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(11) **EP 1 348 769 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
01.10.2003 Bulletin 2003/40

(51) Int Cl.7: **C21B 9/00**

(21) Application number: **02076252.2**

(22) Date of filing: **29.03.2002**

(84) Designated Contracting States:
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU
MC NL PT SE TR**
Designated Extension States:
AL LT LV MK RO SI

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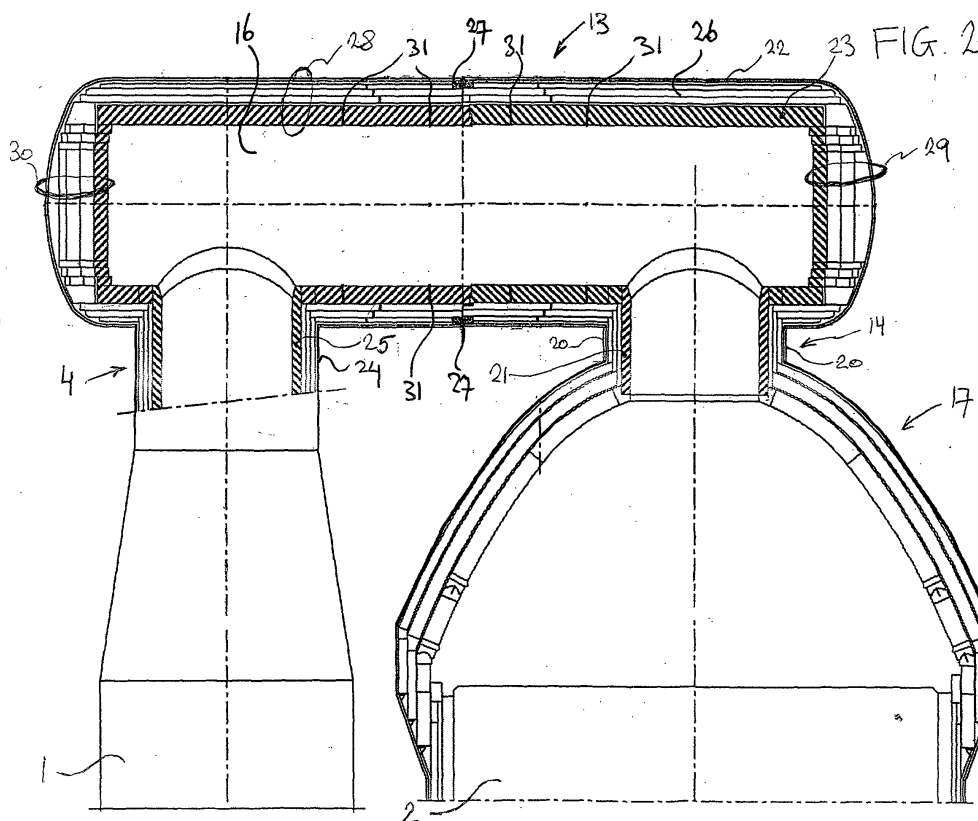
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(54) **Regenerative hot blast stove and cross over conduit for such a regenerative hot blast stove**

(57) Regenerative hot blast stove comprising a combustion shaft (1), a regenerative shaft (2) arranged adjacent to the combustion shaft, and a cross over conduit (13) connecting the combustion shaft (1) with the regenerative shaft (2) for enabling gas flow from the combustion shaft via the cross over conduit into the regenerative shaft, which cross over conduit comprises a transverse section for at least bridging a gap between

the combustion shaft and the regenerative shaft, the transverse section being essentially formed of a refractory wall (28) extending around a bore (16), the bore (16) leading to a first and a second connecting opening for connecting the cross over conduit with the combustion shaft and the regenerative shaft, wherein at least the first connecting opening is provided in the refractory wall of the transverse section, the connecting opening extending through the refractory wall to the bore.



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Description

[0001] The invention relates to a regenerative hot blast stove comprising a combustion shaft, a regenerative shaft arranged adjacent to the combustion shaft, and a cross over conduit connecting the combustion shaft with the regenerative shaft for enabling gas flow from the combustion shaft via the cross over conduit into the regenerative shaft, which cross over conduit comprises a transverse section for at least bridging a gap between the combustion shaft and the regenerative shaft, the transverse section being essentially formed of a refractory wall extending around a bore, the bore leading to a first and a second connecting opening for connecting the cross over conduit with the combustion shaft and the regenerative shaft.

