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(54) **Convection barrier**

(57) A convection barrier (2) for a freezer (1) comprises a plurality of individual flaps (20) arranged one above the other in a manner such as to be capable of forming a closed curtain of individual flaps (20), with each individual flap (20) extending over a predetermined width corresponding at least to the width of the interior of the freezer and being pivotable (5) between a closed position and an open position so as to allow access to the interior of the freezer when the flap (20) is in the open position, and actuation means (24,240) attached to the individual flaps (20) for allowing an actuator (40,400) to engage the actuation means (24,240) of an individual flap (20) so as to pivot (5) the said flap (20) between the closed position and the open position.

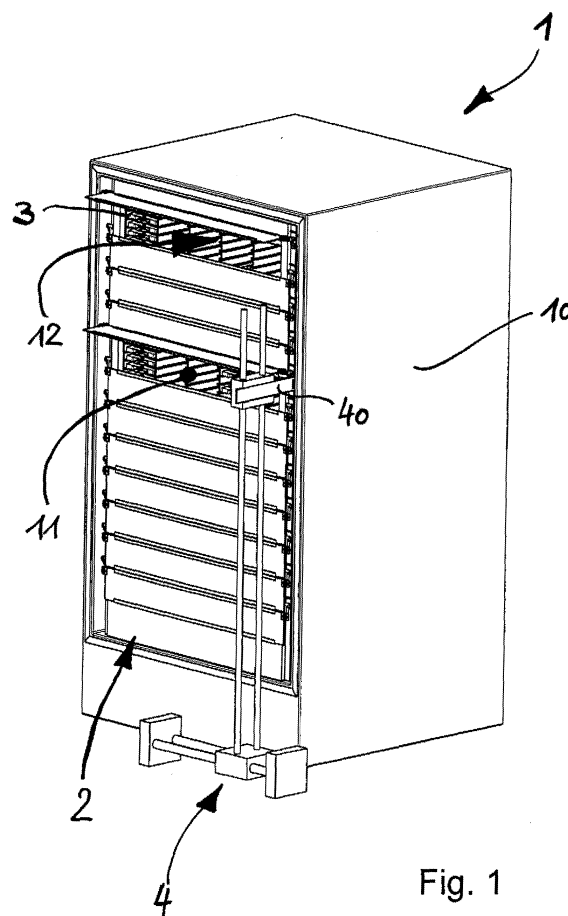


Fig. 1

Description

[0001] The present invention relates to a convection barrier in accordance with the features of claim 1, and to a freezer comprising such convection barrier.

[0002] In clinical studies a wide variety of assays can be carried out to answer questions related to diagnosis (e.g. biomarker), treatment (e.g. efficacy of a drug) and prevention of diseases.

[0003] Large sample collections of biological samples can be established e.g. within the context of clinical studies. Such biological samples can be e.g. blood samples (whole blood, plasma, serum), urine samples, tissue samples, or samples containing cells (e.g. primary cells, stem cells), proteins, DNA, RNA (RNAi, mRNA), or antibodies.

[0004] An automated facility for storing biological samples at -80°C is used in the UK biobank and is described, for example, in the article "Designing and implementing a largescale automated -80°C archive" by Justin M. Owen and Peter Woods, published in the International Journal of Epidemiology 2008; 37: i56-i61 (doi: 10.1093/ije/dym293). The store described therein comprises a system of drawers arranged in a manner so as to form a shelf, which allows robotic access to the biological samples whilst maintaining storage conditions. The drawers can be opened individually by the robot pulling the respective drawer outwards so as to allow access to the interior of the drawer where the biological samples are stored.

[0005] However, this system has some disadvantages. Firstly, at its front surface each drawer is provided with a block made of styrene in a manner such that the styrene blocks of adjacently arranged drawers abut against one another. Upon opening an individual drawer by pulling the said drawer outwardly, this does inherently bear the risk that an adjacently arranged drawer is also pulled out although this is not intended and may cause an unwanted temperature rise of the stored samples. Also, the small but continuous leakage of cold air (or cold nitrogen) at the butt faces of adjacent styrene blocks is in total comparatively high, since the -80°C storage compartments do not have front doors permitting a tight separation of the -80°C areas from the -20°C areas in the system.

