Office de la Propriété Intellectuelle du Canada
Un organisme d'Industrie Canada

Canadian Intellectual Property Office
An agency of Industry Canada

CA 2576367 A1 2006/02/16

(21) 2 576 367

(12) DEMANDE DE BREVET CANADIEN
CANADIAN PATENT APPLICATION

(13) A1

(86) Date de dépôt PCT/PCT Filing Date: 2005/07/19
(87) Date publication PCT/PCT Publication Date: 2006/02/16
(85) Entrée phase nationale/National Entry: 2007/02/12
(86) N° demande PCT/PCT Application No.: CH 2005/000421
(87) N° publication PCT/PCT Publication No.: 2006/015505
(30) Priorité/Priority: 2004/08/13 (CH1342/04)

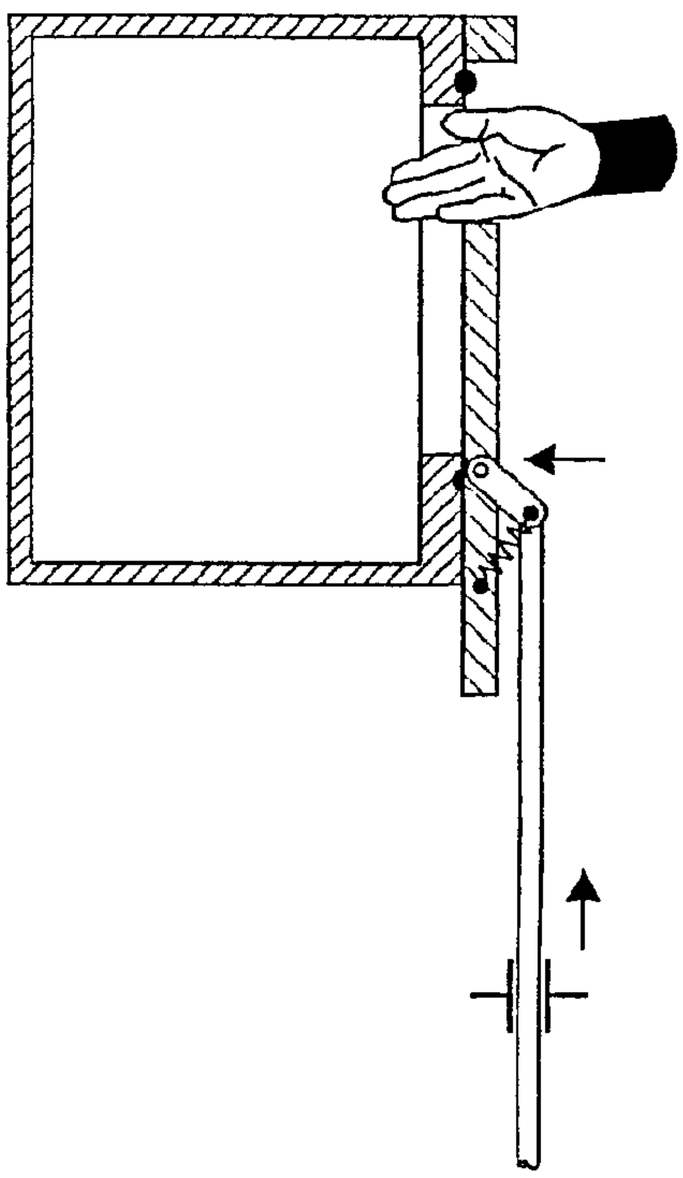
(51) Cl.Int./Int.Cl. *B01J 3/03* (2006.01), *B01L 1/02* (2006.01), *F16J 13/24* (2006.01)

(71) Demandeur/Applicant:
OC OERLIKON BALZERS AG, LI

(72) Inventeurs/Inventors:
SCHOLTE VAN MAST, BART, CH;
JAEGER, SILVIO, LI

(74) Agent: FETHERSTONHAUGH & CO.

(54) Titre : SAS A VIDE
(54) Title: VACUUM LOCK



(57) Abrégé/Abstract:
Disclosed is a vacuum lock comprising a closable door opening (10) that is disposed in a vertical direction. Said vacuum lock is provided with the following characteristics: a) a sliding door (1) is arranged parallel to the plane of the door opening (10) as well as at a short distance therefrom for opening and closing purposes; b) the rear side of the door (1) is effectively connected to a driving rod (2) while being mounted at a given distance from the door opening; c) the door (1) is connected to the driving rod (2) via a directing mechanism such that the door (1) is laterally pressed against a seal (4) that surrounds the door opening (10) when the closing process is interrupted by an obstacle (7) in the area of the door opening (10); d) the door (1) is joined to the driving rod (2) and/or the directing mechanism located at the driving rod end by means of a spring element (8) in such a way that said driving rod just compensates the weight of the door (1), thus ensuring that no injuries can occur when someone accidentally reaches into the lock opening during the closing process.

ABSTRACT

Disclosed is a vacuum lock comprising a closable door opening (10) that is disposed in a vertical direction. Said vacuum lock is provided with the following characteristics: a) a sliding door (1) is arranged parallel to the plane of the door opening (10) as well as at a short distance therefrom for opening and closing purposes; b) the rear side of the door (1) is effectively connected to a driving rod (2) while being mounted at a given distance from the door opening; c) the door (1) is connected to the driving rod (2) via a directing mechanism such that the door (1) is laterally pressed against a seal (4) that surrounds the door opening (10) when the closing process is interrupted by an obstacle (7) in the area of the door opening (10); d) the door (1) is joined to the driving rod (2) and/or the directing mechanism located at the driving rod end by means of a spring element (8) in such a way that said driving rod just compensates the weight of the door (1), thus ensuring that no injuries can occur when someone accidentally reaches into the lock opening during the closing process.

