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(54) **METHOD AND APPARATUS FOR HEAT-TREATMENT OF A FIBER PRODUCT - NOZZLES ARE ELONGATED IN MACHINE DIRECTION**

VERFAHREN UND VORRICHTUNG ZUR WÄRMEBEHANDLUNG EINES FASERPRODUKTES, DIE DÜSEN ERSTRECKEN SICH IN RICHTUNG DER MASCHINE

PROCEDE ET APPAREIL POUR TRAITER PAR UN GAZ CHAUD UN PRODUIT FIBREUX, LES INJECTEURS ETANT DISPOSES LONGITUDINALEMENT DANS LE SENS DES FIBRES

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(73) Proprietor:
Rockwool International A/S
2640 Hedehusene (DK)

(72) Inventor: **HOEGENHAVEN, Aron Per**
DK-9550 Mariager (DK)

(74) Representative: **Kyed, Iver et al**
Hofman-Bang A/S
Hans Bekkevolds Allé 7
2900 Hellerup (DK)

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Description

[0001] The invention relates-to a method of thermally treating a moving mineral fibre web wherein oppositely directed gas streams are introduced into the fibre web from opposite sides thereof through inlet zones and wherein the gas streams thus introduced are released from the same side as they are introduced through outlet zones.

[0002] DK patent application No. 2558/78 discloses a curing oven comprising means for passing a hot gas stream through a mineral fibre web arranged between two gas permeable conveyor belts in a direction perpendicular to the web plane.

[0003] It is known that the amount of heat which is transmitted from the hot air to the thermocuring binder contained in the mineral fibre web is proportional to the pressure at which the hot air is introduced into the mineral fibre web.

[0004] Therefore, attempts have been made to increase the curing capacity of curing ovens of the type mentioned above by increasing the air pressure on the inlet side of the web.

[0005] In case of heat treatment of mineral fibre webs and in particular mineral fibre webs with a low density, an increase in the differential pressure may result in irregular compressions of the mineral fibre web which compressions are probably due to the fact that the mineral fibres are displaced relative to each other in areas where there is a comparatively low fibre density under the influence of the high differential pressure and that the curing of the binder is insufficient at this point,

[0006] Such compressions may easily result in the formation of an uncontrollable amount of cavities in the fibre web imparting thereto an unacceptable appearance and an uneven insulating capacity.

[0007] DE patent publication No. A 22753 IVC/80b, published on 06/12/56, describes a method of the above-mentioned type. In this known method hot gas streams introduced from opposite sides of the mineral fibre web and through slot openings which extend perpendicularly to the direction of movement of the mineral fibre web are forced to move parallel to the web plane in the direction of movement of the mineral fibre web or opposite thereto before the gas is passed away from the fibre web through slot openings which extend perpendicularly to the direction of movement of the web.

[0008] It is stated that the purpose of this forced movement of hot gas parallel with the web plane is to maintain the gas within the mineral fibre web for as long as possible thereby allowing it to release as much heat as possible.

[0009] The invention is based on the discovery that; as a consequence of the exceptionally large surface area of the mineral fibres, typically 500 m^2/kg, an almost instantaneous change of the mineral fibre temperature occurs when the fibre web is exposed to the influence of hot or cold gas streams. Therefore, there is no need to force such gas streams to remain within the fibre web for a long period. Contrary to the teachings of DE publication No. A 22753 it has been shown that the gases may be allowed to escape immediately after their contact with the mineral fibres. This means that the travelling distance to be overcome by the gases in the mineral fibre web may be made short and that the gases may be introduced under a high pressure without ensuing compression of the fibres.

[0010] Thus, the method according to the invention is futher carried out by the features of characterizing portion of Claim 1.

[0011] The terms "gas" and "gases" as used herein mean that they comprise any hot gaseous medium including water vapour.

[0012] The method according to the invention is particularly suitable for curing the binder of a mineral fibre product containing an uncured thermocuring binder and in the following it will be explained more in detail in connection with a curing process wherein hot gases are used to effect curing of a thermocuring binder. However, it should be understood that the method is also suitable for other thermal treatments, including cooling, of a mineral fibre product by introducing hot or cold gases into the mineral fibre product.

[0013] The gas flow pattern obtained by heat treating a mineral fibre web according to a preferred embodiment of the method according to the invention is illustrated in the drawings wherein Fig. 1 is a sectional view of a mineral fibre web 1 which is moved by two gas permeable conveyor belts 4 in a plane perpendicular to the paper plane. Through air inlet zones 2 which are elongated and extend in the direction of movement of the fibre web 1 hot gas streams are introduced, which gas streams, following deflection so as to move parallel with the web plane, are once again deflected so as to move out of the fibre web 1 through the outlet zones 3 located adjacent to the air inlet ducts 2.

