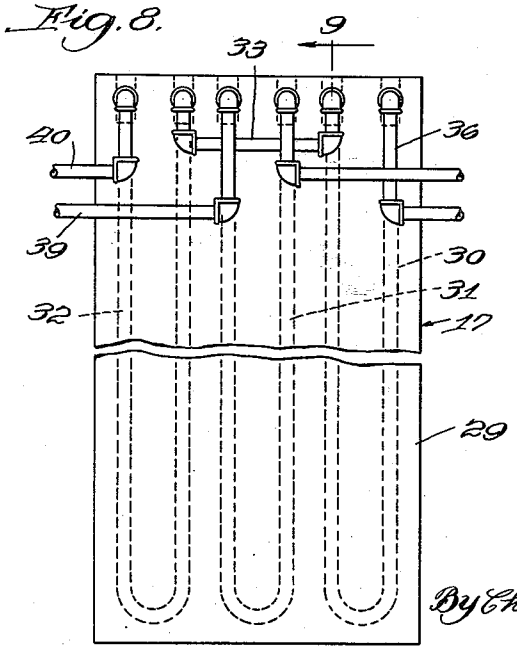
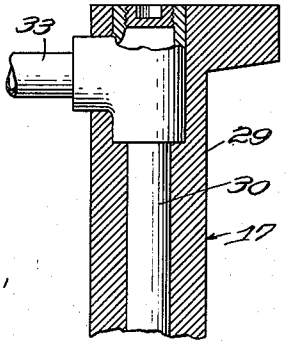


Fig. 9.