[0006] Cooling of a complete humidity controlled room for storing biological samples as described above to about -80°C (or below) is generally feasible. However, at said temperatures standard handling devices, such as for example robots, usually do not work properly. Therefore, particularly for long-term storage of biological samples, specific -80°C freezers are typically used.

[0007] Such freezers for long term storage of samples usually have a tight and thermally insulating door which separates the environment outside the freezer from the -80°C interior of the freezer. In a so-called "robotic store", a plurality of such freezers is arranged in a -20°C room as well as a robot for taking the samples out of the re-

spective freezer. As mentioned above, the robot cannot be arranged in a -80°C environment, since this simply is not economically feasible in such an environment, and in addition maintenance of the robot would be difficult then. Instead, the robot is arranged outside the freezers in the -20°C environment where it is capable of working properly. However, particularly with conventional upright standing freezers certain problems may arise. Firstly, upon having opened the door in order to allow the robot to access the interior of the freezer, the -80°C cooled air flows out of the interior of the freezer while at the same time -20°C air flows from the environment into the interior of the freezer thus leading to a rise in temperature and humidity within the freezer. This is all the more the case, since the door of the freezer usually must remain open for a considerable period of time until the desired sample (or a number of samples) has been taken out by the robot. Secondly, opening and closing of the door results in a negative pressure inside the freezer which makes the door extremely difficult to get opened again until the negative pressure is equalized by inflowing air, e.g. through the sealing of the door of the freezer or through a pressure equilibration valve in the wall of the freezer. This usually takes a considerable period of time which may amount up to 30 minutes, for example. In addition, the cooling down of the -20°C air which is more humid than the -80°C air results in formation of ice within the freezer. Accordingly, defrosting of the freezer is required more often.

[0008] It is therefore an object of the invention to overcome the afore-mentioned disadvantages and to suggest suitable measures to avoid or at least greatly reduce the above-described scenarios. Also, loss of energy should be reduced to a minimum while at the same time frequent access to the stored biological samples should be possible.

[0009] This objective is achieved through a convection barrier as it is specified by the features of the independent claim directed to such convection barrier, and through a freezer comprising such convection barrier. Specific advantageous embodiments are specified by the features of the dependent claims.

[0010] In particular, the convection barrier for a freezer in accordance with the invention comprises:

- a plurality of individual flaps arranged one above the other in a manner such as to be capable of forming a closed curtain of individual flaps, with each individual flap extending over a predetermined width corresponding at least to the width of the interior of the freezer and being pivotable between a closed position and an open position so as to allow access to the interior of the freezer when the flap is in the open position, and
- actuation means attached to the individual flaps for allowing an actuator to engage the actuation means of an individual flap so as to pivot the said flap between the closed position and the open position.

[0011] The curtain formed by the individual flaps covers the opening which allows access to the freezer, so that the -80°C air may not flow out of the freezer as the door of the freezer is open. On the other hand, it must be possible to get access to the desired sample or samples stored in the interior of the freezer. This can be achieved by allowing an actuator (such as a robot or a part thereof) to open an individual flap so as to generate a row-like opening to the interior of the freezer. Depending on where the sample to be accessed is stored in the interior of the freezer, only one of the flaps must be opened so as to allow the robot to get access to the sample. Thus, outflow of -80°C air from the interior of the freezer and inflow of -20°C air to the interior of the freezer is prevented or at least greatly reduced. Accordingly, the above-identified disadvantages of temperature rise in the interior of the freezer, generation of negative pressure making the door of the freezer extremely difficult to open, etc., are prevented or at least greatly reduced.

[0012] For example, the arrangement of flaps forming the closed curtain may be achieved by arranging the flaps in a manner such that the butt faces of adjacently arranged flaps form the tight seal when they are in the closed position. Alternatively, and also by way of example, the arrangement of flaps forming the closed curtain may be achieved by arranging the flaps in a manner such that the flaps at least partially overlap and form the tight seal when they are in the closed position (similar to the tiles of a roof).