[0014] The establishment a flow pattern such as the one shown in the drawing allows for an increase in the curing capacity of from 2 to 3 times compared to curing by means of hot gas streams which are passed transversally through the fibre web.

[0015] As mentioned in connection with the description of the drawing, the gas inlet zones and the adjacent gas outlet zones may be elongated.

[0016] It is preferred that the zone into which hot gas is introduced from the one side of the fibre web is located just opposite the zone into which gas is introduced from the opposite side, but the two zones may be positioned slightly displaced relative to each other. Furthermore the opposite zones should not necessarily be of the same size. Usually, however, at least 25% of the area of the smallest zone should be overlapped by the opposite zone.

[0017] The pressure difference between the gas inlet zone and the adjacent gas outlet zone(s) may be provided in different manners. However, it is preferred to

use a pressure which exceeds the atmospheric pressure in the gas inlet zone and atmospheric or subatmospheric pressure in the gas outlet zone(s).

[0018] However, it may also be convenient to use a subatmospheric pressure in the gas outlet zone(s) and an atmospheric pressure in the gas inlet zone.

[0019] It is essential that the differential pressures in the adjacent zones are maintained within suitable ranges

[0020] When elongated gas inlet zones extending in the direction of movement of the fibre web are used, the widths of said zones are preferably larger than or equal to the widths of the adjacent gas outlet zones.

[0021] The elongated gas inlet zones are preferably divided in the longitudinal direction to form separate sections and different pressures may be maintained in adjacent sections.

[0022] Thus, us advantageous to maintain a lower pressure difference between the first section in a gas inlet zone and the corresponding gas outlet zone than between the subsequent sections and the corresponding gas outlet zone(s).

[0023] During the initial heat treatment the areas of the fibre web in which the fibre density is lowest are most exposed to fibre compression. It is therefore important that this initial heat treatment is carried out under a comparatively low differential pressure.

[0024] As the gas flow is strongest in the said areas having low fibre density curing and an ensuing fixture of the fibres is quickly effected in these areas. In this manner these areas obtain such high degree of resistance to fibre compression that increased differential pressures may be applied in the subsequent sections without a risk of fibre compression.

[0025] The increased curing capacity mentioned above is not conditioned by the entire curing operation being carried out as described above. Thus, if has been found that the increase in the curing capacity may be obtained by such modifications of portions of existing curing ovens, e.g. 20-90% and particularly preferred the first half thereof, that the curing therein is carried out by the method according to the invention.

[0026] It has also been found that it may be advantageous to allow the first portion of the curing operation to be effected by heat conduction, viz, by supplying heat to the gas permeable belts which are usually used to move mineral fibre webs through a curing oven, so as to form thin cured surface layers by contact of the belts with the fibre web surfaces. By initially carrying out the curing as described above, following formation of said thin set surface layers, higher differential pressures may be applied without the risk that recesses are formed in the fibre web surfaces.

[0027] According to the invention the mineral fibre web is preferably maintained between two gas permeable belts, such as lamella belts, while it is treated with the gas streams supplied at the opposite sides.

[0028] The term "mineral fibres" as used herein comprises inorganic fibres produced from minerals. Examples of such fibres are rock wool fibres, glass wool fibres and slag fibres.

[0029] The method according to the invention is suitable for thermal treatment of mineral fibre webs having densities which are comprised within wide ranges, but it is particularly suitable for the treatment of light products of e.g. mineral fibre webs having a density of down to 7 kg/m^3, but preferably a density of 15-60 kg/m^3. The fibre webs may be composed of one or more fibre layers.

[0030] FI-B-80102 discloses a method for drying a fibre web wherein a fibre web arranged between two air tight heat conductive belts is heated by heat supply to the belts.

[0031] GB patent No. 867530 discloses an apparatus for drying a textile fibre web wherein the fibre web is kept freely suspended in a drying zone wherein hot air is blown against the fibre web sides through slotted nozzles located on opposite sides of the fibre web.

[0032] The invention further relates to an apparatus for carrying out the method described above. The apparatus comprises the features of Claim 11.

[0033] According to the invention each gas outlet duct is preferably connected to one or more gas inlet openings through a conduit wherein a gas pump and optionally heating means are provided.

