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(54) **Spray booth**

Spritzkabine

Cabine de pulvérisation

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Description

[0001] The present invention concerns a spray booth. More particularly, the invention concerns a spray booth of the kind equipped with means for generating a forced airflow capable of avoiding inhalation of harmful volatile products by the operator.

[0002] An example of spray booth of the known kind is disclosed in EP 1 120 168 A.

[0003] Spray booths of the above kind are widely used for painting vehicle bodyworks, frames, aircraft parts and so on, but they can also be used for other processes, such as applying lutes and other materials involving volatile product exhalation.

[0004] It is known that particularly harmful volatile substances are used in all such processes. Although in industrial applications automatic robots are often used to operate inside the booth, resorting to one or more operators for the whole process or anyway for specific operations or final touches is not infrequent.

[0005] To avoid the risk that the operator(s) inhale(s) harmful substances, the present regulations require that a forced airflow is generated in the booth, with a suitable speed to quickly and constantly evacuate harmful substances.

[0006] Since the airflow is to be constantly maintained during the process and it must have a suitable speed (about 0.5 m/sec), it is necessary to provide suitably sized aspirators and/or fans that, of course, are strongly energy consuming.

[0007] Moreover, in many regions in the world and for several months in the year, the air introduced into the booth is to be heated or cooled to reach a comfortable temperature for the operator.

[0008] A further problem related with the use of spray booths of the described kind is the need to decontaminate the exhausted air before discharging it again into the outer environment.

[0009] Due to the considerable amount of air passing through the booth, decontaminating equipment capable of bearing so heavy a working load are therefore required. Indeed, it is to be remembered that conventional spray booths have a great volume (e.g. in aerospace industry booths with a surface area exceeding 100 m² are used).

[0010] An example of a spray booth or a paint boot that ensures an efficient exhaust of harmful volatile materials is disclosed in US-A-4, 926, 746; according to this document, it is provided that just a portion of the paint booth, which is large enough to allow a worker to move about inside, is air ventilated.

[0011] The known paint booth does not solve the problem of efficiently determining the position of the worker, and, consequently, where exactly the air ventilation is required.

[0012] Therefore, it is an object of the present invention to provide a spray booth that ensures the optimum and efficient exhaust of harmful volatile materials so as to meet the existing regulations and that does not have the

above drawbacks.

[0013] The above and other objects are achieved by the spray booth as claimed in the appended claims.

[0014] The invention is based on the assumption that it is not necessary to ventilate the whole of the booth at the above mentioned speed, but only those areas inside the booth where the operators are present. Indeed, harmful substance emission, being related with the working cycle, is concentrated only where the operators are present. Moreover, a quick and effective exhaust of said substances is required only where the operators are present.

[0015] The spray booth according to the invention is characterised by the use of a set of independent aeration systems, each capable of effectively ventilating a portion of reduced volume of the booth itself.

[0016] Moreover the invention entails the use of means capable of detecting at any instant the position(s) of the operator(s) present inside the spray booth. In such manner, it is possible to actuate only those ventilation systems corresponding to the sections where the operators are present.

[0017] Advantageously, thanks to the splitting of the booth volume, a considerable energy saving is achieved with an important reduction in the operating costs, without thereby substantially adding to the booth manufacturing costs.

[0018] Moreover, according to the invention, the operator can safely work, since the necessary airflow is ensured in the section he occupies in any working phase.

[0019] A preferred exemplary embodiment of the invention will now be better disclosed with reference to the accompanying drawings, in which:

- Fig. 1 is a diagrammatic side view of a spray booth according to the invention;
- Fig. 2 is a cross-sectional view along line II - II of the spray booth shown in Fig. 1;
- Fig. 3 is a diagrammatic side view of a spray booth according to a second preferred embodiment.

[0020] Referring to Fig. 1, there is shown a spray booth according to the invention, generally denoted by reference numeral 1 and comprising a base 1a, side walls 1b to 1e and a ceiling 1f. Such parts define a substantially free room for housing one or more articles to be processed.

[0021] The floor of spray booth 1 is divided into a set of platforms (P1, P2...Pn) that notionally divide said booth 1 into a set of adjacent regions Z1, Z2...Zn. Each region Z1, Z2...Zn is equipped with an independent ventilation system, comprising at least one blower and one aspirator, disclosed in more detail hereinafter.