[0013] In one embodiment of the convection barrier according to the invention, the individual flaps are provided with a bi-stable locking means being connected to the actuation means for releasably locking the individual flaps in the closed or in the open position, respectively. This embodiment is advantageous since the respective flap can be stably locked in the open or the closed position respectively. In a specific embodiment of the convection barrier according to the invention, the bi-stable locking means comprises a spring, which keeps the flap locked in the open or the closed position with the aid of tensioning forces.

[0014] In a further embodiment of the convection barrier according to the invention, at least on the edges abutting or overlapping the adjacently arranged flap, lips are attached to the individual flaps. Preferably, a lip is attached to at least one of the edges abutting or overlapping the adjacently arranged flap. Such lips serve a plurality of purposes. Firstly, they further improve the seal of the interior of the freezer. Secondly, they form a protection for the material the flaps are made of. And thirdly, they simplify the process of opening and closing the flap, since the frictional coefficient of the material the lips are made of is low. A particularly suitable material for the lips is Teflon® (polytetrafluoroethylene).

[0015] In one embodiment of the convection barrier according to the invention, the individual flaps are made of glass ceramics. Glass ceramics is a material which has only a low thermal conductivity. Thus, the interior of

the freezer is additionally protected against the comparatively "high" temperatures (-20°C) outside the interior of the freezer (where the temperature is about -80°C). Since the glass ceramics has a very small thermal expansion coefficient, the temperature gradient perpendicular to the flaps does not cause bending of the flaps which could give rise to a leakage between adjacent flaps

[0016] As already mentioned further above, a further aspect of the invention relates to a freezer comprising a housing and a door, the housing having an opening allowing access to the interior of the freezer through the opening as the door of the freezer is open. The freezer further comprises a convection barrier as it has already been described with respect to the various embodiments discussed above. The convection barrier is arranged such that the opening allowing access to the interior of the freezer is covered by the flaps of the convection barrier. The advantages correspond to those already discussed above in connection with the various embodiments of the convection barrier, so that they need not be reiterated here.

[0017] Further advantageous aspects of the invention will become apparent from the following description of embodiments of the invention with the aid of the schematic drawings in which:

Fig. 1 shows an embodiment of the freezer according to the invention with an embodiment of the convection barrier according to the invention mounted thereto,

Fig. 2 shows the embodiment of the convection barrier only,

Fig. 3 shows an enlarged perspective view of detail III of Fig. 2, and

Fig. 4 shows an enlarged side view of detail III of Fig. 2.

[0018] Fig. 1 shows a perspective view of an embodiment of a freezer 1 according to the invention with an embodiment of a convection barrier 2 according to the invention mounted thereto, with the door of the freezer not being shown in Fig. 1 for the sake of simplicity. Freezer 1 comprises a housing 10 having an opening 11 at the front side of freezer 1. A plurality of compartments are arranged in the interior 12 of freezer 1, in which drawers 3 carrying trays containing the stored samples can be arranged. Also shown schematically in Fig. 1 are parts of a robot 4 for automated access to the samples, in particular an actuator 40 for opening and closing the flaps of the convection barrier 2.

[0019] The embodiment of the convection barrier 2 according to the invention shown in Fig. 1 mounted to freezer 1 is shown in Fig. 2 prior to being mounted to freezer 1. Convection barrier 2 comprises a plurality of individual flaps 20 mounted to an outer frame 21, with flaps 20 being

adjacently and abuttingly arranged one above the other so that they form a closed curtain when the flaps 20 are in the closed position. However, in Fig. 2 two such flaps 20 are shown in the open position for the sake of better understanding, although in practice usually only one of the flaps 20 is in the open position at a time.

[0020] In Fig. 3 detail III of Fig. 2 is shown in an enlarged perspective view. In Fig. 3 one flap 20 is shown in the open position while both the flap 20 arranged immediately below the open flap 20 and the flap 20 arranged immediately above the open flap 20 are in the closed position.

