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(54) **High-productivity steel heating furnace, particularly for rolling plants**

(57) A high-productivity steel heating furnace, particularly for rolling plants, comprising a furnace body (2) which contains a heating chamber (3) in which means (4) for supporting the products (5) being heated are arranged. The chamber (3) has an inlet door (14) for the products to be heated and an outlet door (15) for the

heated products, and is delimited by a bottom (10), by side walls (6-9) and by a ceiling or roof (11) of the furnace body. The furnace is provided with means for heating the heating chamber. The ceiling or roof is substantially flat and the heating means are constituted by burners (12, 13) arranged on the side walls (6-9) of the furnace body (2).

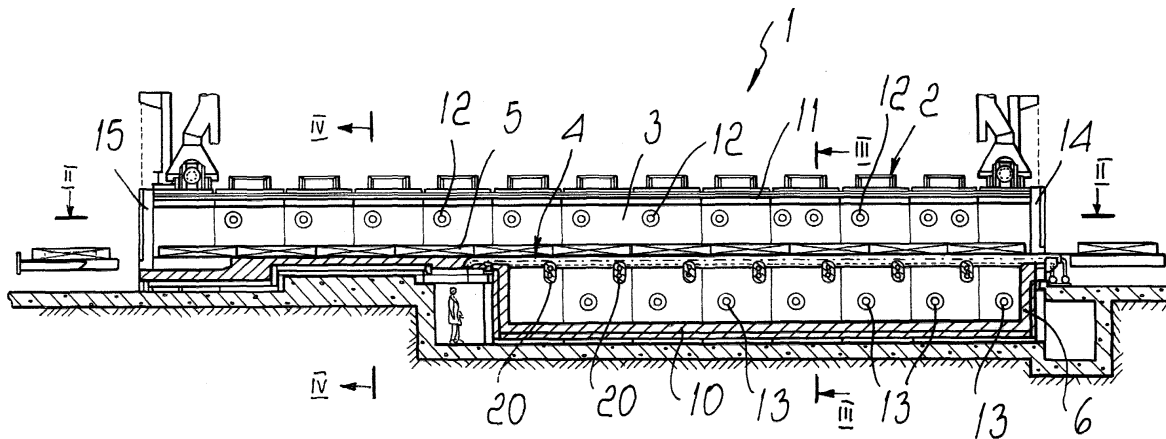


Fig. 1

Description

[0001] The present invention relates to a high-productivity steel heating furnace, particularly for rolling plants.

[0002] Heating furnaces for heating steel products, such as billets, slabs, rods, et cetera, before rolling them are known.

[0003] Heating furnaces of old design are generally constituted by a furnace body in which a heating chamber is provided being delimited by respective side walls, by a bottom wall and by a ceiling or roof having a characteristic shape with multiple nose-like portions in order to divide the heating chamber into a plurality of regions. Also the bottom of the chamber is generally shaped like the roof in order to divide the chamber into various heating regions.

[0004] Inside the heating chamber there is a surface for supporting the products to be heated which is arranged horizontally and on which the products are made to advance, usually by pushing, from an inlet toward an outlet.

[0005] In these furnaces, heating is achieved by means of burners which are applied to the roof, above the product supporting surface, and, if one wishes to heat the products also from below, to the bottom of the chamber below the supporting surface.

[0006] These furnaces have the problem of having a very complicated structure which is mainly due to the shape of the roof and bottom of the heating chamber. Moreover, these furnaces have a rather limited productivity.

[0007] More recently designed heating furnaces have a heating chamber which is delimited, in an upward region, by a roof which is shaped so as to divide the chamber into two main regions: a region for heating by convection, which is located proximate to the product inlet, and a region for heating by radiation, which lies between the convection heating region and the product outlet.

[0008] More particularly, the roof of the furnace lies on a substantially horizontal plane in the radiation heating region and has a shallower portion, proximate to the inlet, in order to form the convection heating region.