[0034] This embodiment permits the gas flowing out of the fibre product to be recycled optionally following renewed heating and to be reintroduced into the fibre product, thereby minimising the heat loss.

[0035] As indicated above, the method and the apparatus according to the invention is particularly suitable for use for curing a continuous binder-containing mineral fibre web, but it may also be used for curing a series of successively moved separate mineral fibre elements. They may also be used for the curing of binder-containing separate elements or stacks thereof.

[0036] The invention will now be described more in detail with reference to the drawings, wherein

Fig. 2 is a vertical sectional view of a preferred embodiment of the apparatus according to the invention, and

Fig. 3 is a partial perspective view of the apparatus according to Fig. 2 wherein some parts are shown in a sectional view.

[0037] The apparatus according to Figs. 2 and 3 comprises an upper endless gas permeable belt 10 and a lower endless gas permeable belt 12, which may serve to move a mineral fibre web 14 through a curing chamber 16.

[0038] The apparatus further comprises an inlet duct 18 for the supply of hot gas. The duct 18 divides into an upper branch duct 20 and a lower branch duct 22. The upper branch duct 20 is connected to an upper gas inlet zone which is divided into sections 24 by longi-

tudinal gas outlet ducts 26 which are open at the ends.

[0039] In a similar manner the lower branch duct 22 is connnected to a lower gas inlet zone which is divided into sections 28 by longitudinal gas outlet ducts 30 which are open at the ends. At the ends the gas outlet ducts 24 and 30 are connected to gas collecting zones 32 and 34 which, through communication ducts 36 and 38, respectively, are in communication with an outlet duct 40.

[0040] As will appear from Fig. 2 the outlet duct 40 is connected to a reheating apparatus 42 comprising a burner 43, which may be used for reheating the gas passed out of the curing chamber 16. The supply of gas to the apparatus 42 and the supply of hot gas to the inlet duct 18 is effected by means of a centrifugal blower 44.

[0041] The apparatus disclosed operates as follows:

[0042] Hot gas from the reheating apparatus 42 is blown through the duct 18 by means of the blowers 44 and on through the branch ducts 20 and 22 to the sections 24 and 28, respectively. From here the hot gas passes through the belts 10 and 12 into the mineral fibre web 14 and from here into the adjacent gas outlet ducts 26 and 30 while forming a gas flow pattern corresponding to the one shown in Fig. 1. From the ducts 26 and 30 the gas passes to the gas collecting zones 32 and 34 and on through communication ducts 36 and 38, respectively, into the outlet duct 40 and back to the apparatus 42.

[0043] As will appear from the above explanation, the hot gas leaves the mineral fibre web 14 immediately following its introduction. This means that the operation may be carried out using small pressure differences between the sections 24,28 and the gas outlet ducts 26 and 30, respectively. Thus, the apparatus permits efficient heat treatment of the mineral fibre web 14 without the ensuing risk of recess formation in the fibre web surfaces.

Claims

1. A method of thermally treating a moving mineral fibre. web (1, 14) wherein oppositely directed hot gas streams are introduced into the fibre web from opposite sides thereof through inlet zones (2; 24, 28) and wherein the gas streams thus introduced are released from the same side as they are introduced through outlet zones (3; 26, 30), **characterized** in that the outlet zones (3; 26, 30) are located adjacent to the inlet zones (2; 24, 28) so that the gas streams are allowed to leave the web (1, 14) without any substantial movement in the longitudinal or transversal direction of the web (1, 14).

2. A method according to claim 1, **characterized** in that the gas inlet zones (2; 24, 28) and the gas outlet zones (3; 26, 30) are elongated.

3. A method according to claim 1 or 2, **characterized** in treating a mineral fibre product containing a thermocuring binder with hot gas streams having a temperature above the curing temperature of the binder to cure the binder.

4. A method according to claim 1, 2 or 3, **characterized** in that the gas inlet zones (2; 24) through which hot gas is supplied from the one side of the fibre product (1, 14) are located exactly opposite to the gas inlet zones (2, 28) through which gas is introduced from the opposite side.

5. A method according to claim 1, 2 or 3, **characterized** in that the gas inlet zones (2; 24, 28) through which a hot gas stream is introduced into the fibre product (1, 14) from the one side thereof partially overlap the gas inlet zones (2; 24, 28) through which a hot gas stream is introduced into the fibre product (1, 14) from the opposite side.

6. A method according to claim 5, **characterized** in that the area in which a gas inlet zone (2; 24, 28) on one side of the fibre product overlaps the corresponding gas inlet zone (2; 24, 28) on the other side constitutes at least 25% of the smallest of the two zones.