[0021] On the longitudinal edges of flaps 20 which abut the longitudinal edges of the respective adjacently arranged flaps 20 lips 22 are attached to the flaps 20. By way of example only, lips 22 may be made of Teflon® while flaps 20 may be made of glass ceramics such as those offered under the trademark ROBAX® by Schott AG, Mainz, Germany. Lips 22 serve various purposes, for example they protect the glass ceramics of flaps 20, they improve the thermal seal provided by the convection barrier 2 and they simplify opening and closing of flaps 20 due to the low frictional coefficient of the Teflon® material.

[0022] Flaps 20 are mounted to holders 23 which themselves are fixed to or are an integral part of an actuation means 24 which allows the flap 20 to be pivoted from the closed position to the open position and vice versa. Bi-stable locking means in form of a spring 25 are provided whereby flaps 20 can be locked either in the open or in the closed position. To achieve this, one end of spring 25 is attached to a pin 26 which is fixedly mounted to frame 21 while the other end of spring 25 is mounted to actuation means 24.

[0023] In order to access a specific sample, that flap 20 which allows access to the respective drawer in which the specific sample is stored in a tray must be pivoted from the closed position (the first stable position) to the open position (the second stable position). This is done with the aid of actuator 40 of the robot which engages the actuation means 24 attached to the respective flap 20. For that purpose, actuator 40 comprises a slot 400 and actuation means 24 comprises a pin 240. To perform the pivotal movement of flap 20 indicated by double-headed arrows 5 in Fig. 4, actuator 40 must be moved in a manner to allow pin 240 to enter slot 400 until pin 240 is located at the closed upper end of slot 400. At that time, actuator 40 is to perform a movement essentially corresponding to arrow 5. This results in spring 25 being increasingly tensioned until the pivotal movement has passed that point in which spring 25 is tensioned to the largest extent. Having passed this point spring 25 pulls pin 240 towards the open position, which is the second stable position. Robot 4 (see Fig. 1) may then pull out the respective drawer 3 holding the tray in which the sample to be accessed is contained. It goes without saying that once the sample has been taken out and flap 20 is to be closed again, the process is to be performed in the

reverse direction. In Fig. 4 the two stable positions are shown, with the upper flap 20 being shown in the stable open position while the lower flap 20 is shown in the stable closed position.

[0024] Having described specific embodiments of the convection barrier according to the invention and of the freezer according to the invention, the invention is not limited to the specific embodiments described. Rather, various modifications are conceivable without departing from the teaching of the invention. Therefore, the scope of protection is intended to be defined by the following appended claims.

15 Claims

1. Convection barrier (2) for a freezer (1), comprising
 - a plurality of individual flaps (20) arranged one above the other in a manner such as to be capable of forming a closed curtain of individual flaps (20), with each individual flap (20) extending over a predetermined width corresponding at least to the width of the interior of the freezer and being pivotable (5) between a closed position and an open position so as to allow access to the interior of the freezer when the flap (20) is in the open position, and
 - actuation means (24,240) attached to the individual flaps (20) for allowing an actuator (40,400) to engage the actuation means (24,240) of an individual flap (20) so as to pivot (5) the said flap (20) between the closed position and the open position.
2. Convection barrier according to claim 1, wherein the individual flaps (20) are provided with a bi-stable locking means (25) being connected to the actuation means (24) for releasably locking the individual flaps (20) in the closed or in the open position, respectively.
3. Convection barrier according to claim 2, wherein the bi-stable locking means comprises a spring (25).
4. Convection barrier according to any one of the preceding claims, wherein at least on the edges abutting or overlapping the adjacently arranged flap (20) lips (22) are attached to the individual flaps (22).
5. Convection barrier according to any one of the preceding claims, wherein the individual flaps (20) are made of glass ceramics.
6. Convection barrier according to any one of claims 5 or 6, wherein the lips (22) are made of Teflon.
7. Freezer (1) comprising a housing (10) and a door,

the housing (10) having an opening (11) allowing access to the interior (12) of the freezer (1) through the opening (11) as the door of the freezer is open, wherein a convection barrier (2) according to any one of the preceding claims is arranged such that the opening (11) allowing access to the interior of the freezer (1) is covered by the flaps (20) of the convection barrier (2).