[0002] Such a regenerative hot blast stove is known. In US 4 169 700 a regenerative hot blast stove of this type is described, having a combustion shaft and an adjacently arranged regenerative shaft, each comprising a refractory lining within an outer shell. The combustion shaft comprises a burner for production of hot combustion exhaust gas. The regenerative shaft is normally filled with a checker work, to be heated by the hot combustion exhaust gas in a combustion stage, and to release its heat to blasting air in a blasting stage.

[0003] In the known regenerative hot blast stove, the top portions of the combustion shaft and the regenerative shaft are each provided with a dome, which domes are connected to each other via a cross over conduit arranged transversely in between the side walls of these domes. The cross over conduit as well as the domes are made of a refractory lining within an outer shell.

[0004] A drawback of this construction is that the refractory wall of the cross over conduit is restrained between the refractory lining of the domes. Due to this situation, problems may arise in horizontal and vertical compensation of expansion differences during thermal cycling of the regenerative hot blast stove. In particular, in the refractory wall at the joints between the dome and the cross over conduit may suffer from damage as a result.

[0005] It is an object of the invention to provide an improved construction.

[0006] According to the invention, there is provided that at least the first connecting opening is provided in the refractory wall of the transverse section, the connecting opening extending through the refractory wall to the bore.

[0007] Herewith a construction is provided using a simple cross over conduit design. Because the first connecting opening is provided through the essentially cylindrical refractory wall, it is now possible to arrange the cross over conduit to be connected overhead above at least one of the combustion shaft or the regenerative shaft. Thereby it is avoided to provide a complicated opening in the dome side wall. Moreover, with the construction according to the invention, it is possible to sup-

port the overhead cross over conduit construction in the centreline of the combustion shaft or regenerative shaft.

[0008] An additional advantage of the invention, is that with the connecting opening provided in the refractory wall of the transverse section, a coupling end to the combustion shaft or the regenerative shaft can simply be provided having its bore at a transverse angle to the bore of the transverse section. Thereby a connection with the combustion shaft or the regenerative shaft can be made using relatively uncomplicated refractory bricks, because there is no need to alter the main direction of the bore of the cross over conduit from transverse to vertical. Herewith damage to the refractory lining in the cross over conduit and/or the dome that may result from thermal cycling of the regenerative hot blast stove, is avoided or at least reduced.

[0009] As will be appreciated, it is not a mandatory requirement of the invention in its broadest definition that the bore be cylindrical, neither that it have a circular cross section. Hence, within the scope of the present invention, the term "bore" is used indicate a passage defined by the inner superficies formed by the refractory wall of the transverse section, including passages formed by a pipe, tapered pipe, a pipe having a bend or a knee, each with a cross section of any shape.

[0010] Nevertheless, it is preferred that the transverse section is essentially cylindrical. Because of the cylindrical shape, the strain related to thermal expansion in the refractory wall can be accommodated and distributed over its entire length using known techniques such as by provision of expansion joints.

[0011] It is an advantage of the invention that the entire transverse section of the cross over conduit can now be constructed in an overhead construction using one simple cylindrical design having a cross section of any shape, due to the fact that the connecting opening is provided in and through the refractory wall to the bore.

[0012] It is more preferred that the essentially cylindrical transverse section has a circular cross section. The circular shape is ideal for accommodating radial strain.

[0013] In an advantageous embodiment, the cross over conduit, as seen from the second connecting opening along the bore, is provided with an end wall extending across the bore beyond the first connecting opening. The end wall does not only end the bore, but is also serves to mechanically support the refractory wall of the transverse section in its longitudinal direction.

[0014] The construction is even further improved in an embodiment wherein the refractory wall comprises a cross over conduit refractory lining within a cross over conduit outer shell, whereby the first connecting opening leads to a coupling end including a coupling end refractory lining, whereby the coupling end refractory lining extends through the opening in the cross over conduit outer shell, and further extends moveably, preferably slideably, in the cross over conduit refractory lining.

[0015] Because of the moveability, preferably slidea-

bility, of the coupling end refractory lining relative to the cross over conduit refractory lining, the coupling end refractory lining is relatively free to move upon thermal cycling of the regenerative hot blast stove. Consequently the accumulating of strain in the refractory lining is reduced and damage to the refractory linings that may result from thermal working of the construction is thus avoided or at least further reduced. Moreover, the need for complicated refractory bricks is even further minimised.