7. A method according to any one of claims 3 through 6, **characterized** in maintaining within the gas inlet zones (2; 24, 28) a pressure which exceeds the atmospheric pressure and in maintaining an atmospheric or subatmospheric pressure in the gas outlet zones (3, 26, 30).

8. A method according to claim 2, **characterized** in that the widths of the gas inlet zones (2; 24, 28) are larger than or equal to the widths of the gas outlet zones (3; 26, 30).

9. A method according to claim 2, **characterized** in that the elongated gas inlet zones (2, 24, 28) are divided longitudinally to form separate sections.

10. A method according to claim 9, **characterized** in that different pressure differences are maintained between a section of a gas inlet zone (2; 24, 28) and the adjacent gas outlet zone (3; 26, 30) and between the remaining section(s) and the adjacent gas outlet zone(s) in adjacent sections.

11. An apparatus for thermally treating a moving mineral fibre web (14) with streams of hot gas comprising means for advancing the fibre web between at least two inlet openings (24, 28) for introducing hot gas into the web and being located at opposite sides of the web and at least two gas outlet openings (26, 30) for releasing the gas introduced into

the web (14) also located at opposite sides of the web, **characterized** in that both the gas outlet openings (26, 30) and gas inlet openings (24, 28) are elongated and extend parallel to the direction of movement of the fibre web (14), and that each outlet opening (26, 30) is located adjacent to the corresponding inlet opening (24, 28) so that the gas introduced into the web (14) leaves the web without any substantial movement in the web (14).

12. An apparatus according to claim 11, **characterized** in that each gas outlet opening (26, 30) is connected to one or more gas inlet openings through a conduit (40, 18) comprising a gas pump (44) and optionally heating or cooling means (42).

Patentansprüche

1. Verfahren zur Wärmebehandlung einer sich bewegenden Mineralfaserbahn (1, 14), bei welchem in entgegengesetzter Richtung verlaufende Heißgasströme in die Mineralfaserbahn von gegenüberliegenden Seiten von dieser über Einlaßzonen (2; 24, 28) zugeführt werden und bei welchem die auf diese Weise zugeführten Gasströme aus derselben Seite wie die, auf der sie eingeströmt sind, über Auslaßzonen (3; 26, 30) abströmen, **dadurch gekennzeichnet, daß** die Auslaßzonen (3; 26, 30) sich benachbart den Einlaßzonen (2; 24, 28) befinden, so daß den Gasströmen ein Entweichen aus der Faserbahn (1, 14) ohne wesentliche Bewegung in Längs- oder Querrichtung der Faserbahn (1, 14) ermöglicht wird.

2. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, daß** die Gaseinlaßzonen (2; 24, 28) und die Gasauslaßzonen (3; 26, 30) längliche Form aufweisen.

3. Verfahren nach Anspruch 1 oder 2, **dadurch gekennzeichnet, daß** ein ein warmaushärtbares Bindemittel enthaltendes Mineralfaserprodukt zum Aushärten des Bindemittels mit heißen Gasströmen behandelt wird, deren Temperatur oberhalb der Aushärtetemperatur des Bindemittels liegt.

4. Verfahren nach den Ansprüchen 1, 2 oder 3, **dadurch gekennzeichnet, daß** die Gaseinlaßzonen (2; 24), durch welche heißes Gas von der einen Seite des Faserprodukts (1, 14) zugeführt wird, sich genau gegenüber den Gaseinlaßzonen (2; 28) befindet, über welche Gas von der gegenüberliegenden Seite zugeführt wird.

5. Verfahren nach Anspruch 1, 2 oder 3, **dadurch gekennzeichnet, daß** sich die Gaseinlaßzonen (2; 24, 28), über welche ein heißer Gasstrom in das Faserprodukt (1, 14) von dessen einer Seite einströmt, und die Gaseinlaßzonen (2; 24, 28), über welche ein heißer Gasstrom in das Faserprodukt (1, 14) von der gegenüberliegenden Seite einströmt, teilweise überlappen.

6. Verfahren nach Anspruch 5, **dadurch gekennzeichnet, daß** die Fläche, mit der sich eine auf der einen Seite des Faserprodukts befindliche Gaseinlaßzone (2; 24, 28) und die entsprechende, auf der anderen Seite befindliche Gaseinlaßzone (2; 24, 28) überlappen, mindestens 25 % der kleineren der beiden Zonen ausmacht.