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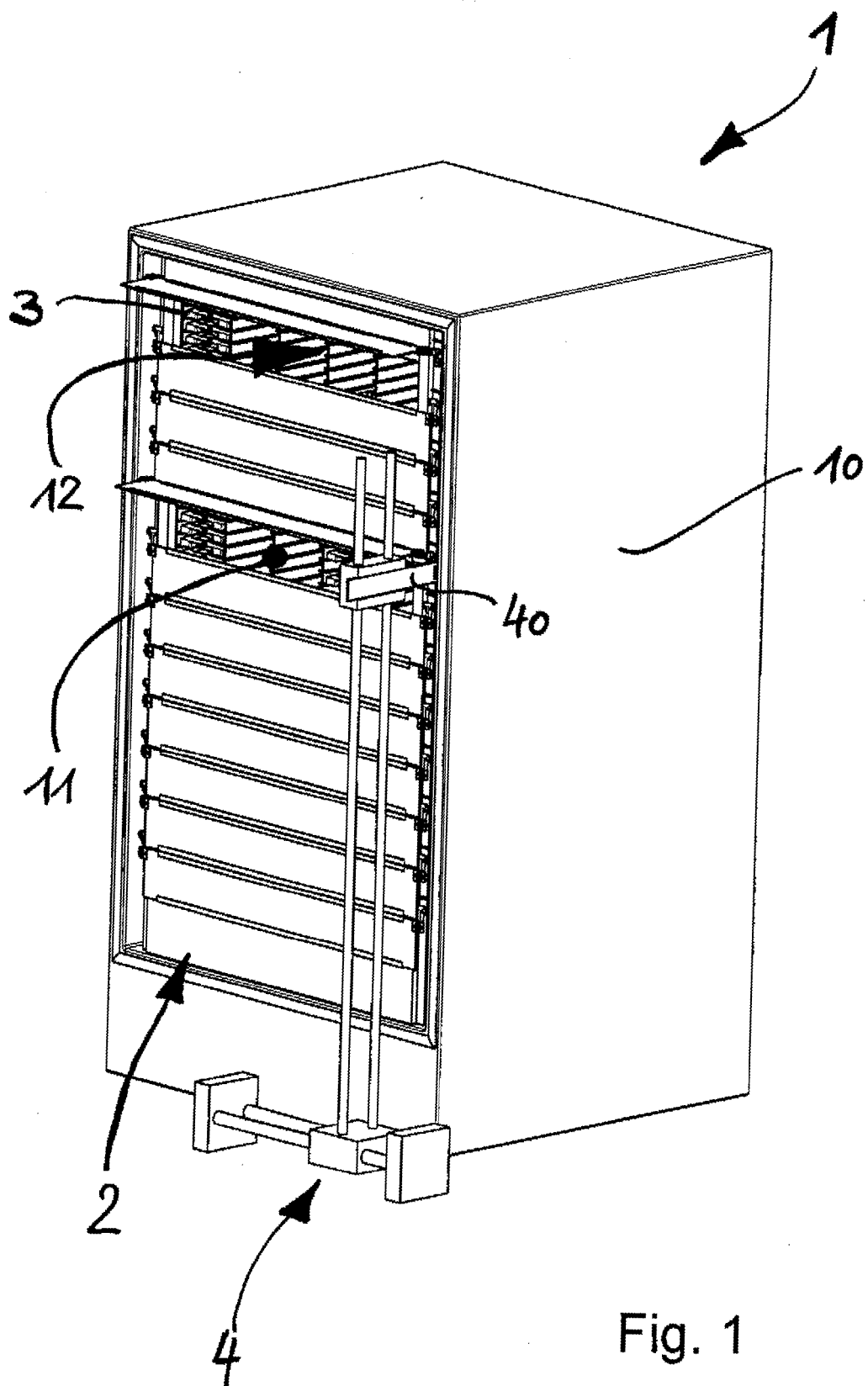