Vacuum Lock

The present invention relates to a vacuum lock that is arranged in a vacuum chamber and has a closable door opening that is disposed in an essentially vertical direction and parallel to the plane of the door, and to a method for introducing substrates into a vacuum chamber.

Vacuum locks or vacuum valves are used in automated vacuum-process installations for transferring substrates that are to be processed from one atmosphere to another; as a rule, such systems are operated pneumatically or electrically. Many such systems use doors that are configured as sliding doors that glide along a vacuum seal that is disposed around the door opening, and are then pressed against this in order to effect a seal. If the sliding door is open, substrates or even complete cassettes with substrates, for example with semiconductor wafers, can be placed in the vacuum chamber. This introduction of substrates into a vacuum chamber through a lock door opening is frequently done by hand, when a human operator extends his arm through the plane of the opening of the door system. The subsequent closing process for the lock doors that is required represents a considerable potential for injury for this operation that is performed by a human operator, particularly in view of the fact that the operator in question must extend his hand through the particular door opening many times in a very brief period of time. A failure of the closing system or an improper action on the part of the operator can cause a correspondingly dangerous situation and possibly severe injuries. According to the prior art, such lock systems are monitored and controlled by electronic systems. In this connection, the usual approach is that the presence of an obstacle or obstruction in the area of the door is detected, and subsequent movement of the door is stopped. As a rule, such systems are costly and complex and do not usually provide the high level of safety that is desired because the electronic systems are themselves prone to failure. This safety problem has been the subject of discussion in various important industrial countries, and the parties concerned have been advised to minimize the safety hazards in an appropriate manner by applying solutions that are more reliable than complex electronic monitoring systems.

It is the objective of the present invention to eliminate the disadvantages of the prior art described heretofore. In particular, it is the objective of the present invention to realize an economically realizable vacuum lock that incorporates a sliding door that is disposed in a vertical direction and which, in the event that an individual inadvertently reaches into the door opening, provides a high level of protection and safety for the individual in question.

According to the present invention, this objective is achieved by the arrangement and the procedure set out in Patent Claim 1 and Patent Claim 8. The secondary Claims define additional advantageous versions of the present invention.

According to the present invention, this objective is achieved in that a vacuum lock is arranged in a vacuum chamber with a door opening that can be closed by a door that is disposed on one plane and arranged so as to be essentially vertical. The door is in the form of a panel-like sliding door that is arranged parallel to the plane of the door opening and at a short distance therefrom so as to be able to slide in order to open or close the door opening. The rear side of the door is effectively connected on the side that is opposite the door opening to a driving rod and a drive system that is supported in bearings in the direction in which it slides and is mounted at a given distance from the door opening. The drive rod is connected to the door through a directing mechanism that can change or reverse the direction of movement of the door, for example a short lever, in such a way that if the closing procedure is impeded by an obstacle and/or a limiting stop in the area of the door opening, the door is pressed laterally against a seal that surrounds the door opening in the vertical direction to the plane of the door opening. The drive rod is so connected to the door and/or to the directing mechanism on the drive-rod side with a spring element that the spring just compensates for or supports the weight of the door. In this way, the door is arranged on the drive rod so as to be spring loaded and move vertically relative to the drive rod, by the length of the spring travel, as determined by the spring element.

This means that the door can be slid over the door opening by the drive rod with a linear motion drive, for example, by a pneumatic or hydraulic lifting cylinder, or by an electric motor linear drive. As soon as the panel-like door, which is, as a rule, metal. reaches its end position and covers the door opening, the transitional movement of the door is prevented by an end stop. This stop initiates a further lateral movement in the vertical direction relative to the door opening that is brought about by the directing mechanism, for example by a lifting mechanism. This presses the door against the seal that surrounds the door opening and thereby seals the vacuum chamber off from the atmosphere on the other side.

If, when the door is being closed, an obstacle such as an object or, in particular, part of a human body, such as a hand, should be in the door opening, the spring-loaded door will contact this object or obstacle resiliently, and according to the present invention, on reaching a maximally permissible closing force of 100 N, it will be stopped by the construction described heretofore. This is achieved in that the drive with the directing mechanism and the spring arrangement is so configured that the door is pressed against the seal and because of the friction of the seal with the surface of the door, this is slowed down and/or stopped. As soon as an obstacle impedes the sliding movement of the door, all that takes place is the lateral movement of the door towards this seal. The whole mechanism is so configured that the spring element can essentially support the weight of the door and can in any case absorb specific frictional forces; a maximal closing force of 100 N remains.

The spring element is so configured that there will be a spring effect during the whole directing phase, which is to say over the complete travel of the lateral pressing movement. This spring effect is sustained until the door is pressed against the seal, stopped, and blocked. This ensures that if the closing process is obstructed by a human body part such as a hand, only the permissible, preset spring force will act on this obstruction, and injuries to the body part will be prevented.

The drive system is so designed that it can, at most, generate the forces discussed heretofore and on reaching the sum of these forces it automatically locks. This ensures that, for example, a human body part such as a hand or an arm is subjected to, at most, 100 N in the event that the closing opening is entered as a result of inattentiveness. This precludes the possibility of injury in a very reliable way. Additional electronic means can be used in order to further minimize these forces and risks of injury; such additional means may include sensors to permanently detect the position of the door or sensors to measure the forces that are coupled with an appropriate movement control system for the door drive.

The directing mechanism that changes the direction in which the door moves from the vertical into—for example—a horizontal or lateral direction can be effected by a deflecting mechanism, a lever mechanism, or by a system of ramps. The lever system and the ramp system are the preferred configurations because these are reliable and can be realized economically.