7. Verfahren nach einem der Ansprüche 3 bis 6, **dadurch gekennzeichnet, daß** innerhalb der Gaseinlaßzonen (2; 24, 28) ein Druck aufrechterhalten wird, der über dem Umgebungsdruck liegt, und daß in den Gasauslaßzonen (3, 26, 30) Umgebungsdruck oder subatmosphärischer Druck herrscht.

8. Verfahren nach Anspruch 2, **dadurch gekennzeichnet, daß** die Gaseinlaßzonen (2; 24, 28) größer oder gleich groß wie die Gasauslaßzonen (3; 26, 30) sind.

9. Verfahren nach Anspruch 2, **dadurch gekennzeichnet, daß** die länglichen Gaseinlaßzonen (2; 24, 28) in Längsrichtung unterteilt sind, um separate Abschnitte zu bilden.

10. Verfahren nach Anspruch 9, **dadurch gekennzeichnet, daß** unterschiedliche Druckdifferenzen zwischen einem Abschnitt einer Gaseinlaßzone (2; 24, 28) und der benachbarten Gasauslaßzone (3; 26, 30) und zwischen dem/den restlichen Abschnitte(n) und der/den benachbarten Gasauslaßzone(n) in benachbarten Abschnitten aufrechterhalten werden.

11. Vorrichtung zur Wärmebehandlung einer sich bewegenden Mineralfaserbahn (14) mit Heißgasströmen, welche aufweist: eine Einrichtung, die die Faserbahn vorwärts transportiert zwischen mindestens zwei Einlaßöffnungen (24, 28), über die heißes Gas in die Faserbahn einleitet wird und die sich an gegenüberliegenden Seiten der Faserbahn befinden, und mindestens zwei Gasauslaßöffnungen (26, 30), über die das in die Faserbahn (14) eingeleitete Gas entweichen kann und die sich ebenfalls an gegenüberliegenden Seiten der Faserbahn befinden, **dadurch gekennzeichnet, daß** sowohl die Gasauslaßöffnungen (26, 30) als auch die Gaseinlaßöffnungen (24, 28) längliche Form haben und sich parallel zur Bewegungsrichtung der Faserbahn (14) erstrecken, und daß sich jede Auslaßöffnung (26, 30) benachbart zur entsprechenden Einlaßöffnung (24, 28) befindet, so daß das in die Faserbahn (14) eingeleitete Gas, ohne eine

wesentliche Bewegung innerhalb der Faserbahn (14), aus der Faserbahn entweicht.

12. Vorrichtung nach Anspruch 11, **dadurch gekennzeichnet, daß** jede Gasauslaßöffnung (26, 30) mit einer oder mehreren Gaseinlaßöffnungen über eine Rohrleitung (40, 18) verbunden ist, die eine Gaspumpe (44) und optional eine Heiz- oder eine Kühleinrichtung (42) aufweist.

Revendications

1. Procédé pour traiter thermiquement une nappe (1, 14) de fibres minérales en déplacement, dans lequel des courants de gaz chaud dirigés en sens opposés sont introduits dans la nappe de fibres à partir des faces opposées de celle-ci à travers des zones d'entrée (2 ; 24, 28) et dans lequel les courants de gaz ainsi introduits sortent par la même face que celle par laquelle ils sont introduits, à travers des zones de sortie (3 ; 26, 30), **caractérisé** en ce que les zones de sortie (3 ; 26, 30) sont situées en adjacence aux zones d'entrée (2 ; 24, 28), de telle manière que les courants de gaz peuvent quitter la nappe (1, 14) sans déplacement substantiel dans la direction longitudinale ou transversale de la nappe (1, 14).

2. Procédé selon la revendication 1, **caractérisé** en ce que les zones d'entrée de gaz (2 ; 24, 28) et les zones de sortie de gaz (3 ; 26, 30) sont oblongues.

3. Procédé selon la revendication 1 ou 2, **caractérisé** par le traitement d'un produit fibreux minéral contenant un liant de thermodurcissement à l'aide de courants de gaz chaud présentant une température au-dessus de la température de durcissement du liant pour durcir le liant.

4. Procédé selon la revendicaion 1, 2 ou 3, **caractérisé** en ce que les zones d'entrée de gaz (2 ; 24), à travers lesquelles le gaz chaud est délivré à partir de la première face du produit fibreux (1, 14), sont situées exactement en face des zones d'entrée de gaz (2, 28), à travers lesquelles le gaz est introduit à partir de la face opposée.