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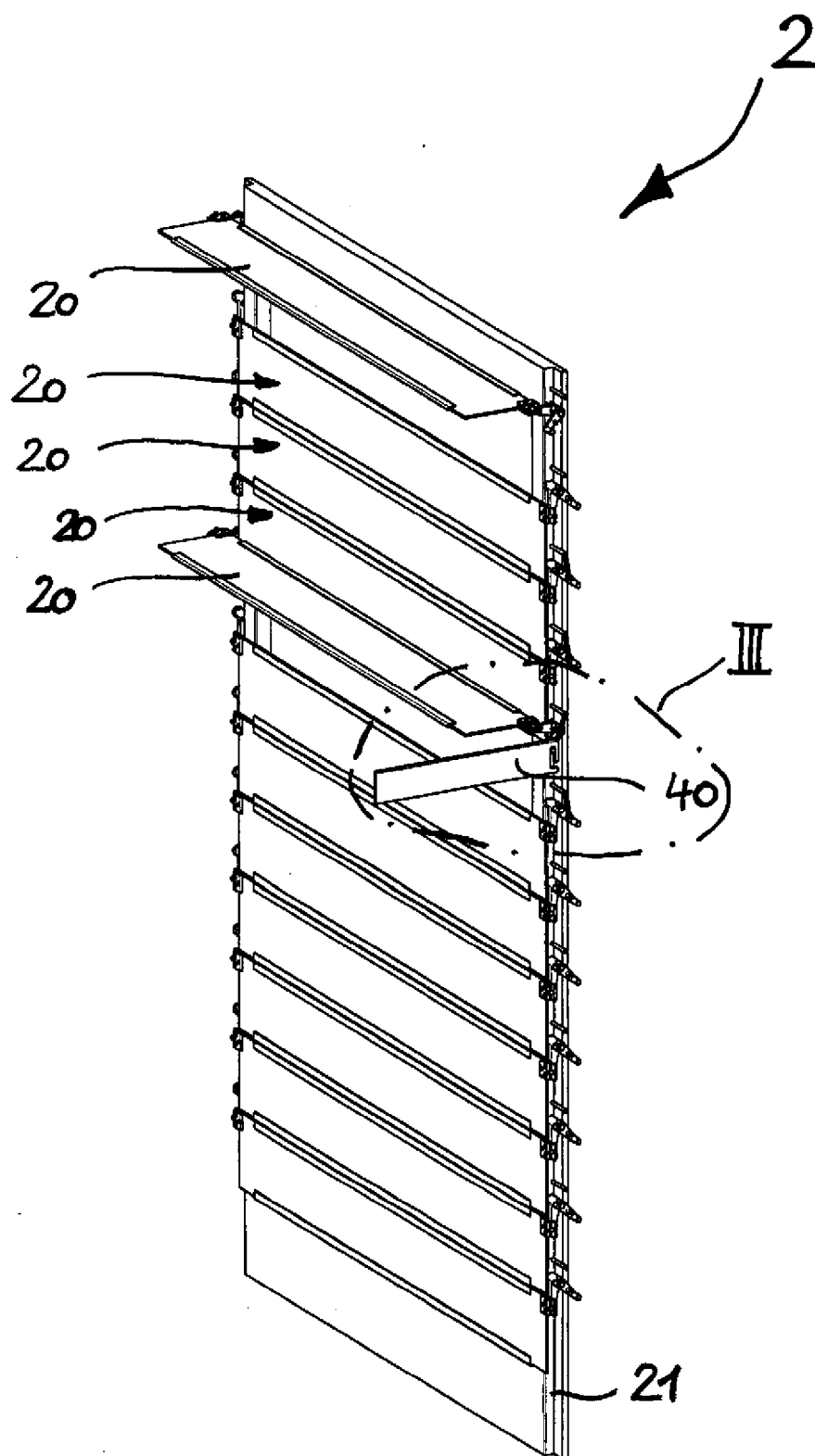