The present invention will be described in greater detail below on the basis of the drawings appended hereto. These drawings show the following:

Figure 1a: a vacuum chamber with a lock, with the door open and with a directing mechanism in the form of a lifting mechanism;

Figure 1b: a vacuum chamber with the lock door at the end stop, covering the lock opening;

Figure 1c: a vacuum chamber with the lock door covering the lock opening and pressed against the seal, the lock being closed and sealed thereby;

Figure 2a: the arrangement as in Figure 1a when open, an obstacle such as a hand being in the opening of the lock;

Figure 2b: the lock arrangement as the door is being closed and coming into contact with the obstacle in the form of a hand;

Figure 2c: the lock arrangement with the door in contact with the obstacle, the door being stopped by being automatically pressed against the seal by the lifting mechanism;

Figure 3a: a further configuration of a lock, with the directing mechanism being in the form of a ramp system, in the open position as in Figure 1a;

Figure 3b: the arrangement as in Figure 3a, with the lock door at the end stop;

Figure 3c: the arrangement as is Figures 3a and 3b, with the lock door at the end stop and pressed against the door opening, and being sealed thereby.

The drawings show preferred configurations of the lock system according to the present invention both schematically and in cross section. Figure 1a shows a vacuum chamber 5 with a sliding door 1 in the open position. The chamber 5 has an opening 10 that is disposed, with a seal, on the outer surface of the chamber 5, so that the outer area of the chamber can be sealed off against the inner area when the door is closed. As a rule, when used in vacuum applications, the vacuum chamber and the associated lock doors are of metal such as aluminum or stainless steel. The door 1 consists of a panel that is arranged so as to be able to slide parallel to the plane of the door opening 10. In every position, the door can be moved against the seal, vertically to the door opening10 in the lateral direction, and pressed against the seal thereby. Usually, the distance of the door relative to the surface of the chamber wall or the door opening 10 amounts to a few millimeters, so that when it is moved in parallel, the door does not come into contact with the chamber wall or the seal 4. The arrangement according to the present invention relates essentially to doors 1 that are moved vertically.

The drive system that slides the door acts from below, the driving force acting against the weight of the door. The door 1 is coupled to a drive system, for example a pneumatic, a hydraulic, or an electric linear drive, by way of a driving rod 2. The driving rod 2 is supported in a guide 14 so that this can be moved in a defined, preferably constant, distance from the door opening 10, in the longitudinal, closing direction, preferably parallel to the surface of the door opening 10, in the longitudinal direction of the rod so as

to open and close the door 1. It is obvious that the drive rod 2 can be configured other than as a rod-like mechanical connecting part.

Here, the door 1 is between the plane of the door opening and the driving rod 2. The driving rod 2 is formed on the side of the door 1 that is remote from the door opening by a directing mechanism that comprises a short lever 3 that is movably connected to the door 1 through a pivot point 9 or a pivot pin 9. There is a spring 8 on the door 1 beneath the point of rotation 9 and this spring is prestressed and connected to the drive side of the lever 3 or preferably in the area of the drive rod 2 is such a way that the spring element 8 just supports the weight of the door 1 and holds the door in the upper position of the lever system opposite the lever 3 and the driving rod 2. This means that the door 1 is spaced apart from the door opening, for example by a few millimeters, so that when the door slides over the door opening 10 during normal operation it touches neither this nor the seal 4. When the door 1 is moved vertically, it moves into the end position, which marks the closed position, against a limiting stop, as is shown in Figure 1b. The closing drive now attempts to force the door against the limiting stop 6, using a force that exceeds the weight of the door and the frictional forces that are active. The lever 3, pretensioned by the spring 8 moves in such a way that the door 1 is displaced laterally, vertically to the door opening, and is thus pressed against the door opening 10 and the seal, as is shown in Figure 1c. If the door 1 encounters an obstacle 7 or strikes the limiting stop 6, lateral forces are generated through the directing mechanism when the door 1 is pressed against the seal 4, and these are absorbed by the guide 14 of the driving rod 2.

As is shown in Figure 2a, an obstacle 7, in particular a hand 7, introduced into the opening of the vacuum chamber, can result in a dangerous situation , in particular injuries to the operator, in the event that the door in accidentally closed. In such a case, when the door is being closed as in Figure 2b, the door will come into contact with the obstacle 7, to wit the hand, and press against this.

According to the present invention, the lifting mechanism3 with the spring element 8 is so dimensioned with the drive that the obstacle, i.e., the hand, cannot be subjected to a

force in excess of 100 N. The spring element 8 in so dimensioned that it just supports the weight of the door 1 and any possible and additional frictional forces before the lever 3 acts in the case of any obstacle 7. As is shown in Figure 2c, because of the obstacle 7, the door 1 is pressed in the lateral direction against the seal on the chamber wall, so that the friction that is generated acts between the seal and the door 1 retard and stop further movement.

In the above examples, the spring element 8 is shown as a tension-loaded spring element. The arrangement can also be realized with a spring that is compression-loaded. In this case, the attachment arrangement for the driving rod 2 and the door 1 must be repositioned accordingly in order that the weight of the door can be spring loaded. The spring element 8 can be realized in many different ways, for example as a coil spring, a disk spring, a leaf spring, a pneumatic spring, or as a flexible rubber element.