5. Procédé selon la revendication 1, 2 ou 3, **caractérisé** en ce que les zones d'entrée de gaz (2 ; 24, 28), à travers lesquelles un courant de gaz chaud est introduit dans le produit fibreux (1, 14) à partir de la première face de celui-ci chevauchent partiellement les zones d'entrée de gaz (2 ; 24, 28) à travers lesquelles un courant de gaz chaud est introduit dans le produit fibreux (1, 14) à partir de la face opposée.

6. Procédé selon la revendication 5, **caractérisé** en ce que l'aire sur laquelle une zone d'entrée de gaz (2 ; 24, 28) d'une face du produit fibreux chevauche la zone correspondante d'entrée de gaz (2 ; 24, 28) de l'autre face constitue au moins 25 % de la plus petite des deux zones.

7. Procédé selon l'une quelconque des revendications 3 à 6, **caractérisé** par le maintien, dans les zones d'entrée de gaz (2 ; 24, 28), d'une pression qui dépasse la pression atmosphérique, et par le maintien d'une pression atmosphérique ou subatmosphérique dans les zones de sortie de gaz (3 ; 26, 30).

8. Procédé selon la revendication 2, **caractérisé** en ce que les largeurs des zones d'entrée de gaz (2 ; 24, 28) sont supérieures ou égales aux largeurs des zones de sortie de gaz (3 ; 26, 30).

9. Procédé selon la revendication 2, **caractérisé** en ce que les zones oblongues d'entrée d'air (2 ; 24, 28) sont divisées longitudinalement pour former des sections distinctes.

10. Procédé selon la revendication 9, **caractérisé** en ce que des différences de pression différentes sont maintenues entre une section d'une zone d'entrée de gaz (2 ; 24, 28) et la zone adjacente de sortie de gaz (3 ; 26, 30) et entre la ou les sections restantes et la ou les zones adjacentes de sortie de gaz dans des sections adjacentes.

11. Dispositif pour traiter thermiquement une nappe de fibres en déplacement (14) à l'aide de courants de gaz chaud, comportant des moyens pour faire avancer la nappe de fibres entre au moins deux ouvertures d'entrée(24, 28) pour introduire du gaz chaud dans la nappe et étant situées sur des côtés opposés de la nappe, et au moins deux ouvertures de sortie de gaz (26, 30) pour faire sortir le gaz introduit dans la nappe (14), également situées sur des côtés opposés de la nappe, **caractérisé** en ce que les ouvertures de sortie de gaz (26, 30) et les ouvertures d'entrée de gaz (24, 28) sont toutes oblongues et s'étendent parallèlement à la direction de déplacement de la nappe fibreuse (14), et en ce que chaque ouverture de sortie (26, 30) est située en ajacence à l'ouverture correspondante d'entrée (24, 28), de manière que le gaz introduit dans la nappe (14) quitte la nappe sans déplacement substantiel dans la nappe (14).

12. Dispositif selon la revendication 11, **caractérisé** en ce que chaque ouverture de sortie de gaz (26, 30) est reliée à une ou plusieurs ouverture(s) d'entrée de gaz par une conduite (40, 18) comportant une pompe à gaz (44) et le cas échéant des moyens (42) de chauffage ou de refroidissement.

