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Schibli et al.

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[54] **METHOD AND APPARATUS FOR CLOSING AND OPENING**

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[52] **U.S. Cl.** **49/31**, 49/141, 49/394, 52/1

[51] **Int. Cl.** **E05f 15/20**

[58] **Field of Search** 49/31, 141, 394; 52/1

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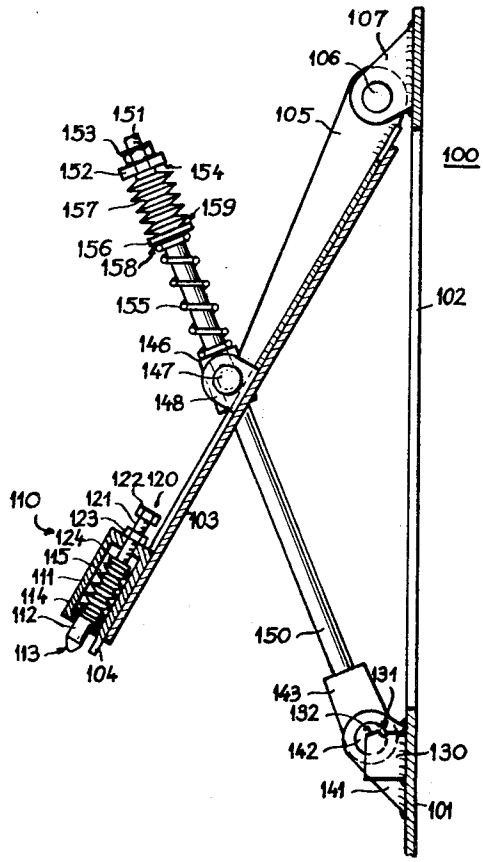
[57] **ABSTRACT**

An aperture, in a rigid housing enclosing a space or volume, is closed by utilizing a cover opening under explosive pressure and cooperating with the housing. The cover is maintained closed by exerting, between the cover and the housing, an elastic holding force which collapses abruptly to zero value on being overcome by explosive pressure within the housing. The cover may be hinged to the housing and may be provided with detent means for releasably latching it in the closed position. Where the housing aperture is of substantial size, two such covers may be used.