[0016] In an advantageous embodiment wherein the coupling end refractory lining extends slideably into the opening in the cross over conduit refractory lining, the coupling end refractory lining extends essentially vertically through the connecting opening. Herewith it is achieved that in case of thermal contraction of the coupling end refractory lining, the coupling end refractory lining can relatively easily slide back through the cross over conduit refractory lining because movement is assisted by its own weight. Consequently, the risk of introducing cracks is reduced.

[0017] Benefit of the advantages set out above are already obtained when one of connecting openings is arranged as described above. However, full benefit of the invention is achieved in an embodiment wherein both the first and second connecting openings are provided in the refractory wall of the transverse section and extending through the refractory wall to the bore.

[0018] In that case, the cross over conduit can be arranged entirely overhead above the combustion and the regenerative shafts, so that the cross over conduit refractory lining is entirely free to vertical movement with respect to the coupling end refractory linings. In addition, both ends of the cross over conduit can be provided with an end wall extending across the bore, for longitudinal support of the cross over conduit refractory lining.

[0019] The invention also relates to a cross over conduit for connecting a combustion shaft with a regenerative shaft arranged adjacently in a regenerative blast stove.

[0020] According to this aspect of the invention, there is provided a cross over conduit comprising a transverse section for at least bridging a gap between the combustion shaft and the regenerative shaft when in use, the transverse section being essentially formed of a refractory wall extending around a bore, the bore leading to a first and second connecting opening for connecting the cross over conduit with the combustion shaft and the regenerative shaft, whereby at least the first connecting opening is provided in the refractory wall of the transverse section, extending through the refractory wall to the bore.

[0021] Because of this arrangement of the connecting openings, the cross over conduit is optimised for overhead construction without the need to provide a bend in refractory wall of the cross over conduit in order to alter the direction of the bore from the transverse direction to that of the combustion shaft or generative shaft in a re-

generative hot blast stove. Herewith the refractory wall of the cross over conduit is less susceptible to damage resulting from thermally induced strain cycling.

[0022] In an embodiment, the refractory wall comprises a cross over conduit refractory lining within a cross over conduit outer shell, and whereby the first connecting opening leads to a coupling end including a coupling end refractory lining, whereby the coupling end refractory lining extends through the opening in the cross over conduit outer shell, and further extends moveably, preferably slideably, in the cross over conduit refractory lining. Thus, the cross over conduit refractory lining is decoupled from the coupling end refractory lining. Herewith a simple construction is obtained, that is less sensitive to damage resulting from thermal strain.

[0023] In a particularly advantageous embodiment, both the first and second connecting openings are provided in the refractory wall of the transverse section and extending through the refractory wall to the bore, and both the first and second connecting openings are facing the same direction. Such cross over conduit can be arranged entirely overhead above the combustion and the regenerative shafts, with parallel extending coupling ends, so that the cross over conduit refractory lining is entirely free to vertical movement with respect to the coupling ends.

[0024] Other embodiments of the cross over conduit, and their respective advantages, can be derived from the description relating to the regenerative hot blast stove according to the invention.

[0025] The invention will now be illustrated with reference to the drawing wherein

FIG. 1, parts a and b, schematically shows a view of a regenerative hot blast stove according to different embodiments of the invention;

FIG. 2 shows a sectional view of the cross over conduit according to an embodiment of the invention;

FIG. 3 shows two sectional views of another embodiment of the invention.

[0026] FIG. 1a shows a schematic view of a regenerative hot blast stove, with a combustion shaft 1, a regenerative shaft 2 arranged adjacent to combustion shaft 1. The combustion shaft contains a burner (not shown) for production of hot combustion exhaust gas. The regenerative shaft is normally filled with a checker work (not shown). There is further provided a cross over conduit 3 connecting the combustion shaft 1 with the regenerative shaft 2, so that gas flow is possible from the combustion shaft via the cross over conduit to the regenerative shaft.

[0027] The cross over conduit has a transverse section comprising a cylindrical refractory wall 8 extending along an essentially horizontal axis, and one of its ends is closed by an end wall 5.

[0028] In the embodiment shown in FIG. 1a, the cross over conduit 3 is connected near its end 5 to the com-

bustion shaft 1 with a vertically positioned intermediate coupling element 4 in between. The cross over conduit 3 extends overhead above the combustion shaft 1, which is made possible by provision of the connecting opening through the cylindrical part 8 of the refractory wall. The other end 6 of the cross over conduit 3 is directly connected to a dome 7, in a similar way as the state of the art represented, for instance, by US 4 169 700, which in turn is connected to the regenerative shaft 2. Seen from the end 6 connected to dome 7 of the regenerative shaft 2, the transverse section extends beyond the connecting opening that is connected to the intermediate coupling element 4.