A further, particularly preferred embodiment is shown diagrammatically in Figure 3. The directing mechanism for reversing the direction of movement, shown in Figure 3a, consists of a first ramp 13' that is disposed vertically on the back of the door and a second ramp 13" that is disposed on the driving rod, with a roller 11 that is disposed between the two ramps; this forms a kind of bearing and rolls between the ramps 13 if the spring-loaded door 1 is displaced relative to the driving rod 2 by an obstacle 7 or a limiting stop 6. During this displacement process, as shown in Figures 3b and 3c, the forces are deflected laterally through the ramps 13 and the door 1 is pressed against the door opening 10 as has been described heretofore. The arrangement can also be operated with only one ramp 13' or 13 " if the roller is fixed on a shaft on one opposing side of a ramp as roller element 11. Even in the case of a directing mechanism realized by ramps, different additional mechanical versions are possible within the framework of the present invention.

Taken as a whole, appropriate dimensioning of the spring element 8 together with the friction of the seal and with the drive system must ensure that a pressure of no more than 100 N can act on the obstacle 7. When dimensioning the driving forces of the drive

system, attention must be paid to ensure that these do not exceed the appropriate forces, even on the drive side, and then stops these or causes them to idle. Additional improvements and refinements are possible by using additional electronic means that measure the position of the door and the effect of the forces and control the drive system accordingly.

Patent Claims

1. Vacuum lock disposed in a vacuum chamber (5) with a door opening (10) that can be closed by a door (1), is essentially vertical and parallel to the door opening (10), and lies in one plane, and has the following characteristics:

a) the door (1) is configured as a panel-like sliding door and is arranged parallel to the plane of the door opening (10) so as to be able to slide, as well as at a short distance therefrom, for opening and closing purposes;

b) the door (1) is effectively connected with a driving rod (2) to the door (1) on the remote side opposite the door opening (1) and is installed at a given distance relative to the door opening (10) in the direction in which it slides, the driving rod (2) being connected to a drive system;

c) the door (1) is connected to the driving rod (2) through a directing mechanism (3, 13', 13", 11) in such a way that the door is laterally pressed against a seal (4) that surrounds the door opening (10), in the vertical direction to the plane of the door opening (10), if the closing process is impeded by an obstacle (7) and/or a limiting stop (6) in the area of the door opening (10);

d) the door (1) is connected with the driving rod (2) and/or with the driving-rod side of the directing mechanism (3, 13', 13", 11) to a spring element (8) in such a way that this just supports the weight of the door (1);

2. Vacuum lock as defined in Claim 1, characterized in that when in comes into contact with the surface of the door (1) the seal (4) generates friction so that a damping element is created, and this retards and/or stops the movement of the door; and in that when this occurs, essentially only a lateral movement takes place when the seal is compressed.

3. Vacuum lock as defined in Claim 1 or Claim 2, characterized in that the drive system and the spring element (8) absorb a force that just supports the weight of the door; and in that the remaining driving force does not exceed 100 N when the door (1) is being closed.

4. Vacuum lock as defined in Claim 3, characterized in that the lock system incorporates additional electronic means for determining the position of the door (1) and/or for purposes of movement control.

5. Vacuum lock as defined in one of the preceding Claims 1 to 5 , characterized in that the directing mechanism (3, 3', 3", 11) incorporates a lever (3) that connects the door (1) and the driving rod (2) so as to be movable.

6. Vacuum lock as defined in one of the preceding Claims 1 to 4, characterized in that the directing mechanism (3, 3', 3", 11) incorporates at least one ramp (13) that is disposed on the door (1) or on the driving rod (2), and a roller element (11) is arranged so as to roll in such a way that when the door (1) is displaced by the action of the spring element relative to the driving rod (2), this is pressed laterally against the door opening (10).

7. Vacuum lock as defined in one of the preceding Claims 1 to 6, characterized in that the lock system is configured as a safety device for personal protection.

8. Method for locking substrates into a vacuum chamber (5), with a closable door opening (10) that is disposed essentially vertically in one plane with a door (1) and having the following features:

a) the door (1) is configured as a panel-like sliding door that, for purposes of opening and closing the door opening, is disposed so as to be parallel to the door opening (10) and at a short distance therefrom so as to be slideable;

b) the door (1) is effectively connected to a driving rod (2) with the door (1) on the side that is remote from the door opening (1) and is supported opposite the door opening (10) at a predetermined distance in the direction in which in slides, the driving rod (2) being connected to a driving system;

c) the door (1) is connected with the driving rod (2) through a short lever (3) in such a way that if the closing process is impeded by an obstacle (7) and/or by a limiting stop (6) in the area of the door opening (10), the door (1) is pressed laterally against a seal (4) that surrounds the door opening (10) in the vertical direction to the plane of the door opening (10);

d) the door (1) in so connected with the driving rod (2) and/or with the lever (3) at the driving rod end by a spring element (8) that this just compensates for the weight of the door (1) when it is closing.

9. Method as defined in Claim 8, characterized in that when the seal (4) contacts the surface of the door (1), the resulting friction forms a damping element that retards and/or prevents the door from moving; and in that when this takes place, essentially only a lateral movement occurs because of the seal being compressed;

10. Method as defined in Claim 8 or Claim 9, characterized in that the drive and the spring element (8) absorb a force that just supports the weight of the door; and in that the remaining drive force does not exceed 100 N when the door is closing;

11. Method as defined in Claim 10, characterized in that the position of the door (1) is ascertained by additional electronic means and/or the path of movement is monitored with a movement control of the door in order to manage the action of the force.

12. Method as defined in one of the preceding Claims 8 to 11, characterized in that the directing mechanism (3, 13',13", 11) includes a lever (3) that movably connects the door (1) and the driving rod (2);

13. Method as defined in one of the preceding Claims 8 to 12, characterized in that the directing mechanism 3, 13',13", 11) is actuated by at least one ramp (13) that is disposed on the door (1) or on the driving rod (2) and a roller (11) is so arranged on the ramp (13) that when the door is displaced by spring action relative to the driving rod (2), this is pressed laterally against the door opening (10);

14. Method as defined in one of the preceding Claims 8 to 13, characterized in that the lock system is used as a security device for the protection of individuals.