[0022] As it will be better disclosed hereinbelow, platforms P1, P2...Pn are connected to pressure sensitive detectors. In this manner, thanks to the pressure exerted by the weight of operator 3 onto the various platforms, it is always possible to locate operator 3 himself within

spray booth 1 and to suitably actuate the ventilation system.

[0023] Referring to Fig. 1, when operator 3 is on platform P_i , the ventilation system is actuated only for region Z_i and for adjacent region Z_j , i. e. for the regions where removal of harmful volatile substances by means of the airflow is actually necessary. The ventilation systems associated with the other regions keep inactive, thereby allowing a considerable energy saving.

[0024] Fig. 2 schematically shows the ventilation system of spray booth 1.

[0025] Each region Z_i of spray booth 1 may be subdivided into a central portion C_i , which is used for spray operations, an upper portion M_i , called "plenum", and a lower portion F_i , devoted to the system filtering the air used for ventilation.

[0026] Ducts 5 located at both sides of central portion C_i are connected to blowers, not shown in the drawing. Said blowers send an airflow at a temperature and a speed suitable for meeting the present regulations through plenum M_i and into central portion C_i , so as to reach the operator and the surrounding environment.

[0027] The airflow, now contaminated by the volatile substances present in central portion C_i , arrives at lower portion F_i of booth 1 through platforms P_i .

[0028] In the preferred embodiment shown in Fig. 2, lower portion F_i is devoted to a wet filtering system 13. The contaminated airflow is made to pass through water supplied by taps 15 and is collected at the bottom of filtering system 13. In this way, most of the harmful substances carried by the airflow are deposited into water, where they can more easily be confined.

[0029] The partly decontaminated air is then sucked into ducts 19 thanks to the action of aspirators, not shown in the drawing, provided in the same ducts 19.

[0030] The aspirators force the airflow along a fixed path. Air is then sent to suitable decontaminating equipment (comprising e.g. a set of carbon filters) before being exhausted into the external environment.

[0031] It is self evident that the blowers and the aspirators are so sized that they ensure effective ventilation of the volume of the only central portion C_i of region Z_i .

[0032] Fig. 2 diagrammatically shows also the operation of platforms P_i , on which the selective ventilation of spray booth 1 is based.

[0033] Platforms P_i consist of movable grids, linked to a stationary floor 8 through a set of resilient joints 11. Thanks to the deformation of joints 11 because of the weight of operator 3, it is possible to detect on which platform P_i operator 3 is and, consequently, to actuate or to stop the ventilation system of region Z_i .

[0034] Fig. 3 diagrammatically shows a second preferred embodiment of the invention. Said embodiment differs from the previous one in respect of the means used for selectively ventilating the region of booth 1 where operator 3 is.

[0035] Instead of using independent blowers and aspirators for each booth region $Z_1, Z_2 \dots Z_n$, here a single

blower is used, sending the forced airflow into upper portion M (the so-called plenum) of booth 1.

[0036] Plenum M is separated from the underlying room by a set of partitions or shutters $S_{1u}, S_{2u} \dots S_{nu}$ in register with the underlying platforms $P_1, P_2 \dots P_n$. Similarly, second partitions or shutters $S_{1d}, S_{2d} \dots S_{nd}$ are present beneath platforms $P_1, P_2 \dots P_n$.

[0037] If, referring to Fig. 3, operator 3 is on platform P_i , only upper shutters S_{iu} and S_{ju} and the corresponding lower shutters S_{id} and S_{jd} are opened, whereas all remaining shutters remain closed. Thus, the airflow will concern only regions Z_i and Z_j where operator 3 is present.

[0038] Clearly, the system of platforms connected to pressure detectors arranged to detect the operator's position is typical of the illustrated embodiment. The spray booth of the invention can use any means for detecting the operator's position inside it. For instance, use can be made of photocells or portable transmitters worn by the operators and associated with a receiver connected to the ventilation system.

[0039] Similarly, the use of a plurality of blowers and aspirators is typical of the illustrated embodiment. Similar results could be achieved for instance by using a single, centralised ventilation system for the whole booth, jointly with a set of valves or partitions arranged to direct the airflow to the desired sections only.