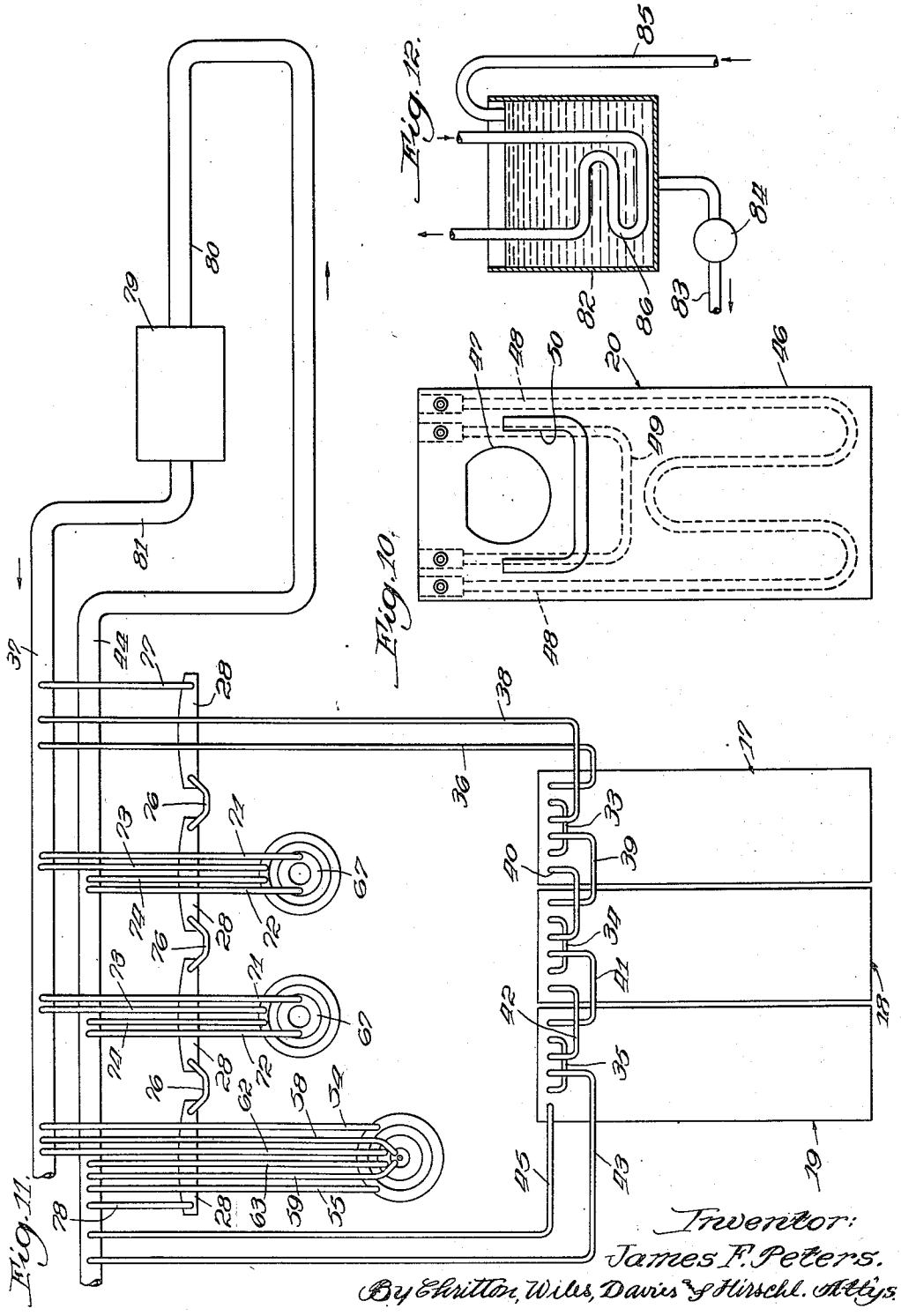


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Filed Aug. 4, 1941 3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

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METHOD OF AND MEANS FOR COOLING HIGH TEMPERATURE STRUCTURES

James F. Peters, Indiana Harbor, Ind., assignor to Inland Steel Company, Chicago, Ill., a corporation of Delaware

Application August 4, 1941, Serial No. 405,428

4 Claims. (Cl. 266—32)

My invention relates to the cooling of structures wherein such high temperatures are produced that in the case of the use of water as commonly employed for the cooling purpose, leakage of the water from the circulating course into the interior of the structure is liable to produce violent explosion.

An example of such a structure is a blast furnace in which the temperature of its contents commonly exceeds 2700° F. At this temperature water leaking into the interior of the furnace from the circulating system in which the water cooled elements, in the form of plates or other structures, are interposed for protecting the fire clay refractory and particularly if it contacts the molten iron or slag, becomes disassociated into hydrogen and oxygen, these gases frequently so reuniting as to result in violent explosion fatal to the workmen and destructive of the furnace.

As is known, the fire clay refractories of the furnaces are not capable of withstanding, unless protected, the high heat generated in the furnaces, and it is therefore the practice to install at the more vulnerable locations in the furnaces, hollow elements through which a cooling medium (water in accordance with common practice as above stated) is constantly circulated. Should the water supply fail, the cooling elements burn out followed by rapid destruction of the refractory and resultant leakage of the water into the furnace and in contact with the molten iron or slag. Such condition is more apt to occur at the tapping hole of the furnace where the iron flows out through a hole in the water-cooled cast iron cooling plate at this point. Due to some abnormalities or gradual erosion this plate is cut back to the point where the cooling pipe embedded in the plate is located and further erosion then results in cutting through the cooling pipe permitting water to leak out into the stream of molten iron with the disastrous results above stated. Another common point of failure is at the slag or cinder notch. Frequently the slag contains globules of iron which are sufficient to cut out the notch and the cooling structure surrounding it. Such cutting away of the notch may also happen if the iron level in the furnaces rises abnormally so that when the notch is opened by the operator iron flows out instead of slag.

As will be understood, the above are given merely as examples of situations in which cooling means are provided for structures subject to high temperatures and it is not to be understood that applicant intends thereby to limit the situations in which his invention may be used.

The primary object of my invention is to provide improvements in the cooling of high temperature structures and particularly, though not exclusively, blast furnaces, to the end that explosions resulting from the leakage of cooling medium from the cooling system into the furnace, will be rendered impossible.

As I have devised my invention for use more particularly in connection with blast furnaces at the specific locations mentioned, but without intending to limit the invention thereto, I have illustrated it in such a structure; a description of the accompanying drawings being as follows:

Figure 1 is a view in vertical sectional elevation of the lower portion of a blast furnace illustrating one situation in which my invention may be utilized.

Figure 2 is an end view of one of the similar fluid-cooled bosh plates of the furnace.

Figure 3 is a section taken at the line 3 on Fig. 2 and viewed in the direction of the arrow.

Figure 4 is an end view of one of the similar fluid-cooled tuyères of the furnace.

Figure 5 is a section taken at the line 5 on Fig. 4 and viewed in the direction of the arrow.

Figure 6 is an end view of one of the similar fluid-cooled slag notches or cinder notches of the furnace.

Figure 7 is a section taken at the line 7 on Fig. 6 and viewed in the direction of the arrows.

Figure 8 is a view in elevation, with a portion thereof broken away, of one of the similar fluid-cooled hearth plates of the furnace.

Figure 9 is a section taken at the line 9 on Fig. 8 and viewed in the direction of the arrow.

Figure 10 is a view in elevation of the fluid-cooled hearth plate of the furnace at the draw-off for the molten metal.

Figure 11 is a view, in the nature of a diagram, showing the several fluid-cooled elements of the furnace connected with apparatus for circulating cooling fluid through these elements; and

Figure 12, another form of apparatus for circulating cooling fluid.