Fig. 2

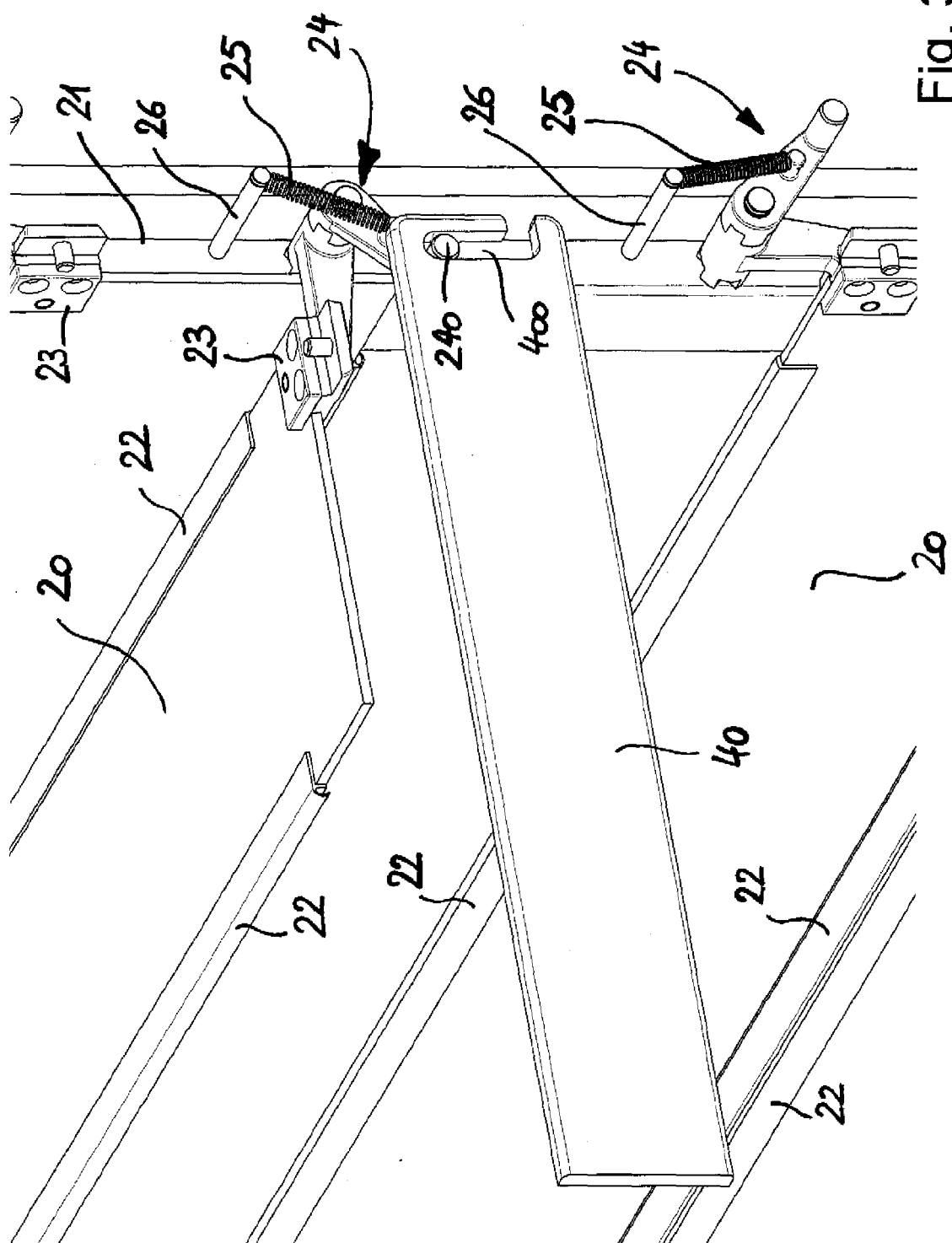


Fig. 3

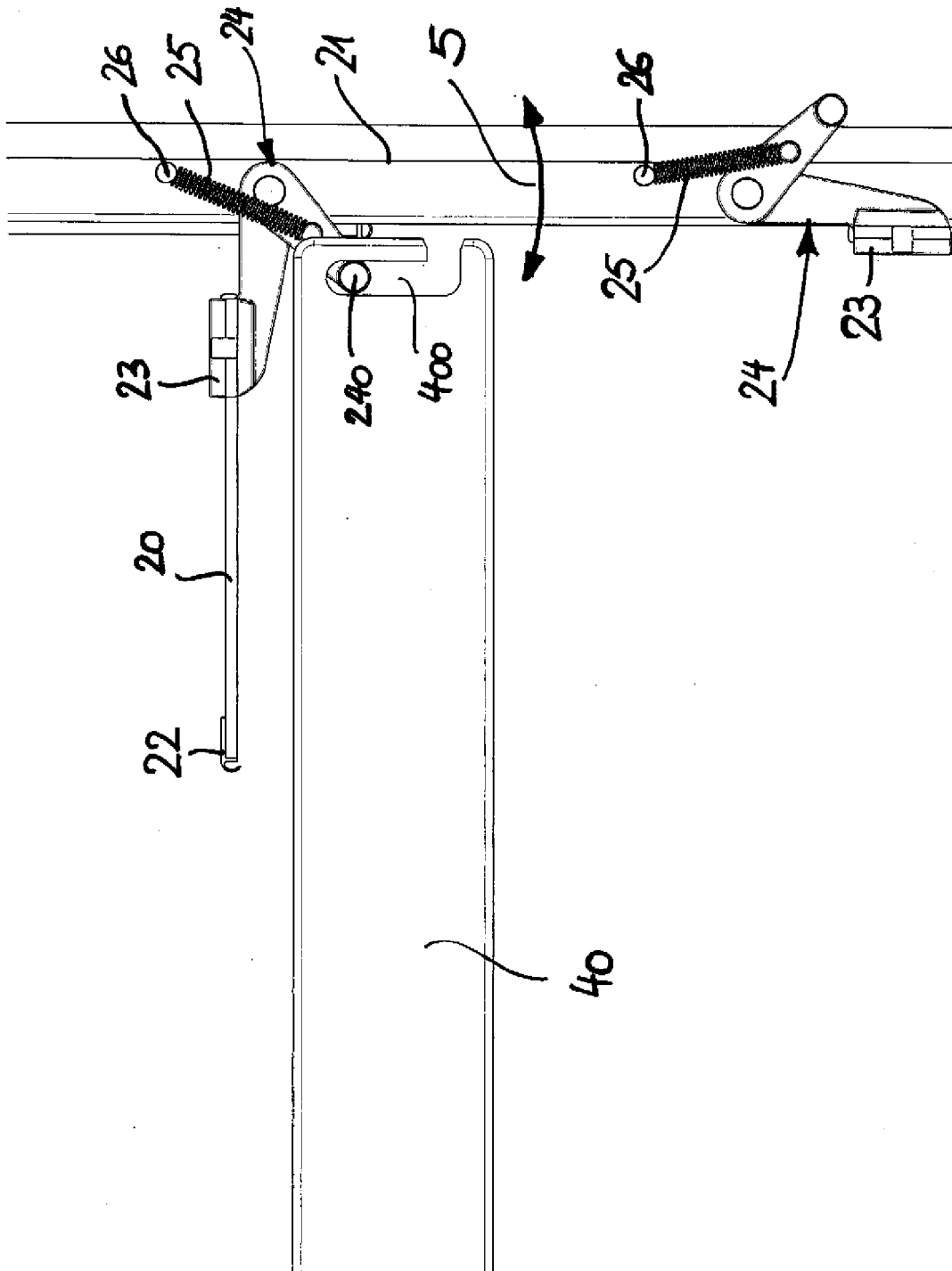


Fig. 4



EUROPEAN SEARCH REPORT

Application Number
EP 09 16 7047

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Place of search The Hague		Date of completion of the search 5 November 2009	Examiner Yousufi, Stefanie
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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EPO FORM 1503 03.82 (P04C01)

**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.
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- **Justin M. Owen ; Peter Woods.** Designing and implementing a largescale automated -80°C archive. *International Journal of Epidemiology*, 2008, vol. 37, i56-i61 **[0004]**