[0029] FIG. 1b shows a schematic view of a regenerative hot blast stove in another embodiment according to the invention. Again, there are provided a combustion shaft 1 and a regenerative shaft 2 arranged adjacent to combustion shaft 1. There is further provided an overhead cross over conduit 13 connecting the combustion shaft 1 with the regenerative shaft 2, so that gas flow is possible from the combustion shaft via the cross over conduit to the regenerative shaft.

[0030] The cross over conduit 13 has a cylindrical refractory wall 18 extending along an essentially horizontal axis, and one of its ends is closed by an end wall 5 and similarly the other one of its ends is closed by an end wall 15. In the embodiment shown in FIG. 1b, the cross over conduit 13 is connected near its ends 5 and 15 respectively to the combustion shaft 1 via a vertically positioned intermediate coupling element 4, and to the regenerative shaft 2 with a vertically positioned intermediate coupling element 14. Cross over conduit 13 extends overhead above the combustion shaft 1 on one side and above the regenerative shaft 2 on the other side, which is made possible by provision of the connecting openings through the cylindrical part 18 of the refractory wall. The regenerative shaft is provided with a dome 17.

[0031] Referring now to FIG. 2, there is shown a sectional view of a cross over conduit construction in a regenerative hot blast stove similar to the one shown in FIG. 1b. There is shown part of the combustion shaft 1, part of the regenerative shaft 2 which is provided with dome 17. The combustion shaft 1 and the regenerative shaft 2 are connected with use of cross over conduit 13. The cross over conduit includes a transverse section, made of a cylindrically shaped refractory wall 28 defining a bore 16, provided with end walls 29 and 30 across the bore 16 on each of the ends of the transversal section. The refractory wall of the cross over conduit 13 includes a cross over conduit outer shell 22 and a cross over conduit refractory lining 23. In between the cross over conduit outer shell 22 and the cross over conduit refractory lining are provided several insulating layers 26. Such insulating layers are also provided at the end walls 29 and 30.

[0032] There are connecting openings provided in the cylindrical refractory wall 28 of the cross over conduit

13. As can be seen, the connecting openings extend through the refractory wall to the bore 16. These connecting openings are located near the end walls 29 and 30 respectively, but such that the cross over conduit refractory wall 28 of the transverse section, and the bore 16, extend out to the end walls beyond the connecting openings. Thus the connecting openings are provided through the cylindrical refractory wall.

[0033] Between the combustion shaft 1 and the cross over conduit 13 is provided an intermediate coupling element 4, and similarly intermediate coupling element 14 is provided the cross over conduit 13 and the dome 17. As can be seen, the coupling elements 4 and 14 are essentially cylindrical and extend about the central vertical axis of the combustion shaft and the regenerative shaft, respectively.

[0034] The intermediate coupling element 14 includes a coupling end outer shell 20 which is covered on the inside with a coupling end refractory lining 21. As can be seen, the coupling end refractory lining 21 extends through the cross over conduit outer shell 22 in the connecting opening provided in the cylindrical refractory wall 28, and it further extends into the cross over conduit refractory lining 23.

[0035] The coupling end refractory lining 21 is vertically slideable with respect to the cross over conduit refractory lining 23 so as to accommodate vertical movement of the cross over conduit refractory lining 23 relative to the coupling end refractory lining 21.

[0036] In a similar way, the intermediate coupling element 4 includes a coupling end outer shell 24 which is covered on the inside with a coupling end refractory lining 25. The coupling end refractory lining 25 extends through the cross over conduit outer shell 22 in a connecting opening provided in the cylindrical refractory wall 28, and it further extends slideably into the cross over conduit refractory lining 23.

[0037] The coupling end outer shells 20 and 24 can be connected to the cross over conduit outer shell 22 using any standard method in this field of art.

[0038] The refractory lining in the transverse section is provided with expansion joints 31, which are known in the art. The presence of the end walls 29 and 30, in combination with the fact that the transverse section is cylindrical, longitudinally supports the refractory lining 23 ensuring that any longitudinal strain is indeed accommodated in the expansion joints 31. This also protects the refractory lining of the coupling ends 21 and 25 from being damaged.

[0039] Also provided are compensation means 27, to accommodate for instance thermal expansion or contraction of the combustion shaft relative to the regenerative shaft. Such compensation means are known in the art.

[0040] As can be seen, the vertically extending refractory linings 21 and 25 of the intermediate coupling ends 14 and 4 are supported by the refractory lining of the underlying domes.