The particular illustrated construction of blast furnace the lower portion only of which is shown, comprises the lower hearth portion 15 and the bosh portion 16.

The hearth portion 15, formed of clay refractory, is provided with an annular horizontal series of fluid-cooled plates comprising a plurality of fluid-cooled plates of one form three of which are shown at 17, 18 and 19 in Fig. 11, and

a fluid-cooled plate 20 (Fig. 10) located at the tapping hole of the furnace indicated at 21 and in practice closed by a mixture of fire clay.

The hearth plates referred to are shown as surrounded by a metal ring 22.

In the surrounding wall 23 of the hearth, above its bottom, are slag or cinder notches one only of which is shown at 24, provided with fluid-cooled protecting means represented generally at 25 (Figs. 1, 6 and 7).

In the surrounding hearth wall 23 above the cinder notches 24 is a horizontal annular series of tuyères indicated generally at 26 and having fluid-cooled protecting means represented generally at 27 (Figs. 1, 4 and 5).

In the bosh 16 of the furnace, which is also made of a clay refractory, and also in the upper portion of the hearth wall 23, is a vertical tier of annular horizontal series of fluid-cooled bosh plates represented at 28 (Figs. 1, 2 and 3).

The fluid-cooled hearth plates of the kind shown at 17, 18 and 19 are illustrated as each comprising a cast metal plate 29 having cast therein three upright U-shaped pipes 30, 31 and 32. In practice and as shown, these hearth plates may be, by way of example, connected together in a multiple of series each series comprising three of these plates, with a source of cooling medium.

In the arrangement shown (Figs. 8, 9 and 11) the upper ends of the inner legs of the pipes 30 and 32 are connected together by pipes 33, 34 and 35. The upper end of the outer leg of the pipe 30 of plate 17 is connected with a pipe 36 which leads from a header pipe 37 connected with a supply of cooling medium hereinafter described. One leg of the intermediate pipe 31 of plate 17 connects with a pipe 38 leading from the header pipe 37. The other leg of this intermediate pipe connects, by a pipe 39, with the outer leg of the pipe 30 of plate 18. The outer leg of pipe 30 of plate 17 connects, by a pipe 40, with one leg of the intermediate pipe 31 of plate 18, the other leg of this intermediate pipe connecting, by a pipe 41, with the outer leg of the pipe 30 of plate 19. The outer leg of the pipe 32 of plate 18 connects, by a pipe 42, with one end of the intermediate pipe 31 of plate 19, the other end of this intermediate pipe being connected, by a pipe 43, with a header pipe 44 connected in circuit with the header 37 as hereinafter described. The outer leg of the pipe 32 of plate 19 connects, by a pipe 45, with the header pipe 44.

By the arrangement described cooling fluid supplied to the header pipe 37 is caused to circulate through the pipes of the plates 17, 18 and 19 for cooling them, the spent fluid thence flowing to the return header pipe 44.

The hearth plate 20 (Fig. 10), also formed of a cast metal plate represented at 46, with a hole 47 therein for registry with the tapping hole 21 in the wall of the hearth 15, has two curved pipes 48 and 49 embedded therein each for connection at one leg with the pipe 37. The other legs of the pipes 48 and 49 would connect with the return header pipe 44. A trough-shaped lip 50 on the plate 20 beneath the hole 47 forms a support for a trough similar to trough 51 through which the molten metal may flow from the furnace.

The slag or cinder notch cooling means comprises an outer notch cooler 52 located in the notch and having an internal pipe coil 53 connected at one end with a pipe 54 opening into the header pipe 37 and at its opposite end with a pipe 55 opening into the header pipe 44. These cooling means also comprise a fluid-cooled cinder monkey 56 the chamber 57 in which is connected with pipes 58 and 59 which connect, respectively, with the header pipes 37 and 44; and an intermediate cooler 60 having a chamber 61 connected with the header pipes 37 and 44 by pipes 62 and 63, respectively.

The tuyères 26 comprise hot blast nozzles one of which is shown at 64 which extend into the tuyère openings in the furnace wall and are connected by pipes with the bustle pipe 65 through which hot air is supplied to the tuyère nozzles, the pipe connecting the nozzle shown with the bustle pipe 65 being represented at 66.

The tuyère-cooling means comprise an inner tuyère cooler 67 having a cooling-fluid chamber 68 and an outer tuyère cooler 69 having a cooling-fluid chamber 70. The inner coolers 67 are connected by pipes 71 to the header pipe 37 and by pipes 72 to the header pipe 44. The outer coolers 69 are connected with the header pipe 37 by pipes 73 and with the header pipe 44 by pipes 74.