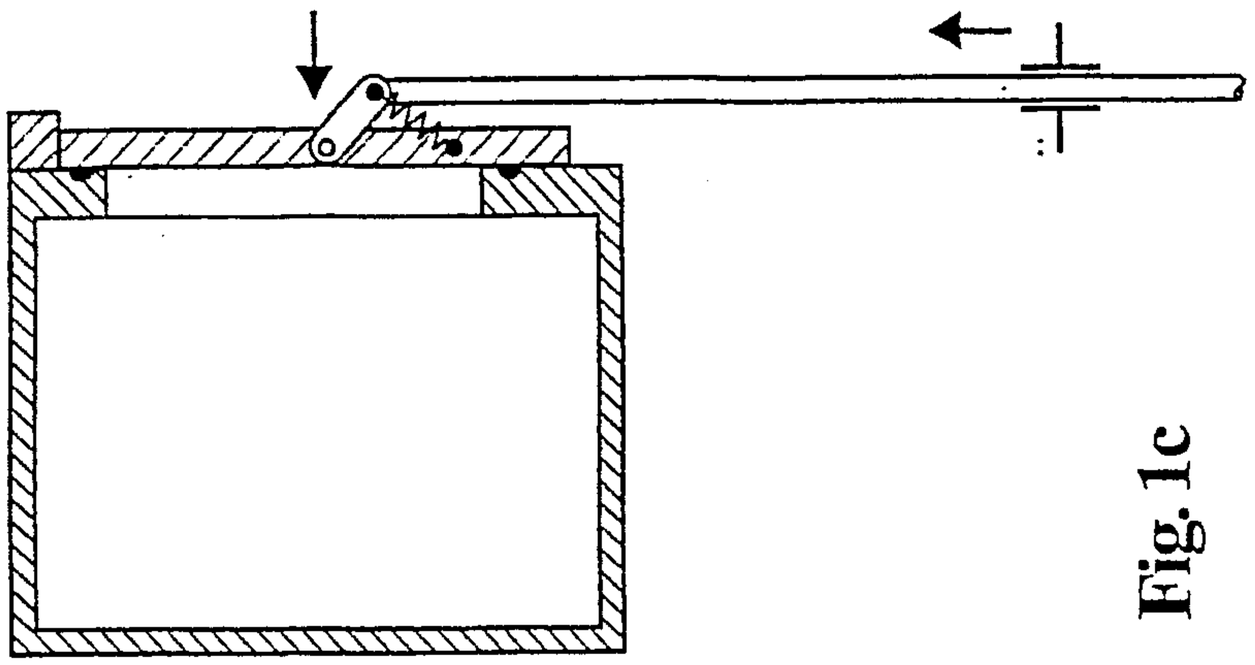


Fig. 1c

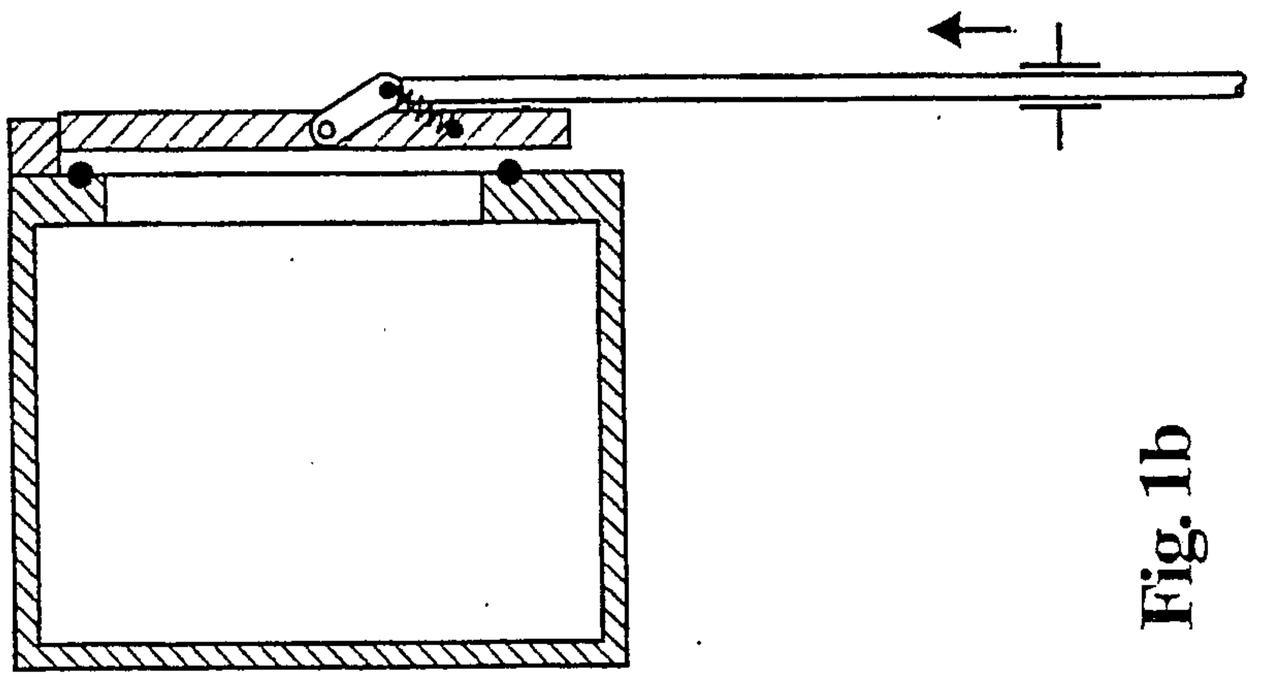