6 Claims, 3 Drawing Figures



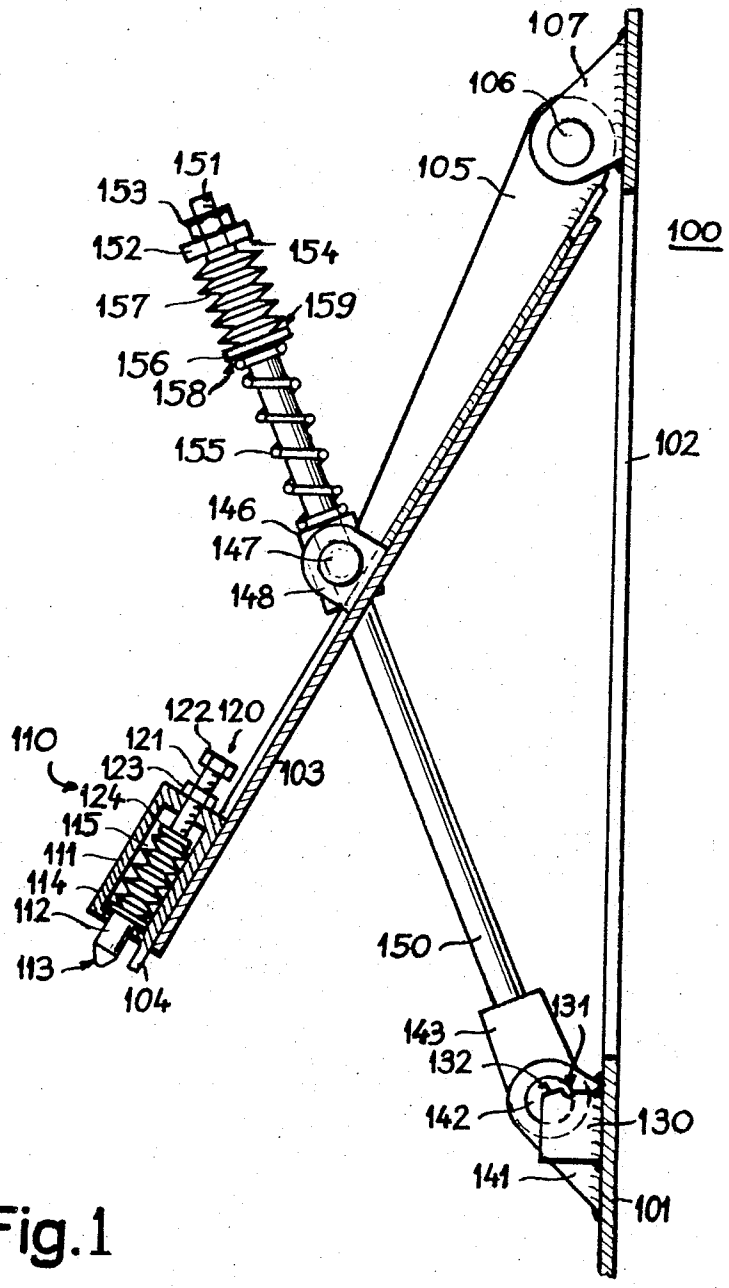


Fig.1

INVENTOR.

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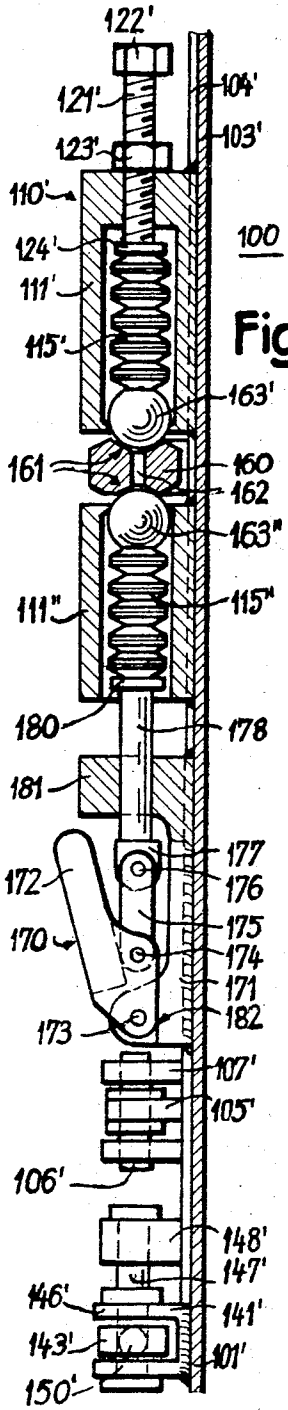
122'
121'
104'
103'
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163"
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180
178
181
177
172
176
175
170
174
171
182
173
107'
105'
106'
148'
147'
146'
141'
143'
101'
150'

Fig. 2

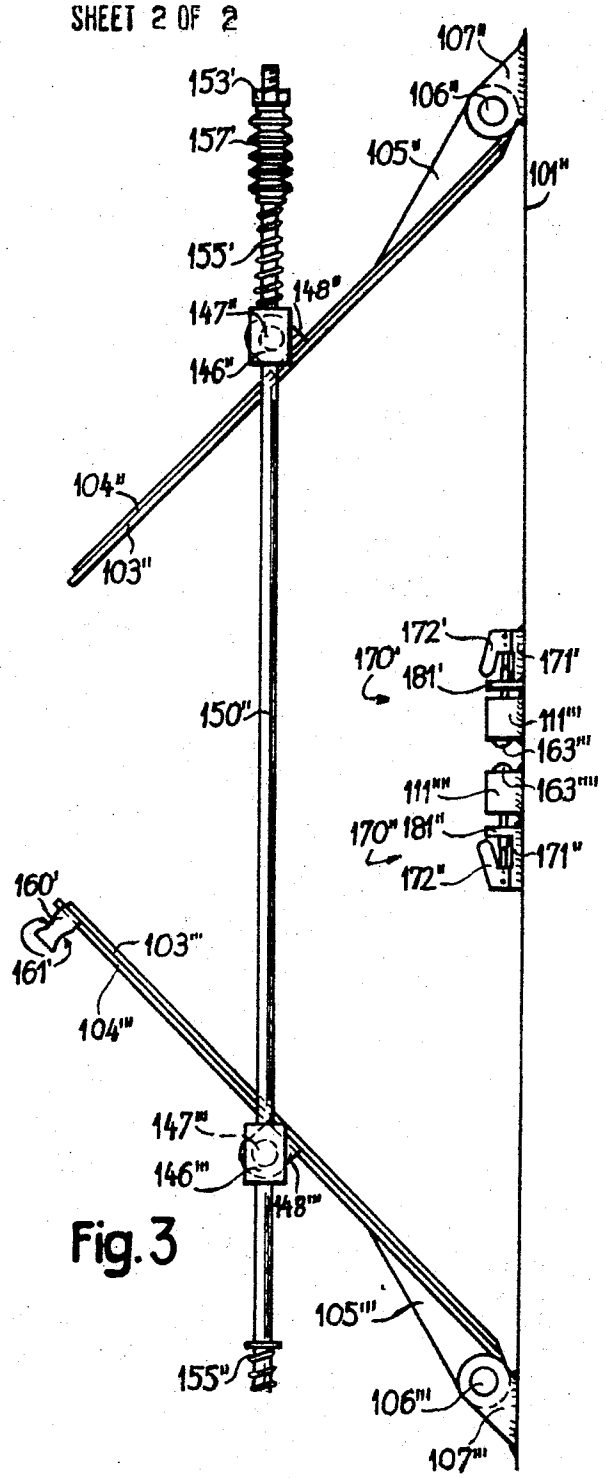
107"
153'
106"
157'
105"
101"
155'
148"
147"
146"
104"
103"
172'
170'
171'
181'
150"
111'''
163'''
111''''
163''''
170"
181"
171"
172"
160'
161'
103'''
104'''
147'''
146'''
148'''
105'''
155"
106'''
107'''