[0040] In the disclosed embodiments, ventilation systems creating a downward vertical airflow have been used. Clearly however the spray booth of the invention can suitably use ventilation systems creating an upward vertical airflow or a laterally directed airflow.

[0041] By way of non limiting example, an estimation is given of the energy saving attainable by using the ventilation system according to the invention in a spray booth 15 m long, 7 m wide and 5 m high. Said booth has a volume of 525 m^3 and its base has a surface area of 105 m^2 .

[0042] It is assumed that a forced airflow at a speed of 0.5 m/s is to be sent, after heating air by 10°C to bring it to a comfortable temperature for the operator.

[0043] If a prior art spray booth is used, since the whole booth is to be reached by the same airflow, an air flow rate of $189,000 \text{ m}^3$ per hour is required and $567,000 \text{ Kcal}$ per hour have to be used for heating said air.

[0044] If the spray booth of the invention is used, let us assume that the booth length is divided into sections 2 m long and that only the two sections adjacent to the operator are ventilated. In this case, the volume to be ventilated decreases from 525 m^3 to 140 m^3 . Under these assumptions, an airflow rate of $50,400 \text{ m}^3$ per hour and $151,200 \text{ Kcal}$ per hour to heat said air are sufficient.

[0045] The spray booth of the invention affords an energy saving of $415,800 \text{ Kcal}$ per hour. If a period of 100 workdays is considered, during which the booth is used 24 hours a day, said energy saving corresponds to about $199,584 \text{ Kg}$ fuel.

[0046] Advantageously moreover a considerable sav-

ing in the installation and operation costs of the air decontaminating system will be achieved, since the amount of air to be decontaminated when leaving the booth is substantially reduced.

[0047] By way of example only, an approximate calculation of the cost savings attainable with the booth of the previous example is given, assuming that the booth has to operate 220 days per year, 24 hours a day.

[0048] When using a prior art booth, the volume of air to be exhausted will be 189,000 m³. The actual cost for setting up a decontaminating system meeting the existing regulations for the above air amount is about 2 to 2.5 Millions Euros.

[0049] Assuming on the contrary that the booth is made in accordance with the present invention, the volume of air to be decontaminated will be 50,400 m³ only, with a cost for setting up the decontaminating and recovery system of about 1 to 1.25 Millions Euros.

[0050] By comparing the amounts of the two illustrated examples, a cost saving of about 1 to 1.5 Millions Euros can be seen.

Claims

1. A spray booth (1) comprising a base (1a), side walls (1b to 1e) and a ceiling (1f), defining inside them a substantially free room for housing one or more articles to be processed, wherein said booth (1) is equipped with means for generating inside said room a forced airflow capable of quickly changing air contained therein, wherein said booth (1) is equipped with means for detecting the position of the operator (3) inside the booth and is divided into adjacent regions or portions (Z1, Z2...Zn), each equipped with corresponding means for generating said forced airflow, said generating means being actuated and stopped so as to confine said flow in the region substantially occupied by the operator (3);
characterised in that the means for detecting the exact position of the operator (3) comprise a portable transmitter worn by the operator (3) and a receiver tuned to the frequency of said transmitter and connected to a system controlling the ventilation of the booth (1).
2. A spray booth (1) according to claim 1, **characterised in that** it comprises a floor beneath which at least one filtering station (13) is provided for filtering the contaminated airflow.
3. A spray booth (1) according to claim 2, **characterised in that** the filtering station (13) comprises a wet filtering system and a plurality of carbon filters.
4. A spray booth (1) according to claim 1, **characterised in that** the means for detecting the exact position of the operator (3) comprise a set of platforms

(P1, P2...Pn) connected with detectors responsive to the pressure exerted by the weight of the operator (3).