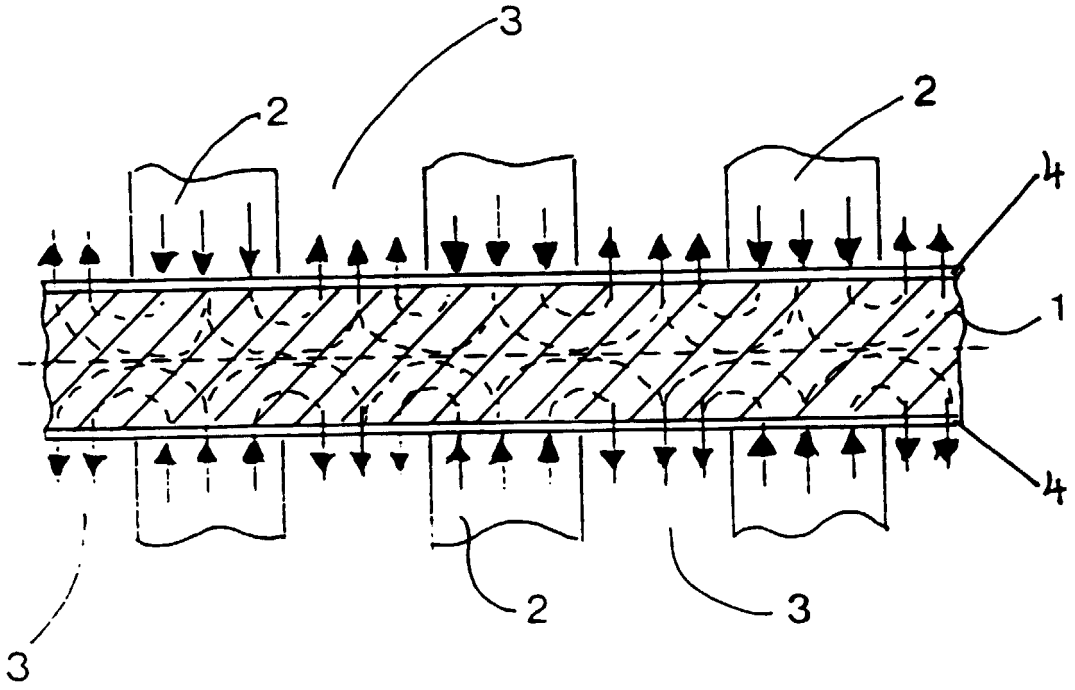

FIG. 1

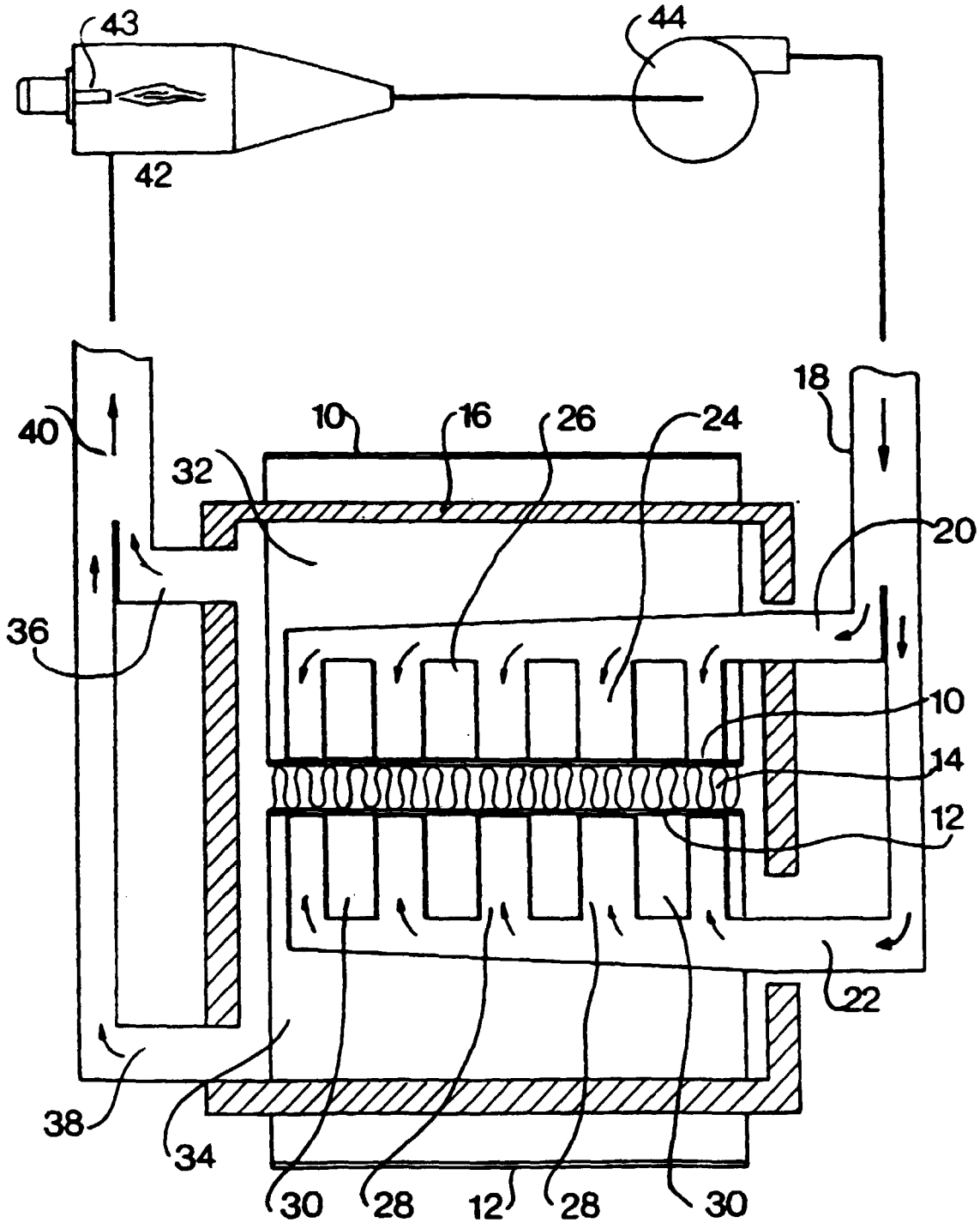