Fig. 1b

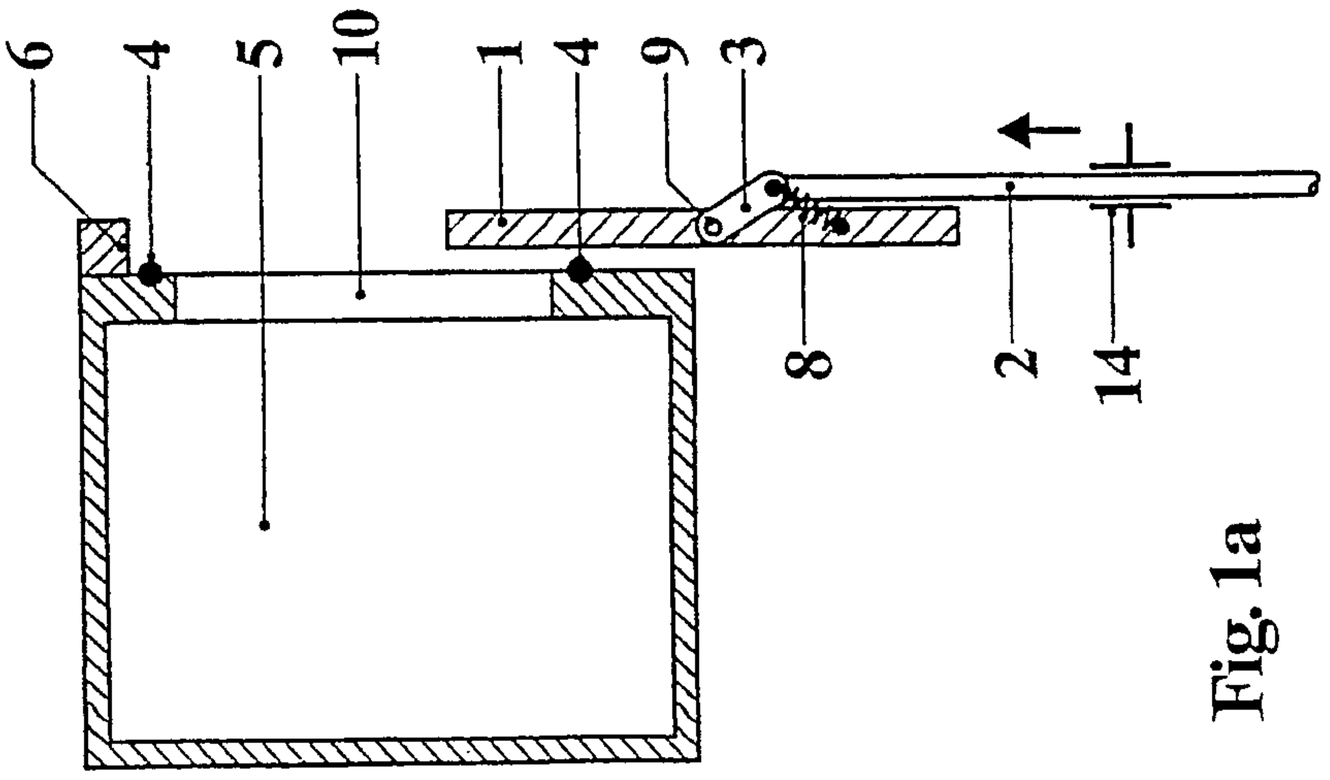


Fig. 1a

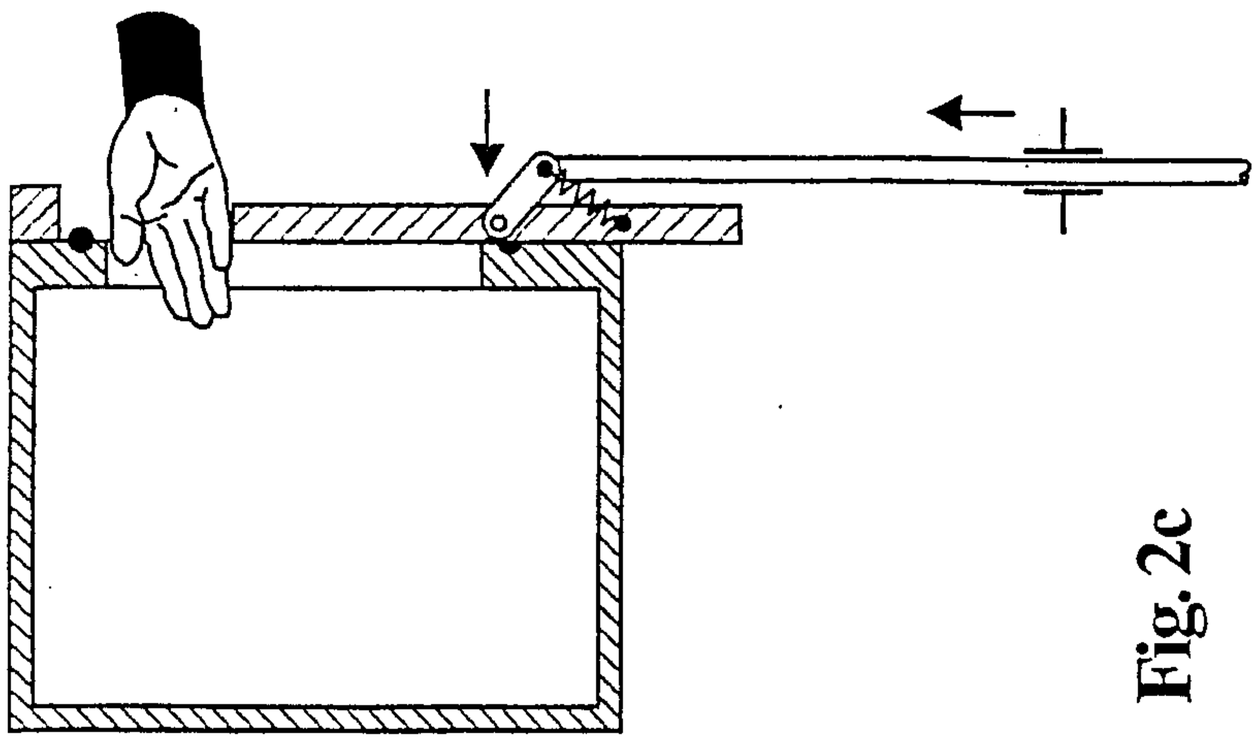