5. A spray booth (1) according to claim 1, **characterised in that** the means for detecting the exact position of the operator (3) further comprise a set of photocells located on the booth walls (1b to 1e) so as to form a grid defining the portions (Z1, Z2...Zn) of the booth (1).
6. A spray booth (1) according to claim 1, **characterised in that** the means for generating the airflow in the portions (Z1, Z2...Zn) of the booth (1) comprise at least one blower and at least one aspirator for each said portion (Zi) of the booth (1), and **in that** said blower and said aspirator are controllable independently of the blowers and aspirators of the adjacent portions.
7. A spray booth (1) according to claim 1, **characterised in that** the means for generating the airflow in the portions (Z1, Z2...Zn) of the booth (1) comprise: a blower in communication with the upper booth portion or plenum (M); a set of independent upper shutters (S1u, S2u... Snu) in said plenum, which shutters can be opened and closed to define a fixed path for the airflow coming from the blower, wherein said path is arranged to lead from the blower to anyone of the portions (Zi) of the booth (1); a set of lower shutters (S1d, S2d ... Snd) in the floor of the booth, said lower shutters being in register with said upper shutters; and an aspirator in communication with a lower booth portion located beneath said floor, and in communication with the internal room of the booth through said lower shutters.

Patentansprüche

1. Eine Spritzkabine (1) weist einen Unterbau (1 a), Seitenwände (1 b bis 1e) und eine Decke (1f) auf, die in ihrem Inneren einen im Wesentlichen freien Raum zur Unterbringung von einem oder mehreren zu bearbeitenden Gegenständen bilden, wobei die Kabine (1) mit Einrichtungen zur Erzeugung einer forcierten Luftströmung in diesem Raum ausgestattet ist, die in der Lage ist, die darin enthaltene Luft schnell auszutauschen und wobei die Kabine (1) mit Einrichtungen zur Bestimmung der Position einer Bedienungsperson (3) in der Kabine ausgerüstet ist und in nebeneinander liegende Bereiche oder Abschnitte (Z1, Z2...Zn) eingeteilt ist, jeder mit entsprechenden Einrichtungen zur Erzeugung der forcierten Luftströmung ausgestattet und diese Generatoren betätigt und abgestellt werden, um so die Strömung in dem im Wesentlichen von dem Bedienungsmann (3) besetzten Bereich zu begrenzen,