[0041] FIG 3 shows an alternative construction. FIG. 3a is a longitudinal section along line a-a shown in FIG. 3b, and schematically shows the bore 45 along its length. FIG. 3b is a longitudinal section along line b-b shown in FIG. 3a, and provides a view along the bore 45.

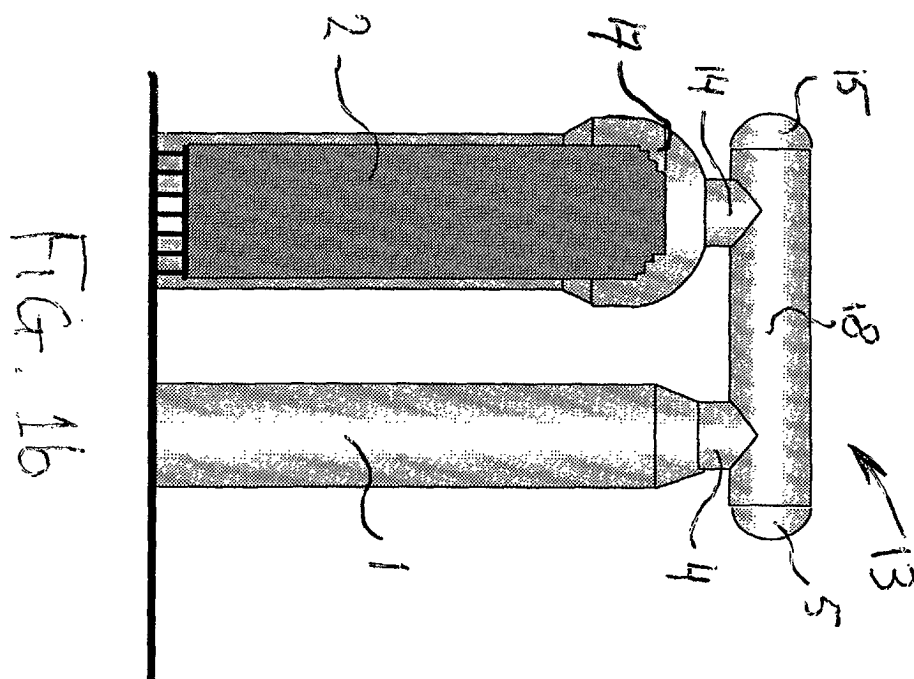
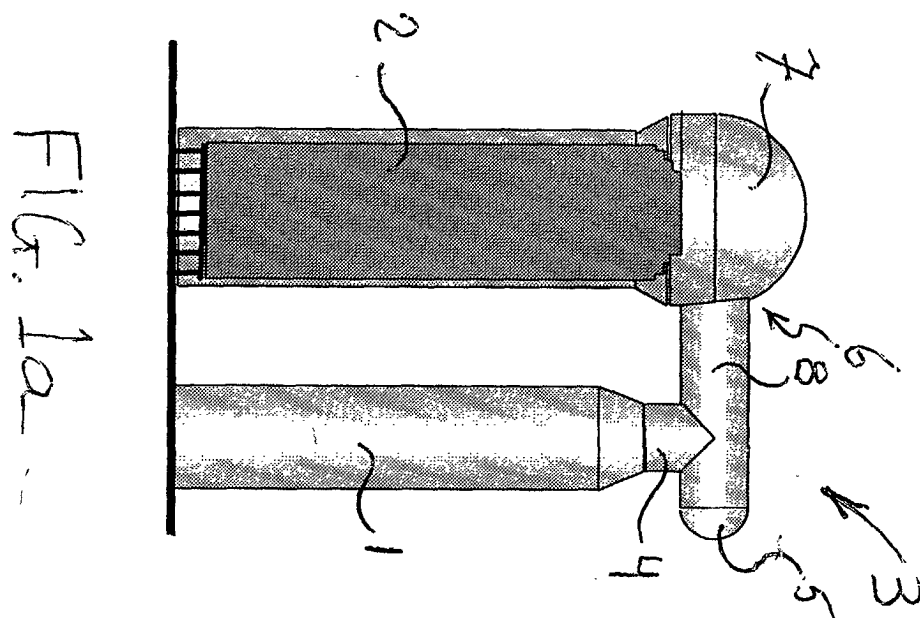
[0042] In this embodiment, the refractory lining 41 of the coupling end is supported by support ledge 40 which is connected to the coupling end outer shell 44. This reduces the load on the refractory lining of the dome 47. Also shown are the cylindrical refractory wall of the transverse section of the cross over conduit, including the cross over conduit refractory lining 33, the insulating layers 36 and the cross over conduit outer shell.