[0009] The products introduced in the furnace are heated by means of burners which are arranged on the roof of the furnace in the radiation heating region and by means of the stream of combustion gases conveyed through the convection heating region.

[0010] When these gases leave the convection heating region, they are used in a regenerator, arranged above the furnace roof, to heat the combustion air that feeds the various burners. Usually, in view of the high temperature of the gases, in order to avoid damage to the regenerator it is necessary to mix said gases with dilution air at the inlet of the regenerator.

[0011] The combustion air is then conveyed to the various burners by means of a plurality of insulated ducts arranged above the roof of the furnace.

[0012] These furnaces, too, have problems.

[0013] The presence of the burners and of the ducts for conveying the preheated combustion air on the roof of the furnace in fact increases the structural complexity of the furnace roof and has a significant effect on the manufacturing costs of these furnaces.

[0014] Moreover, the convection heating region, by forcing a particular shape of the furnace roof, further increases these costs.

[0015] The use of the regenerator also constitutes a considerable increase in plant complexity which affects furnace production and maintenance costs.

[0016] The presence of the convection heating region, in addition to slowing the advancement rate of the heated products because in order to achieve the necessary heating efficiency it requires a reduction in the height of the furnace in said region, also limits the gap of the furnace inlet, making it difficult to perform maintenance through said inlet.

[0017] As regards the general operation of these furnaces, there is a limit to productivity which is mainly due to the type of burner used and to the heating of the products performed in two separate steps: a scarcely effective convection step and a more effective radiation step.

[0018] The aim of the present invention is to solve the above-noted problems, by providing a steel heating furnace, particularly for rolling plants, which is structurally simpler and able to achieve higher productivities than conventional heating furnaces.

[0019] Within this aim, an object of the invention is to provide a heating furnace which, by virtue of its great structural simplicity, can be produced at a lower cost than conventional heating furnaces.

[0020] Another object of the invention is to provide a heating furnace which allows simple maintenance.

[0021] This aim and these and other objects which will become better apparent hereinafter are achieved by a steel heating furnace, particularly for rolling plants, comprising a furnace body which contains a heating chamber in which means for supporting the products being heated are arranged, said chamber having an inlet door for the products to be heated and an outlet door for the heated products, said heating chamber being delimited by a bottom, by side walls and by a ceiling or roof of said furnace body, means for heating said heating chamber being provided, characterized in that said ceiling or roof is substantially flat and in that said heating means are constituted by burners arranged on the side walls of the furnace body.

[0022] Further characteristics and advantages of the invention will become better apparent from the description of a preferred but not exclusive embodiment of the heating furnace according to the invention, illustrated only by way of non-limitative example in the accompanying drawings, wherein:

Figure 1 is a schematic sectional side view, taken along a vertical plane, of the heating furnace according to the invention;

Figure 2 is a schematic sectional view of Figure 1, taken along the line II-II;

Figure 3 is an enlarged-scale schematic sectional view of Figure 1, taken along the line III-III;

Figure 4 is an enlarged-scale schematic sectional view of Figure 1, taken along the line IV-IV.

[0023] With reference to the figures, the heating furnace according to the invention, generally designated by the reference numeral 1, comprises a furnace body 2 in which there is a heating chamber 3 in which means 4 for supporting the products 5 being heated are arranged.

[0024] The chamber 3 is delimited by substantially vertical side walls 6, 7, 8 and 9, by a bottom 10, and by a ceiling or roof 11.

[0025] The furnace is provided with means for heating the chamber 3.

[0026] According to the invention, the ceiling or roof 11 is substantially flat and preferably horizontal along its entire extension, and the heating means are constituted by burners 12 and 13 arranged on the side walls of the furnace body.

[0027] The chamber 3 has an inlet door 14 for the products 5 to be heated and an outlet door 15 for the heated products.