- dadurch gekennzeichnet, dass** die Einrichtungen zur Bestimmung der genauen Position der Bedienungsperson (3) einen von der Bedienungsperson (3) getragenen tragbaren Sender und einen auf die Frequenz des Senders abgestimmten Empfänger aufweist, der an ein System zur Steuerung der Belüftung der Kabine (1) angeschlossen ist.
2. Spritzkabine (1) nach Anspruch 1, **dadurch gekennzeichnet, dass** sie unten einen Boden mit mindestens einer Filterstation (13) umfasst, die zur Filterung der verunreinigten Luftströmung vorgesehen ist.
3. Spritzkabine (1) nach Anspruch 2, **dadurch gekennzeichnet, dass** die Filterstation (13) ein Nassfiltersystem und eine Vielzahl von Kohlefiltern umfasst.
4. Spritzkabine (1) nach Anspruch 1, **dadurch gekennzeichnet, dass** die Einrichtungen zur Bestimmung der genauen Position der Bedienungsperson (3) eine Gruppe von Plattformen (P1, P2...Pn) aufweist, die mit Fühlern verbunden sind, die auf den vom Gewicht der Bedienungsperson (3) ausgeübten Druck ansprechen.
5. Spritzkabine (1) nach Anspruch 1, **dadurch gekennzeichnet, dass** die Einrichtungen zur Bestimmung der genauen Position des Bedienungsmannes (3) weiter einen an den Spritzkabinenwänden (1b bis 1e) angeordneten Satz von Fotozellen umfassen, um ein die Abschnitte (Z1, Z2...Zn) der Kabine (1) definierendes Netzwerk zu bilden.
6. Spritzkabine (1) nach Anspruch 1, **dadurch gekennzeichnet, dass** die Einrichtungen zur Erzeugung des Luftstroms in den Bereichen (Z1, Z2...Zn) der Kabine (1) mindestens ein Gebläse und mindestens eine Absaugung für jeden Abschnitt (Zi) der Kabine (1) umfassen und dass das Gebläse und die Absaugung unabhängig von den Gebläsen und Absaugungen der benachbarten Abschnitte steuerbar sind.
7. Spritzkabine (1) nach Anspruch 1, **dadurch gekennzeichnet, dass** die Generatoren für den Luftstrom in den Abschnitten (Z1, Z2...Zn) der Kabine (1) Folgendes umfassen: ein Gebläse in Verbindung mit dem oberen Kabinenabschnitt oder Raum (M); eine Gruppe von unabhängigen oberen Klappen (S1 u, S2u...Snu) in diesem Raum und jene Klappen geöffnet und geschlossen werden können, um einen von dem Gebläse ausgehenden festgelegten Weg des Luftstroms zu bestimmen, wobei dieser Weg zur Kanalisierung vom Gebläse zu irgendeinem der Abschnitte (Zi) der Kabine (1) angeordnet ist; eine Gruppe von unteren Klappen (S1d, S2d...Snd) im Boden der Kabine, wobei diese unteren Klappen mit den oberen Klappen zusammenpassen; sowie eine Absaugung in Verbindung mit einem unter dem Boden angeordneten unteren Kabinenabschnitt und durch die unteren Klappen in Verbindung mit dem Innenraum der Kabine.
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- 10 **Revendications**
1. Cabine de pulvérisation (1) comprenant une base (1a), des parois latérales (1b à 1e) et un plafond (1f), définissant entre eux une enceinte essentiellement libre permettant de loger un ou plusieurs produits à traiter, dans laquelle ladite cabine (1) est équipée de moyens servant à produire à l'intérieur de ladite enceinte une circulation d'air forcée capable de changer rapidement l'air qui y est contenu, dans laquelle ladite cabine (1) est équipée de moyens permettant de détecter la position de l'opérateur (3) à l'intérieur de la cabine et est divisée en zones ou parties adjacentes (Z1, Z2 ... Zn), chacune étant dotée de moyens correspondant pour produire ledit flux d'air forcé, lesdits moyens de production étant mis en action et arrêtés de façon à confiner ledit flux dans la zone essentiellement occupée par l'opérateur (3) ; **caractérisée en ce que** les moyens permettant de détecter la position exacte de l'opérateur (3) comporte un émetteur portable porté par l'opérateur (3) et un récepteur accordé sur la fréquence dudit émetteur et connecté à un système contrôlant la ventilation de la cabine (1).
2. Cabine de pulvérisation (1) selon la revendication 1, **caractérisée en ce qu'elle** comprend un plancher au-dessous duquel au moins un poste de filtration (13) est prévu pour filtrer le flux d'air contaminé.
3. Cabine de pulvérisation (1) selon la revendication 2, **caractérisée en ce que** le poste de filtration (13) comporte un système de filtration humide et une pluralité de filtres de carbone.
4. Cabine de pulvérisation selon la revendication 1, **caractérisée en ce que** les moyens permettant de détecter la position exacte de l'opérateur (3) comprennent un ensemble de plateformes (P1, P2 ... Pn) connectées par des détecteurs sensibles à la pression exercée par le poids de l'opérateur (3).
5. Cabine de pulvérisation (1) selon la revendication 1, **caractérisée en ce que** les moyens permettant de détecter la position exacte de l'opérateur (3) comprennent, de plus, un ensemble de cellules photoélectriques situées sur les parois de la cabine (1b à 1e) de façon à former une grille définissant les parties (Z1, Z2 ... Zn) de la cabine (1).
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6. Cabine de pulvérisation selon la revendication 1, **caractérisée en ce que** les moyens permettant de produire le flux d'air dans les parties (Z1, Z2 ... Zn) de la cabine (1) comportent au moins un ventilateur soufflant et au moins un ventilateur extracteur pour chaque dite partie (Zi) de la cabine (1), et **en ce que** ledit ventilateur soufflant et ledit ventilateur extracteur peuvent être commandés indépendamment des ventilateurs soufflants et des ventilateurs extracteurs des parties adjacentes. 5 10
7. Cabine de pulvérisation (1) selon la revendication 1, **caractérisée en ce que** les moyens permettant de produire le flux d'air dans les parties (Z1, Z2 ... Zn) de la cabine (1) comprennent : un ventilateur soufflant en communication avec la partie supérieure de la cabine ou collecteur d'air (M) ; un ensemble d'obturateurs supérieurs indépendants (S1u, S2u, ... Snu) dans ledit collecteur d'air, lesquels obturateurs peuvent être ouverts et fermés en vue de définir une trajectoire fixe pour ledit flux d'air venant du ventilateur soufflant, dans laquelle ladite trajectoire est agencée en vue de conduire du ventilateur soufflant vers l'une quelconque des parties (Zi) de la cabine (1) ; un ensemble d'obturateurs inférieurs (S1d, S2d ... Snd) dans le plancher de la cabine, lesdits obturateurs inférieurs étant en alignement avec lesdits obturateurs supérieurs ; et un ventilateur extracteur en communication avec une partie inférieure de la cabine placée au-dessous dudit plancher, et en communication avec l'enceinte interne de la cabine par l'intermédiaire desdits obturateurs inférieurs. 15 20 25 30