Fig. 2

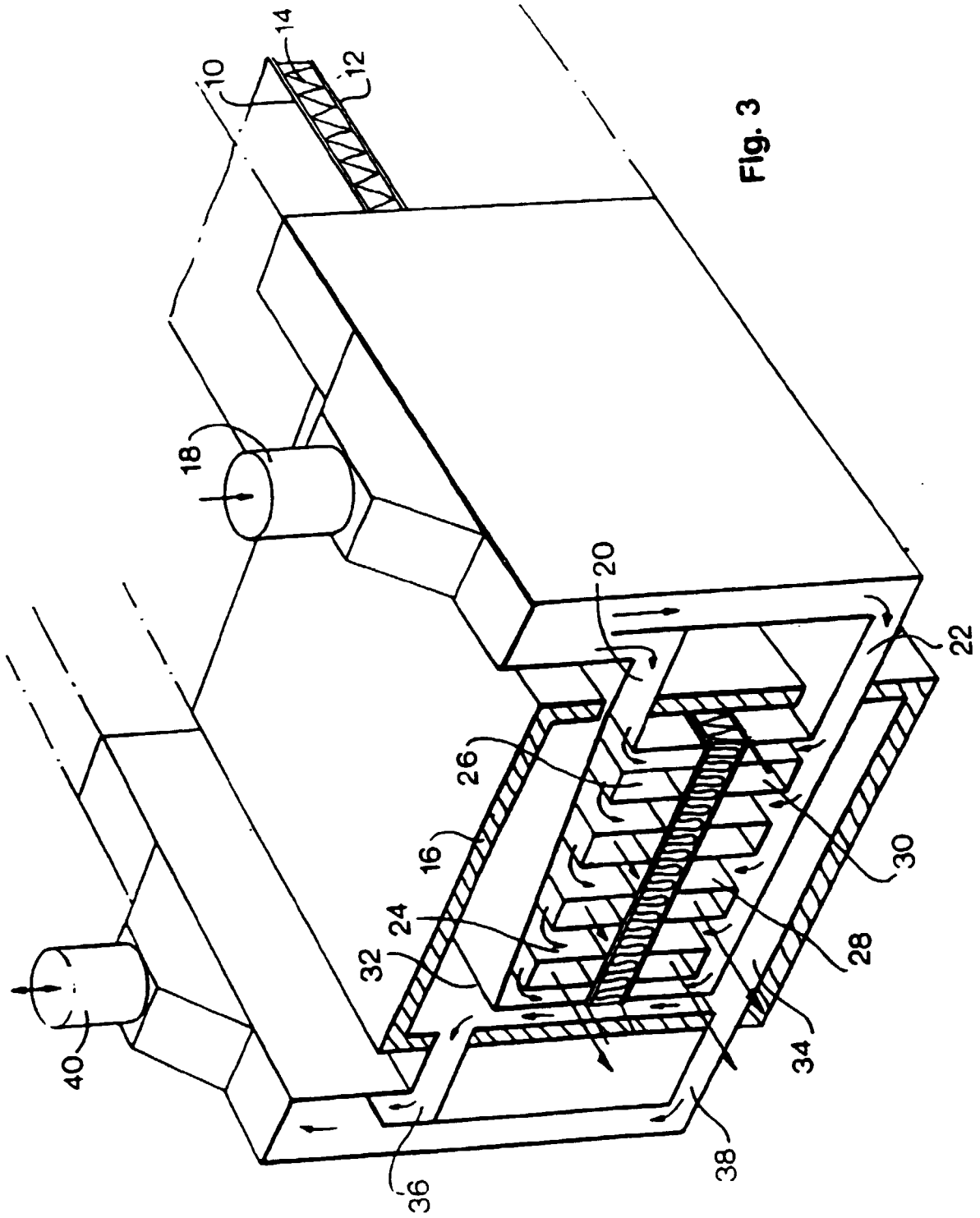

Fig. 3