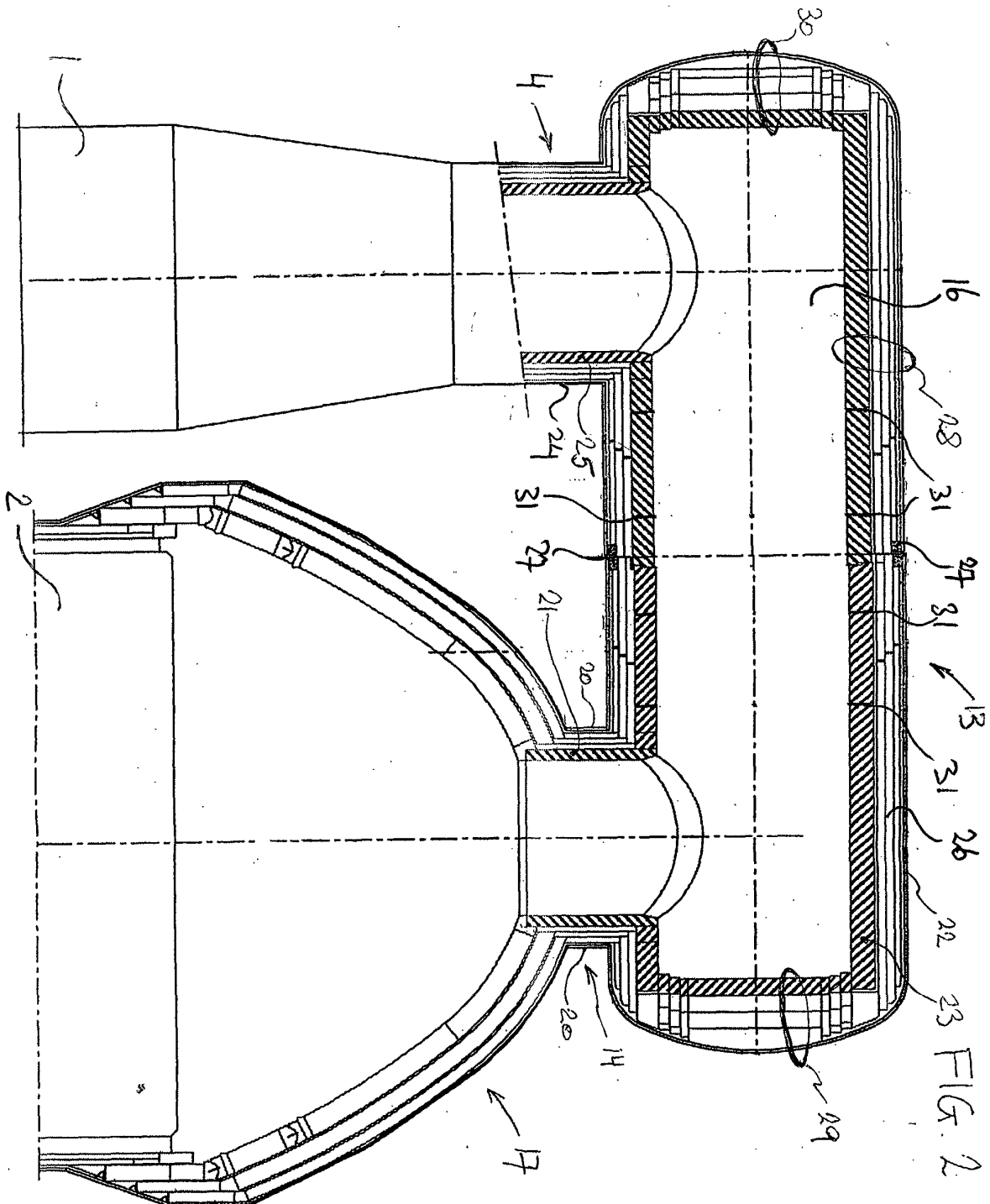
Claims

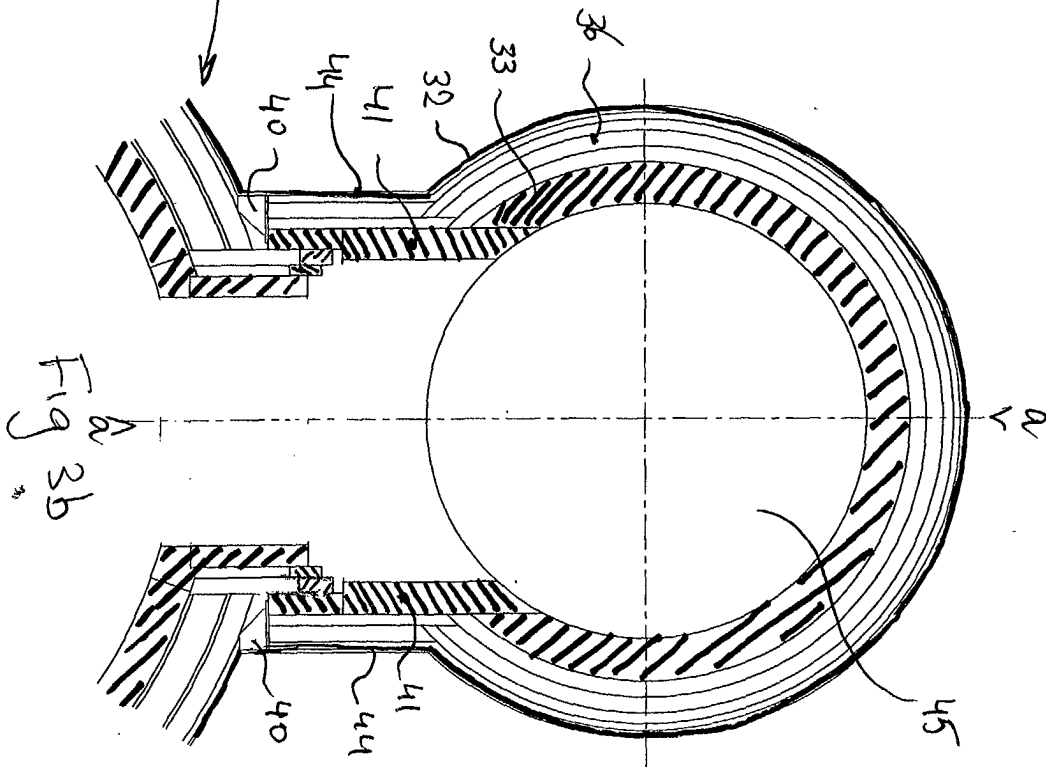
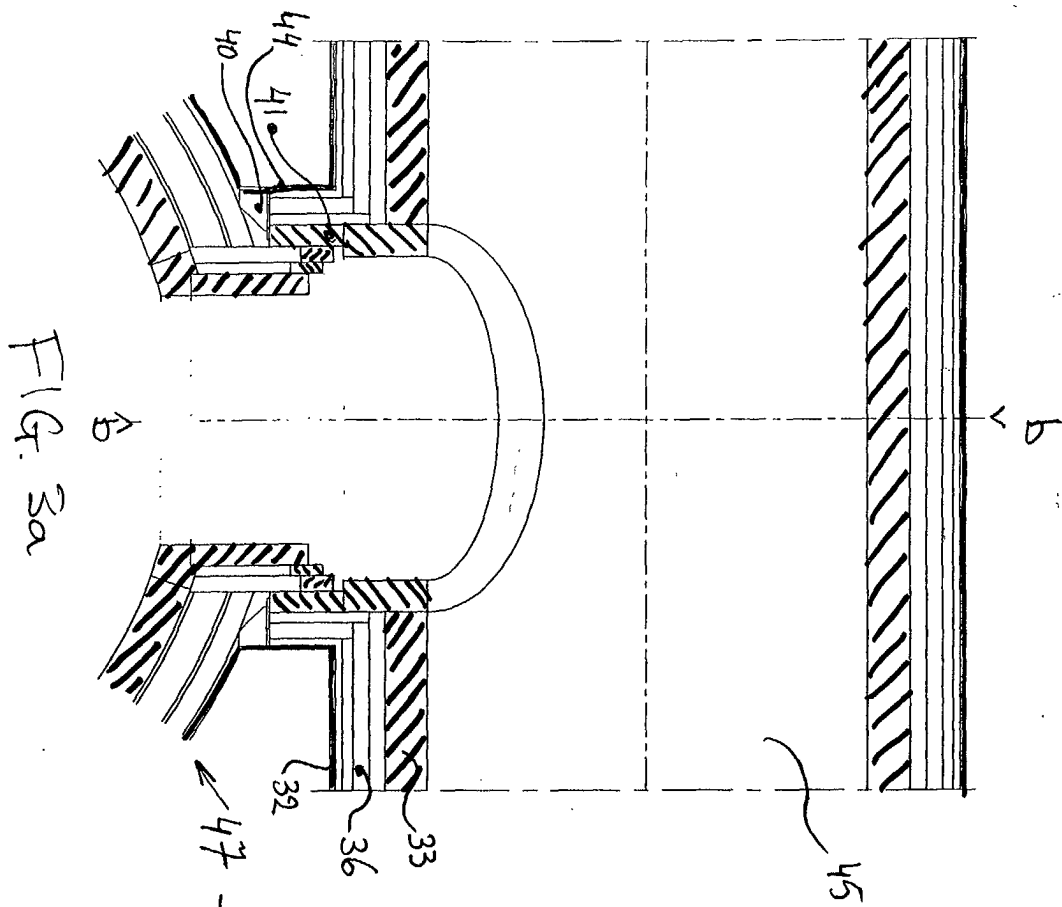
1. Regenerative hot blast stove comprising a combustion shaft, a regenerative shaft arranged adjacent to the combustion shaft, and a cross over conduit connecting the combustion shaft with the regenerative shaft for enabling gas flow from the combustion shaft via the cross over conduit into the regenerative shaft, which cross over conduit comprises a transverse section for at least bridging a gap between the combustion shaft and the regenerative shaft, the transverse section being essentially formed of a refractory wall extending around a bore, the bore leading to a first and a second connecting opening for connecting the cross over conduit with the combustion shaft and the regenerative shaft, **characterised in that** at least the first connecting opening is provided in the refractory wall of the transverse section, the connecting opening extending through the refractory wall to the bore.
2. Regenerative hot blast stove according to claim 1, wherein, as seen from the second connecting opening along the bore, the bore extends beyond the first connecting opening.
3. Regenerative hot blast stove according to claim 1 or 2, wherein the transverse section is essentially cylindrical, preferably essentially circular cylindrical.
4. Regenerative hot blast stove according to any one of the preceding claims, wherein the cross over conduit, as seen from the second connecting opening along the bore, is provided with an end wall extending across the bore beyond the first connecting opening.
5. Regenerative hot blast stove according to any one of the preceding claims, wherein the refractory wall comprises a cross over conduit refractory lining within a cross over conduit outer shell, and whereby the first connecting opening leads to a coupling end