[0028] The inlet door 14 is arranged on an inlet opening formed in the side wall 6 that constitutes the front wall of the furnace, while the outlet door 15 is arranged on an outlet which is formed in the side wall 7 that constitutes the rear wall of the furnace.

[0029] The doors 14 and 15 are constituted by gates which, if the products 5 are made to advance in the heating chamber 3 by pushing, can move vertically from a minimum opening position, in which they allow only the passage of the products 5 entering or leaving the heating chamber 3, to a maximum opening position, in which their lower side is substantially at the same level as the roof 11.

[0030] If the advancement of the products 5 in the heating chamber 3 is achieved in another manner, for example by using a supporting surface with movable portions (movable-hearth advancement), the doors 14 and 15 may also be closed completely.

[0031] Since the flat shape of the roof 11 allows the inlet and the outlet to occupy substantially completely the front wall 6 and the rear wall 7 of the furnace, during maintenance or when rapid cooling of the inside of the furnace is required it is possible to open the doors 14 and 15 completely, providing very wide access openings which facilitate maintenance and allow rapid evacuation of the air and gases present inside the furnace.

[0032] The burners are preferably constituted by regenerative burners, preferably of the type disclosed in patent application MI98A-001595 in the name of this same Applicant.

[0033] The burners 12 and 13 are arranged on the mutually opposite side walls 8 and 9 of the furnace body

2 and are arranged in pairs, i.e., each burner 12, 13 arranged on one side wall faces, and is preferably aligned with, a corresponding burner 12, 13 arranged on the opposite side wall 9 of the furnace.

[0034] Preferably, each burner 12, 13 is designed to operate alternately with respect to the facing burner.

[0035] Substantially, while one burner 12, 13 is active, the gases produced by the combustion of the active burners are aspirated through the burner that faces said active burner. These gases are passed through heat exchange elements arranged inside the burner so as to heat them, and said heat exchange elements transfer their heat content to the combustion air, which is fed to the burner when it is activated.

[0036] In this manner, high thermal efficiency for the burners is achieved.

[0037] Moreover, for the furnace according to the invention preference is given to burner management of the on-off type, i.e., each burner, when it is activated, is made to run at full capacity. The heating of the chamber 3 is achieved, according to a preset heating pattern, from the inlet door 14 toward the outlet door 15, by operating the various burners 12, 13 according to a preset sequence.

[0038] The supporting means 4 are preferably constituted by a grid of tubular elements 20 (commonly known as skids) which form a substantially horizontal surface for the support and sliding of the products 5 being heated. Such tubular elements 20 are connected to ducts 21 for supplying and circulating a cooling fluid, for example water, which is circulated inside the tubular elements 20 in order to cool them adequately so that they cannot be damaged by the high temperatures reached inside the chamber 3.

[0039] The tubular elements 20 are conveniently supported by said side walls 8 and 9 of the furnace body.

[0040] The burners 12 are arranged above the supporting surface formed by the tubular elements 20, and if required it is also possible to provide burners 13 below the supporting and sliding surface formed by the tubular elements 20 at least along a section of the heating chamber 3 that starts from the inlet door 14.

[0041] In this case, the bottom 10 of the furnace has a shallower part exclusively in the region where the products 5 are to be heated from below as well.

[0042] According to requirements, the sliding and supporting surface for the products 5 can be constituted entirely by the tubular elements 20 or, as shown, the tubular elements 20 can be used to support the products 5 only along part of the extension of the chamber 3, while the remaining part of the supporting surface can be constituted by a refractory cladding.

[0043] For the sake of completeness in description, it should be noted that the internal surface of the furnace is lined with refractory material in a per se known manner.

[0044] Operation of the heating furnace according to the invention is as follows.

[0045] The products 5 to be heated are gradually introduced in the chamber 3 through the inlet door 14 and are made to advance toward the outlet door 15, for example by means of the thrust of products 5 inserted subsequently in the chamber 3.