The bosh plates 28, provided usually of a very large number, are series connected in groups, each group in the arrangement shown, comprising four of the bosh plates, the chambers 75 of which are connected together by pipes 76, one end plate of the series being connected to the header pipe 37 by a pipe 77 and the other end plate of the series to the header pipe 44 by a pipe 78.

It may here be stated that while I have shown and described a certain grouping, as a unit, of fluid-cooled elements of certain specified numbers, no limitation of the invention should be understood therefrom as any other suitable grouping of fluid-cooled elements and of any other suitable number, may be employed.

In accordance with my invention I utilize, as the cooling medium for circulation through the hollow cooling elements, any suitable liquid or gaseous fluid which will be sufficiently effective to produce the desired cooling action and possess such properties that contact of the cooling medium with the high temperature contents of the furnace—in the case of a blast furnace the molten iron or slag—will not result in explosions or damage of any kind.

A wide range of cooling mediums for my purpose may be utilized. Examples of suitable liquids which may be used are carbon tetrachloride or "Prestone". Examples of suitable gaseous fluids which may be used are air or a typical gas as used in refrigerating processes, such as for example sulfur dioxide.

It is desirable in the use of certain cooling mediums in accordance with my invention, that, especially from the standpoint of economy, provision be made for the repeated recirculation of the medium through the cooling elements of the furnace, requiring that the medium after discharging from the cooling elements be cooled to recondition it for the most effective use.

Fig. 11 illustrates a desirable construction of refrigerating and circulating system for the cooling medium where a gaseous fluid, such as for example sulphur dioxide, is used as the cooling medium for the cooling elements of the furnace. In this arrangement I provide a refrigerating unit 79 of any suitable construction, such as for example as commonly provided and comprising a compressor, condenser and evaporator (none of which is shown). The inlet of the compressor would be connected with the return header 44 by a pipe 80 and the evaporator with the header pipe

37 by a pipe 81, the refrigerant thus being supplied to the cooling elements of the furnace to perform the cooling function and after passing therethrough returned to the refrigerating unit for recompression, condensing and expansion.

Where the cooling medium used for the elements to be cooled, is a liquid, as for example carbon tetrachloride or Prestone as above referred to, the liquid may, by way of example, be cooled preliminary to its return to the furnace by the apparatus disclosed in Fig. 12. This apparatus comprises a tank 82 for the cooling liquid, shown as open at its top, which would connect with the header pipe 37 by a pipe 83 having a pump 84 and with the return header pipe 44, by a pipe 85 discharging into the upper portion of the tank. Immersed in the tank 82 is a coil 86 for the circulation therethrough of a cooling medium such as for example water at service line temperature, or preliminarily cooled if desired, or a refrigerating medium supplied from a refrigerating apparatus of any desirable construction. Provision is thus made for reducing the temperature of the liquid in tank 82 to that desired for the cooling of the cooling elements of the furnace.

In operation, in accordance with this arrangement, the cooling liquid is circulated through a closed course from the tank 82, through the cooling elements of the furnace, and thence back to the tank for temperature reconditioning before being returned to the furnace.

When air, or other gas requiring cooling through heat-exchange relationship to a cooling agent, is to be used as the cooling medium for the cooling elements of the furnace any suitable apparatus may be employed, as for example an apparatus such as that shown in Fig. 12 modified to omit the return pipe 85 and with a blower for circulating the air to be used for cooling, substituted for the pump 84.

While I have referred to the cooling of a plurality of cooling elements of a furnace, it will of course be understood that the invention is not limited thereto as it may be utilized in the cooling of a single cooling element only of a furnace.

What I claim as new and desire to secure by Letters Patent, is:

1. In a high temperature furnace provided with a cooling element through which a cooling medium is circulated, the method of eliminating explosion in the event of contacting of the cooling medium with the high temperature contents of the furnace, which comprises utilizing as such cooling medium a liquid of such composition that in contacting the high temperature contents of the furnace a non-explosive gas will result.

2. In a blast furnace provided with a cooling element through which a cooling medium is circulated, the method of eliminating explosion in the event of contacting of the cooling medium with the molten iron or slag, which comprises utilizing as such cooling medium a liquid of such composition that in contacting the molten iron or slag a non-explosive gas will result.

3. The method of eliminating explosion in a high temperature furnace having a cooling element through which a cooling medium is circulated, in the event of contact of the cooling medium with the high temperature contents of the furnace, which comprises utilizing carbon tetrachloride as such cooling medium.

4. The method of eliminating explosion in a high temperature furnace having a cooling element through which a cooling medium is circulated, in the event of contacting of the cooling medium with the high temperature contents of the furnace, which comprises utilizing carbon tetrachloride as such cooling medium, cooling the cooling medium after it is discharged from the cooling element by heat exchange relationship to a cooling agent, and returning the cooling medium in cooled condition to said element for cooling the latter.

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