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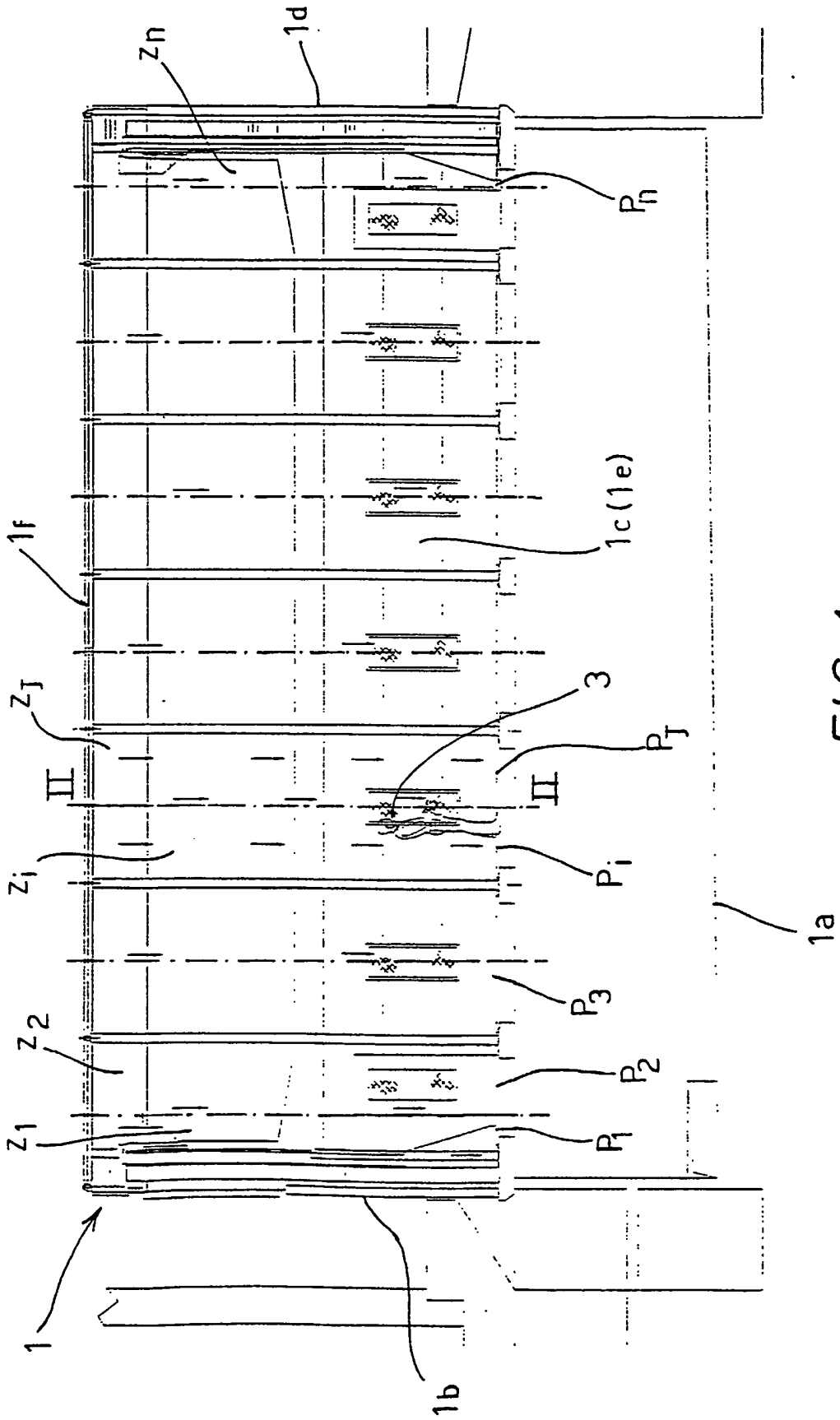