Fig. 2c

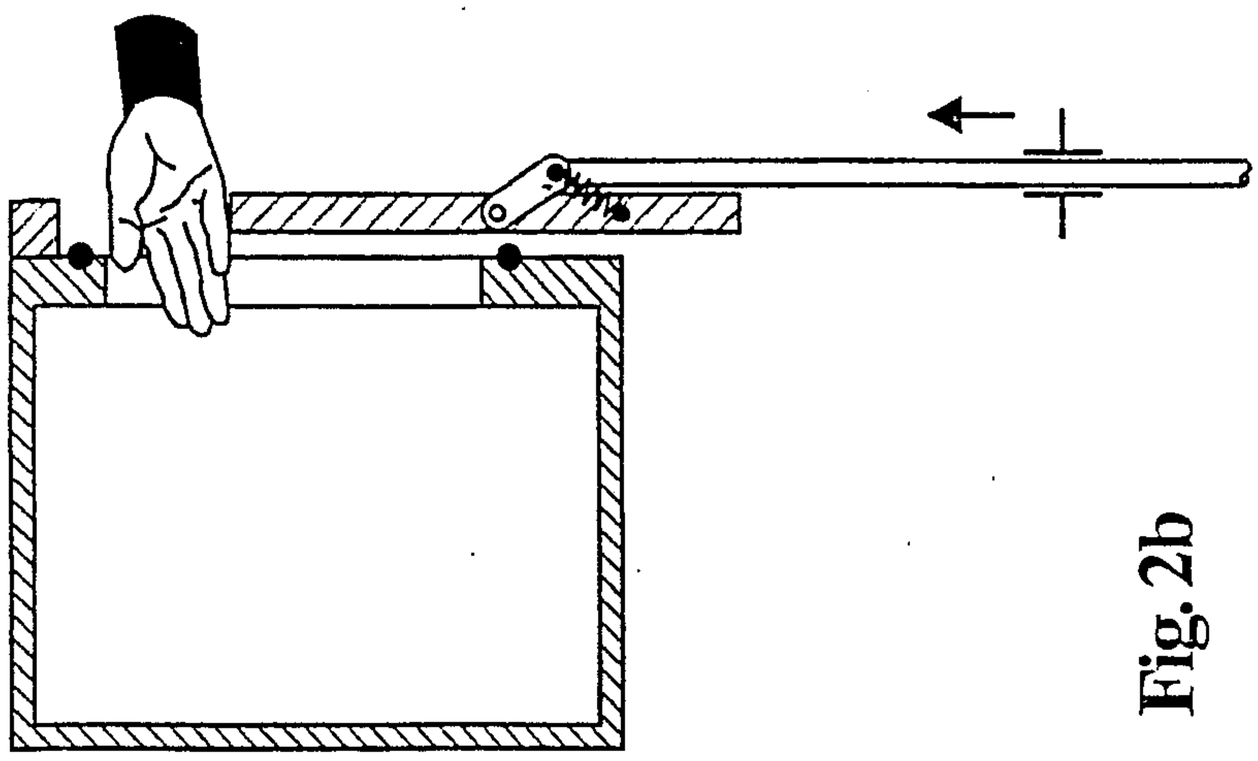


Fig. 2b

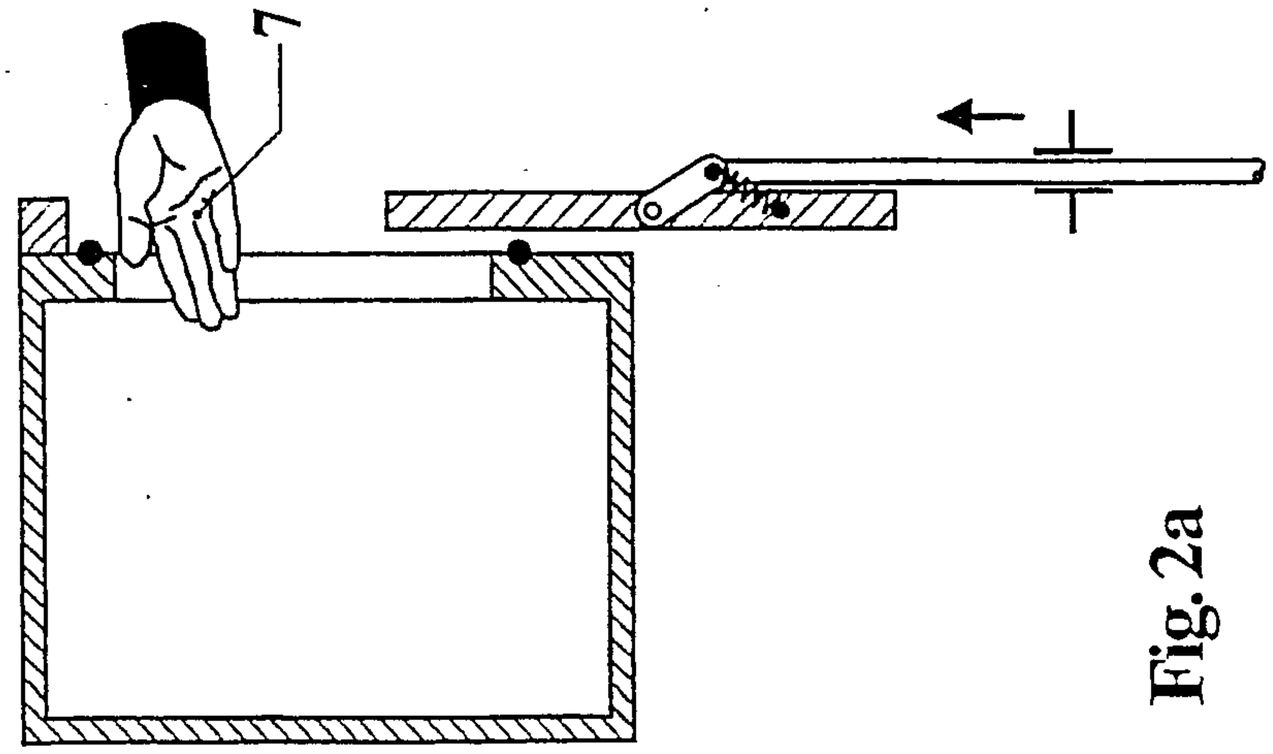