[0046] It should be noted that the products 5, as soon as they are inserted in the heating chamber 3, are heated by radiation, thus producing a much more rapid heating of said products 5 than allowed in the convection heating region of conventional heating furnaces.

[0047] During advancement inside the chamber 3, the products 5 are gradually heated to the intended temperature until they exit from the outlet door 15.

[0048] It should be noted that the particular shape of the roof 11 of the furnace and the arrangement of the burners on the side walls of the furnace body 2 make the furnace roof extremely simple from a structural standpoint, allowing to reduce significantly the production costs of the heating furnace according to the invention with respect to those entailed by conventional heating furnaces. Moreover, since the heating furnace according to the invention does not have a convection heating region, it can provide for heating of the products 5 from below starting from the inlet door 14, thus achieving even higher effectiveness in heating the products 5.

[0049] Substantially, the heating furnace according to the invention, for an equal length or equal roof surface, is capable of ensuring a markedly higher productivity than conventional heating furnaces.

[0050] The heating furnace according to the invention, by virtue of its particular roof, of the arrangement of the burners, and of the use of regenerative burners, does not require regenerators and complicated ducts for feeding the combustion air to the various burners, thus achieving further plant simplification and reducing production costs even further.

[0051] Since the burners are arranged exclusively on the side walls, access to the roof during maintenance is also improved.

[0052] It should be noted that in the furnace according to the invention the use of regenerative burners allows to access the burners while they are not active in order to perform any maintenance, without necessarily requiring furnace shutdown.

[0053] Moreover, the heating furnace according to the invention ensures control over the level of oxidation of the heated products 5, improving the yield and also reducing the production of scale on the product surface.

[0054] In practice it has been observed that the heating furnace according to the invention fully achieves the intended aim and objects, since it allows, with a simpler structure, to achieve distinctly higher productivities than conventional heating furnaces.

[0055] The heating furnace thus conceived is susceptible of numerous modifications and variations, all of which are within the scope of the inventive concept; all the details may further be replaced with other technically equivalent elements.

[0056] In practice, the materials employed, so long as they are compatible with the specific use, as well as the dimensions, may be any according to requirements and to the state of the art.

5 [0057] The disclosures in Italian Patent Application No. MI2000A001564, from which this application claims priority, are incorporated herein by reference.

10 [0058] Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly such reference signs do not have any limiting effect on the scope of each element identified by way of example by such reference signs.

Claims

1. A steel heating furnace, particularly for rolling plants, comprising a furnace body which contains a heating chamber in which means for supporting the products being heated are arranged, said chamber having an inlet door for the products to be heated and an outlet door for the heated products, said heating chamber being delimited by a bottom, by side walls and by a ceiling or roof of said furnace body, means for heating said heating chamber being provided, **characterized in that** said ceiling or roof is substantially flat and **in that** said heating means are constituted by burners arranged on the side walls of the furnace body.
2. The heating furnace according to claim 1, **characterized in that** said burners are constituted by regenerative burners.
3. The heating furnace according to claims 1 and 2, **characterized in that** said burners are mounted in pairs, so that the two burners of a same pair are mounted on the two mutually opposite side walls of the furnace body, so as to face each other and be mutually aligned.
4. The heating furnace according to one or more of the preceding claims, **characterized in that** the two burners of a same pair can be activated alternately: while one of the two is active, the other one aspirates the combustion gases from said heating chamber, and vice versa.
5. The heating furnace according to one or more of the preceding claims, **characterized in that** said burners are adapted to be operated according to an on-off logic.
6. The heating furnace according to one or more of the preceding claims, **characterized in that** said supporting means comprise a grid of tubular elements

(skids) which form a substantially horizontal surface for the support and sliding of the products being heated, said tubular elements being connected to means for supplying and circulating a cooling fluid in said tubular elements.

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7. The heating furnace according to one or more of the preceding claims,

characterized in that said tubular elements are supported by the side walls of the furnace body.