including a coupling end refractory lining, whereby the coupling end refractory lining extends through the opening in the cross over conduit outer shell, and further extends moveably, preferably slideably, in the cross over conduit refractory lining.

6. Regenerative hot blast stove according to claim 5, wherein the coupling end refractory lining extends essentially vertically in the connecting opening.
7. Regenerative hot blast stove according to claim 5 or 6, wherein the coupling end is essentially cylindrically shaped.
8. Regenerative hot blast stove according to any one of the preceding claims, wherein both the first and second connecting openings are provided in the refractory wall of the transverse section and extending through the refractory wall to the bore.
9. Cross over conduit for connecting a combustion shaft with a regenerative shaft arranged adjacently in a regenerative blast stove, the cross over conduit comprising a transverse section for at least bridging a gap between the combustion shaft and the regenerative shaft when in use, the transverse section being essentially formed of a refractory wall extending around a bore, the bore leading to a first and second connecting opening for connecting the cross over conduit with the combustion shaft and the regenerative shaft, **characterised in that** at least the first connecting opening is provided in the refractory wall of the transverse section, extending through the refractory wall to the bore.
10. Cross over conduit according to claim 9, whereby the refractory wall comprises a cross over conduit refractory lining within a cross over conduit outer shell, and whereby the first connecting opening leads to a coupling end including a coupling end refractory lining, whereby the coupling end refractory lining extends through the opening in the cross over conduit outer shell, and further extends moveably, preferably slideably, in the cross over conduit refractory lining.
11. Cross over conduit according claim 9 or 10, wherein both the first and second connecting openings are provided in the refractory wall of the transverse section and extending through the refractory wall to the bore, and both the first and second connecting openings are facing the same direction.









European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 02 07 6252

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	GB 1 001 317 A (SILICA-UND SCHAMOTTEFABRIKEN MARTIN & PAGENSTECHER) 11 August 1965 (1965-08-11) * page 1, line 49 - line 54 * *, sentence 75 - sentence 86 * * page 2, line 15 - line 33; claims 1-8; figures 1-3 *	1-11	C21B9/00
A	DE 937 609 C (HEINRICH KOPPERS) 12 January 1956 (1956-01-12)		
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			C21B
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 26 August 2002	Examiner Elsen, D
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			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 02 07 6252

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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26-08-2002

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82