Fig. 2a

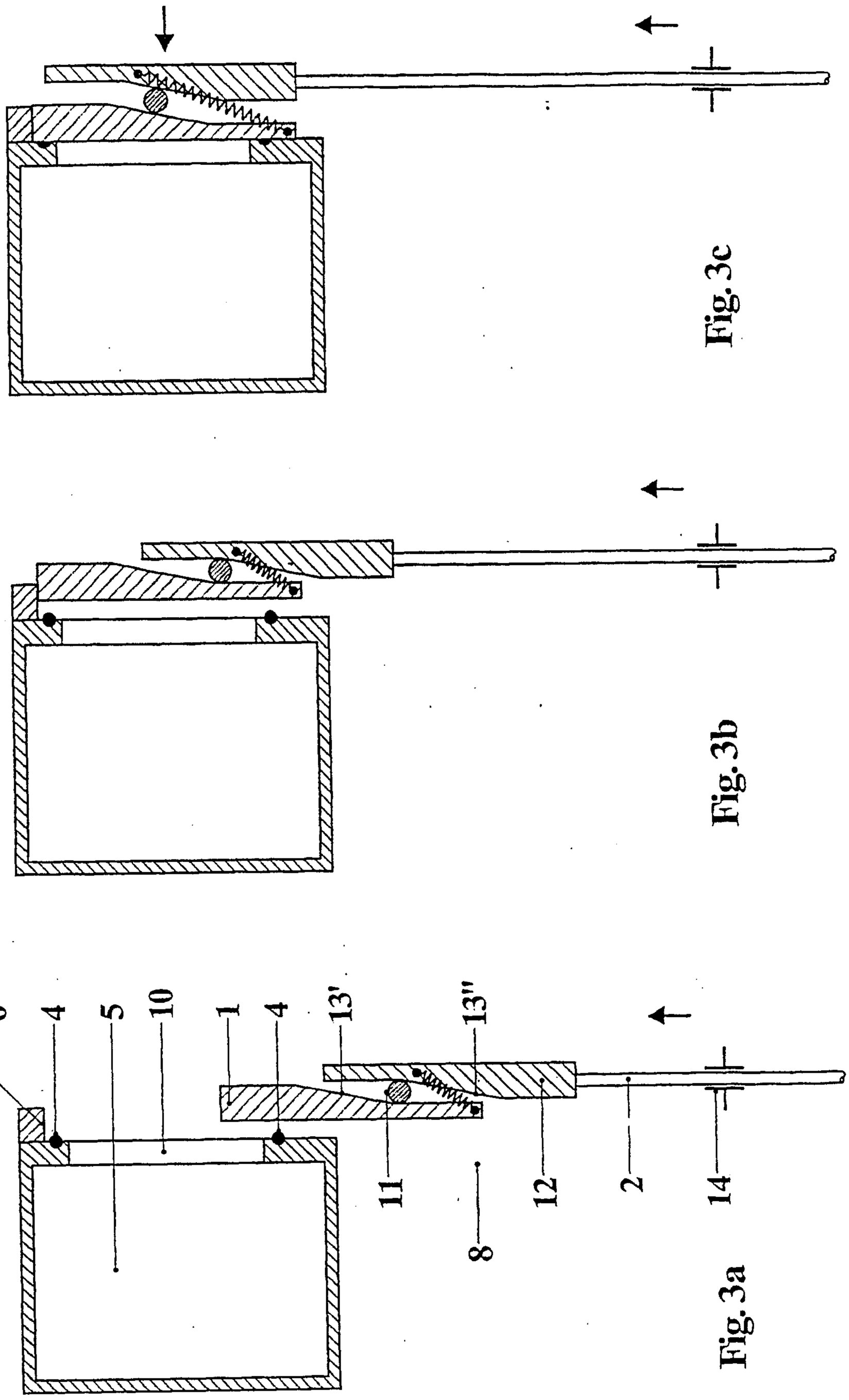


Fig. 3a

Fig. 3b

Fig. 3c