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8. The heating furnace according to one or more of the preceding claims, **characterized in that** said burners are arranged above said surface for the support and sliding of the products being heated.

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9. The heating furnace according to one or more of the preceding claims, **characterized in that** along at least part of said heating chamber said burners are arranged both above and below said surface for the support and sliding of the products being heated.

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10. The heating furnace according to one or more of the preceding claims, **characterized in that** said inlet door and said outlet door are constituted by gates arranged at a respective inlet and outlet, said gates being vertically movable from a closure position or from a minimum opening position, in which they allow only the passage of the products entering or leaving the heating chamber, to a maximum opening position, in which their lower side is substantially at the level of said ceiling or roof.

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11. The heating furnace according to one or more of the preceding claims, **characterized in that** said ceiling or roof is arranged on a plane which is substantially parallel to said surface for the support and sliding of the products being heated.

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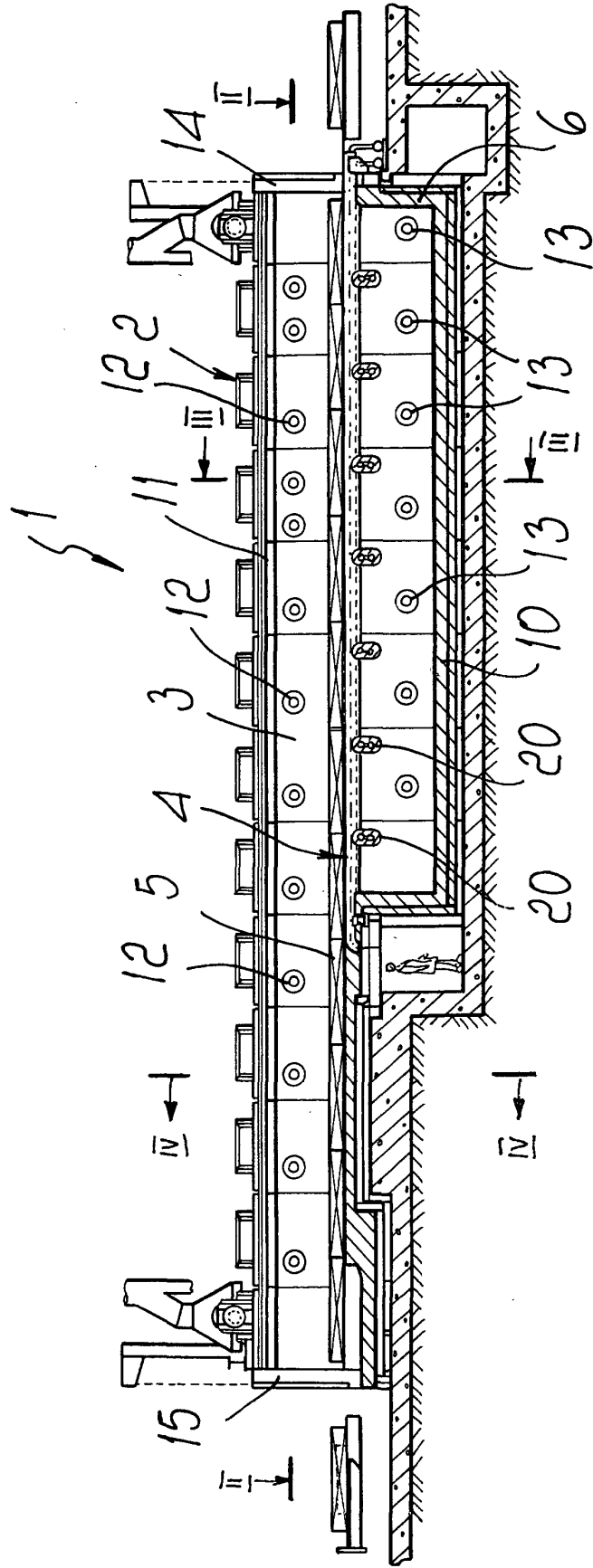