Fig. 3

METHOD AND APPARATUS FOR CLOSING AND OPENING

BACKGROUND AND SUMMARY OF THE INVENTION

This invention relates to a method for closing an aperture in a rigid housing enclosing a space, by utilizing a cover opening under explosive pressure and cooperating with the housing.

The problem underlying the invention is to provide housings of processing units, which foreseeably may possibly be seriously damaged by explosion-like detonations or by actual explosions occurring within the housing, with one or more explosion-relief apertures. These apertures are to be closed by explosion-relief covers in a manner such that each closure satisfies the following conditions.

The aperture in the machine housing is to be closed in such a way that, under normal material processing occurring inside the machine housing, both the machine housing having the aperture, on the one hand, and especially the cover fitted in the housing to close the aperture, on the other hand, act conjointly as one rigid machine housing.

When explosion-like detonations, or actual explosions, occur within the machine housing, there is a very rapid response in that the cover clears the largest possible area of the aperture in a very short time for relief of the pressure within the housing.

The closure must provide the smoothest possible surface toward the inside of the machine housing, that is, toward the processing space enclosed by the housing.

If possible, the cover should be suspended in an articulated manner on the machine housing to avoid complete separation of the cover from the housing.

Finally, the cover should be easily installed.

It is especially important to provide such explosion-relief devices in processing plants of the chemical industry and in shredding and transport systems in garbage processing. In other words, the sector in which the objective of the invention is important comprises processing plants which, with a very great probability, are imperiled by explosion-type detonations or by actual internal explosions, so that an additional condition, besides those mentioned above, must be fulfilled. Namely, there must be no need for maintenance over very long periods of time.

In addition, it is desirable, in very many cases, that the opening path of the explosion-responsive dampers, covers, or flaps be limited, and that, when an opening movement of the damper takes place for the relief of an explosion, an elastic limitation of the opening path is assured. Thereby, damage to the aperture closing device as a whole and of the damper or cover suspension in particular need not be suffered.

For certain cases, it is necessary, moreover, that large relief apertures are to be closed by two pivoted dampers or covers. For this condition, a locking system must be provided which gives the same assurances of safety and operation with the same principle.

A significant application of such dampers, for closing an explosion-relief aperture, is in shredding devices, in particular devices for the shredding of garbage, in that occasional unpredictable detonations and explosions may occur therein and lead to considerable damage.

From the foregoing, it will be appreciated that the use of such dampers or covers involves two contradictory conditions. That is, during normal operation of the shredding device, the damper must close the aperture absolutely tightly. On the other hand, when small explosions, or explosion-like detonations occur, the damper must open reliably, quickly and as widely as possible.

In endeavoring to find a suitable solution for these apparently contradictory requirements, it must be realized that, during shredding, parts are hurled against the damper and their kinetic energy is dissipated by impact with the damper. This load on the damper, however, is so local as not to cause opening of the damper. By contrast, the explosive pressure produced in a detonation or explosion in the space closed off by the damper and the housing exerts itself uniformly over the entire damper area. Thereby, even at relatively small detonations, forces in the amount of the product of the damper area and the explosive pressure, become operative on the locking mechanisms, and these forces are able to overcome the locking forces of the locking mechanisms only if the design of the locking mechanism is suitable. Thus, the problem to be solved resides primarily in suitably designing the locking mechanism taking into consideration the mentioned conditions.