FIG. 1

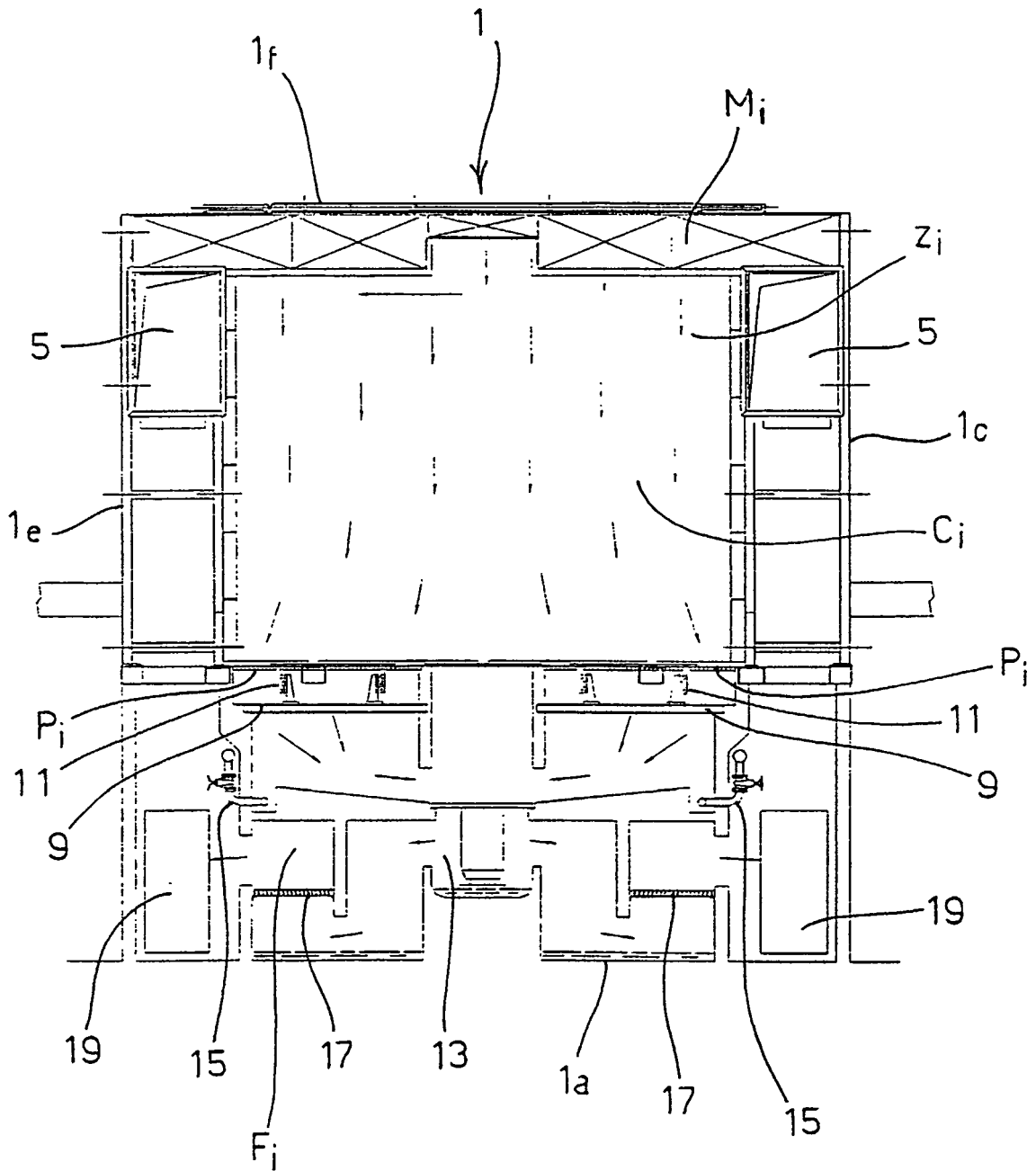


FIG. 2

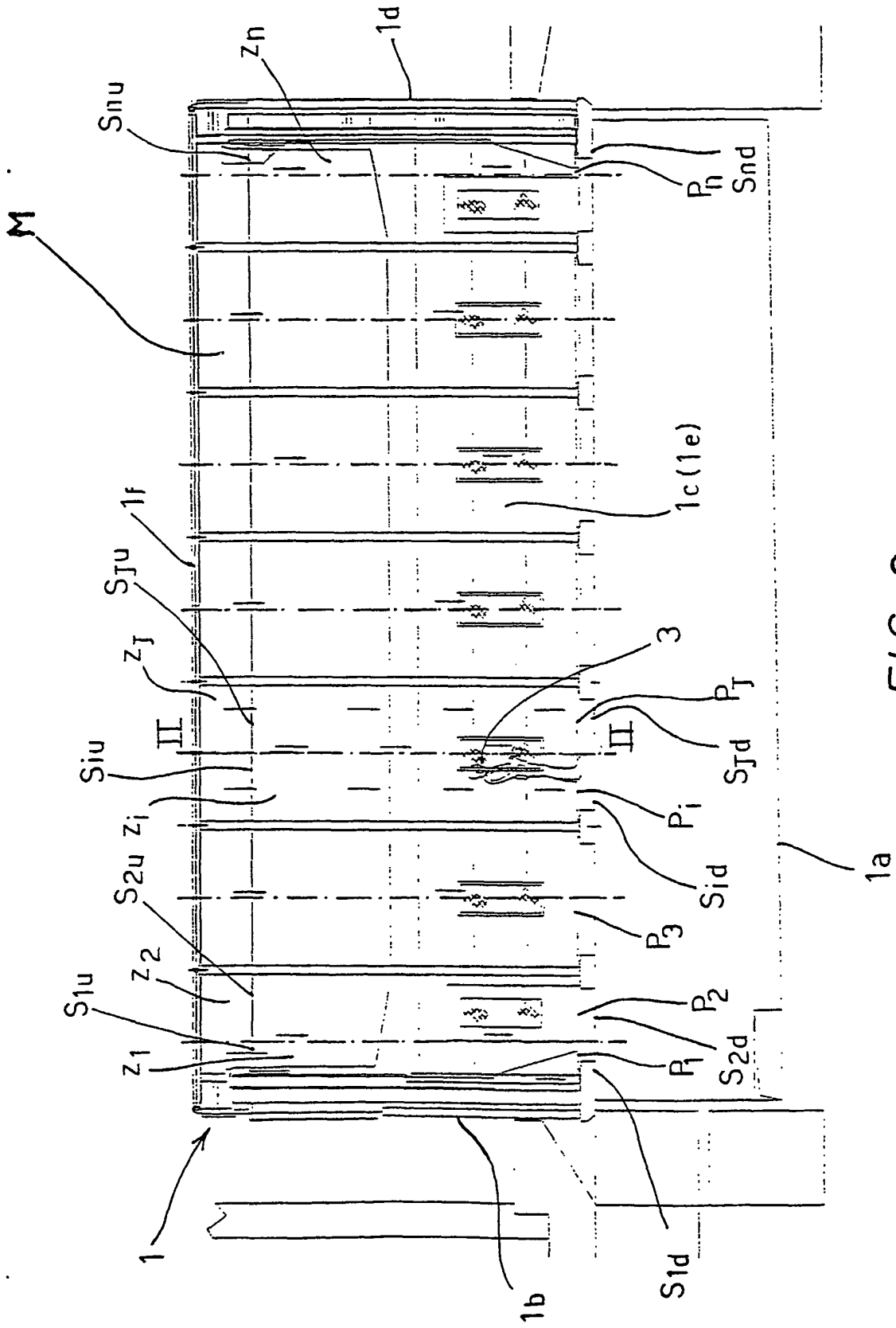


FIG. 3

REFERENCES CITED IN THE DESCRIPTION

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