FIG. 1

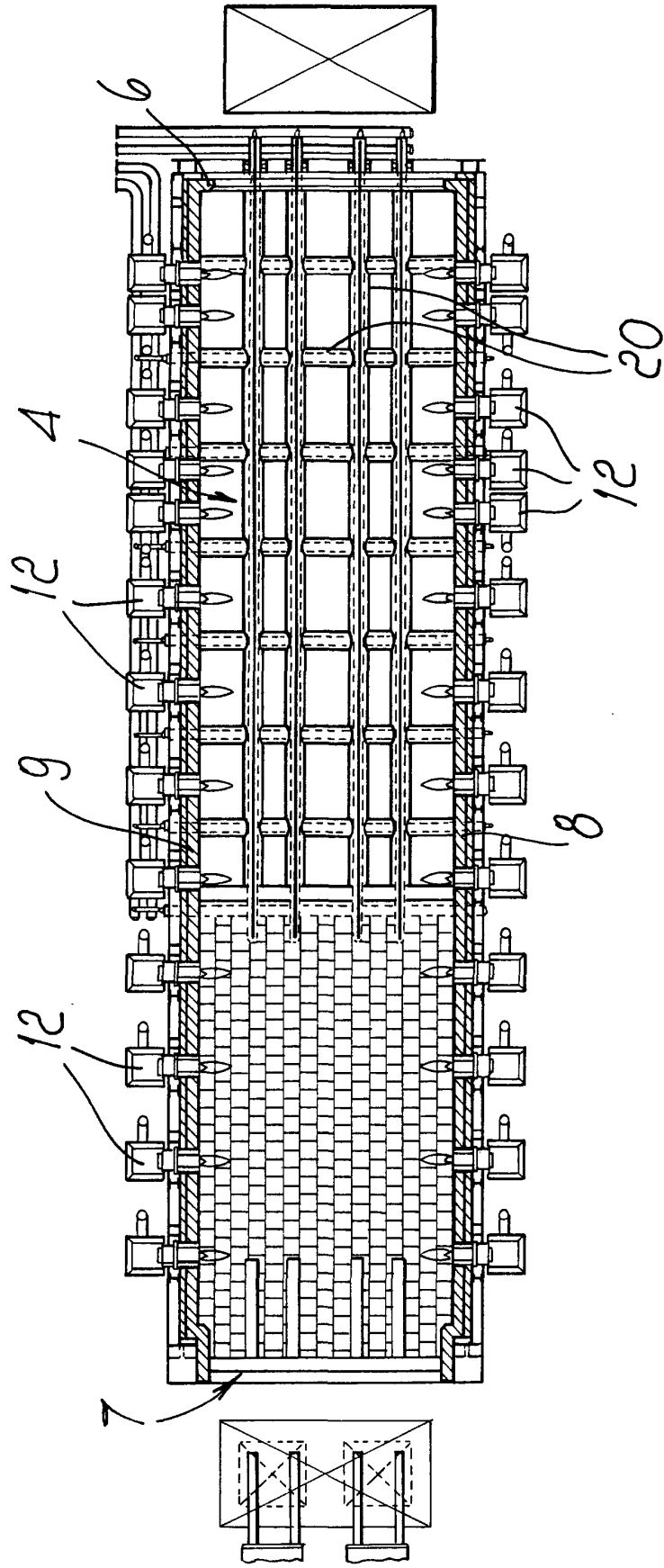


FIG. 2

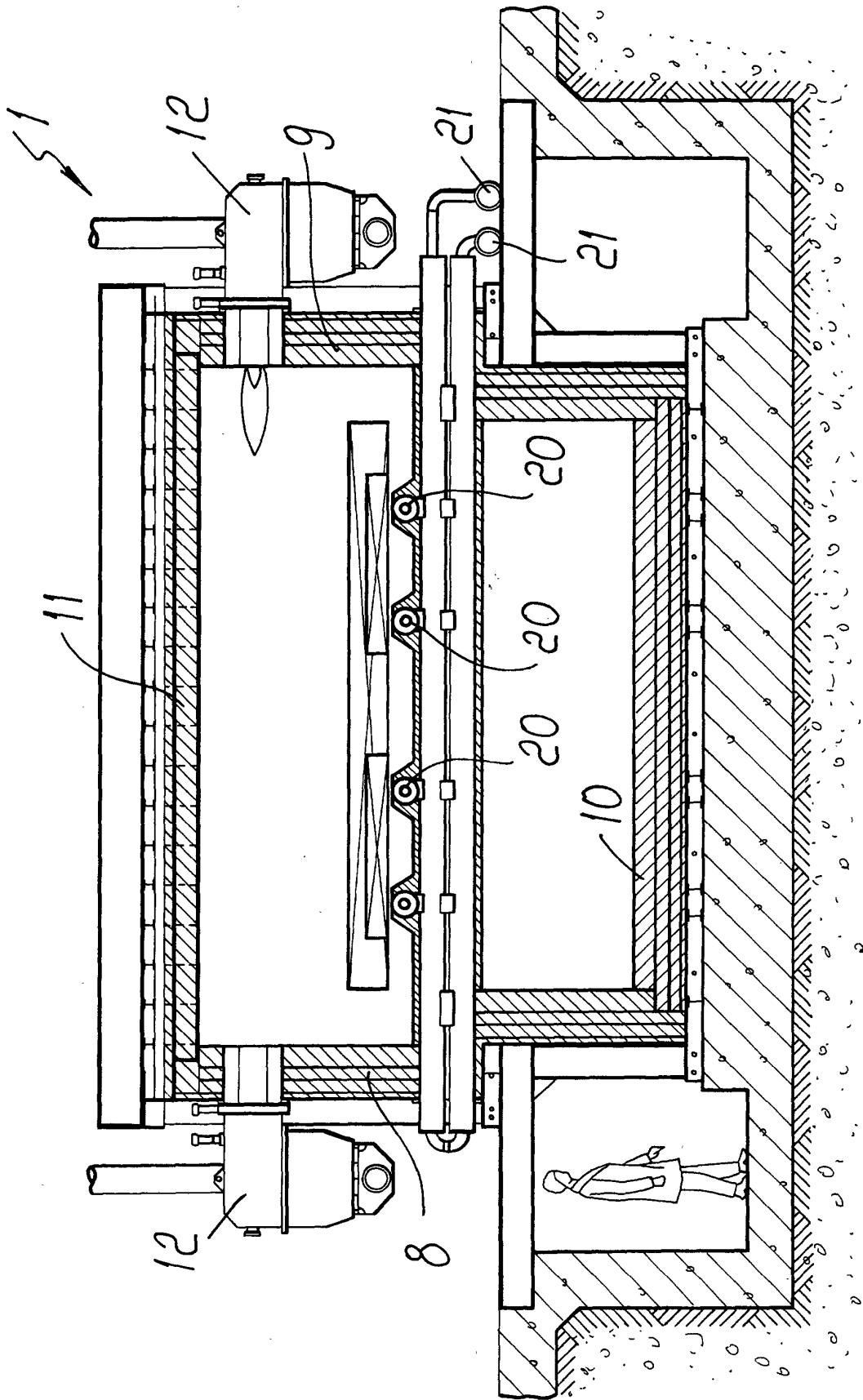


FIG. 3

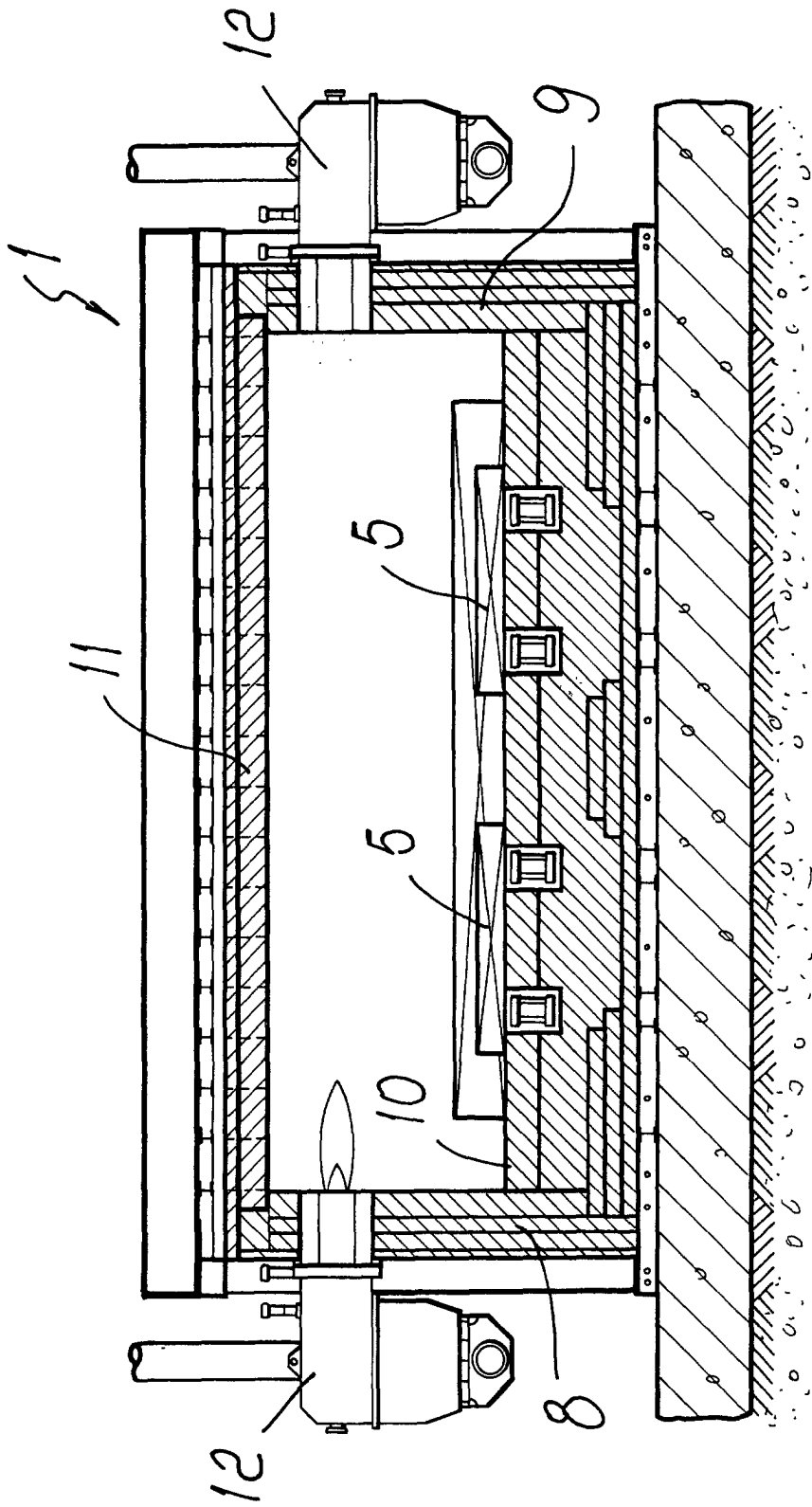


FIG. 4



European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 01 11 5609

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.CI.7)
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The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 27 November 2001	Examiner Coulomb, J
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

EPO FORM 1503 03/82 (P/04/001)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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