In accordance with the invention, a method for solving this sphere of the problem is characterized in that the cover is held in the closed position by an elastic holding force exerted between the housing and the cover, this elastic holding force collapsing abruptly to zero value on being overcome by explosive pressure within the housing. In the closed position, the elastic holding force can hold the cover in a stable position, and it is only upon being overcome by the explosive pressure that the holding force collapses to zero so that the cover can occupy an unstable position.

The invention is also directed to apparatus for performing the method, and this apparatus is characterized in that, between two structural parts, correlated, on the one hand, to the boundary of the aperture formed in the machine housing which encloses the space and, on the other hand, to the cover, there is installed an elastically releasable locking device. This device is installed in such a manner that, responsive to an explosive pressure, an initial tension provided by the locking device is overcome, and the cover is moved suddenly from a stable closed position to a tension-free open position clearing the aperture in the housing.

The cover may be mounted pivotally on the machine housing for elastic connection with the housing.

The locking device may have two detent elements which are elastically displaceable relative to each other, one element being connected with the cover and a counter element being connected with the fixed boundary of the aperture closed by the cover. The detent element and the counter element have mating convex and concave, or vice versa, interengaging surfaces.

Locking may be effected with the use of a combination of two detent elements, elastically displaceable relative to each other, of which one element is assigned to the damper or cover and the counter element to the boundary of the aperture closed by the damper, with the detent action being effected by cooperation of convex and concave mating surfaces. At least one of the elements may be designed, depending on the correlation, to be adjustable to the tensioned closed position and to an unloaded or untensioned open position. The correlation of the two interlocking elements can be ef-

fected either between the damper and the boundary of the aperture, or between two dampers, by suitable correlation.

To limit the opening movement of the dampers closing the explosion-relief aperture, there may be provided, opposite the articulated suspension, a pull rod, also mounted in an articulated fashion, which receives, between the articulated suspension and its end, a guide sleeve connected with the damper. A compression spring is interposed between this guide sleeve and the pull rod opposite the mounting of the pull rod. The compression spring may be designed to have progressive spring action and, in the closed state of the damper, the spring is completely unloaded.

An object of the invention is to provide an improved method of closing an aperture in a rigid housing enclosing a space, by utilizing a cover opening under explosive pressure and cooperating with the housing.

Another object of the invention is to provide improved apparatus for closing an aperture in a rigid housing enclosing a space, by utilizing a cover opening under explosive pressure and cooperating with the housing.

A further object of the invention is to provide such a method and apparatus in which the cover is held in closed position by an elastic holding force exerted between the cover and the housing, the elastic holding force suddenly collapsing to zero upon being overcome by explosive pressure.

Another object of the invention is to provide such a method and apparatus in which the cover, responsive to explosive pressure, is moved from a stable position closing the aperture to an unstable position clearing the aperture.

For an understanding of the principles of the invention, reference is made to the following description of typical embodiments thereof as illustrated in the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

In the drawing:

FIG. **1** is a longitudinal sectional view through an embodiment of the invention illustrating the cover partially opened;

FIG. **2** is a sectional view illustrating a cover locking system having two different adjustment possibilities; and

FIG. **3** is a longitudinal sectional view illustrating a double damper closure embodying the invention.

In the embodiment shown in FIG. **1**, an explosion-relief aperture **102** is provided in a fixed casing **101** enclosing a processing space **100.** To close aperture **102,** there is provided a cover **103** which, along its periphery, has a packing strip **104** resting on casing or wall **101.** Cover **103** is articulatedly or hingedly mounted through straps or ribs **105** engaging hinge pins **106** in straps or ribs **107** secured to casing or wall **101.** Opposite the hinged suspension **105, 106, 107** of cover **103,** there is mounted one of two elastically interlocking elements, of which the element **110** is composed as will now be described. Element **110** includes a housing **111** fixedly connected with cover **103.** A displaceable detent element **112** is provided in housing **111,** and has a convex detent head **113** and a stop **114** for engaging housing **111.** Housing **111** also encloses a compression spring **115,** preferably formed by several plate springs. The housing also has mounted therein a tension-adjusting device **120** comprising a screw **121** having a head **122** and a lock nut **123** arranged thereon, together with a pressure plate **124.**

Cooperating with the locking device **110** there is a counter part **130** which is secured to wall or casing **101.** Counter element **130** is formed, as an essential feature, with a concave detent recess **131** and, in certain cases, it is advantageous that the entry into this detent recess **131,** as referred to the detent element **112,** presents an inclination **132** so that closing of the cover and engagement of detent element **112** into detent recess **131** is effected more easily.

To limit the opening movement of cover **103,** a pull rod **150** is pivotally mounted in straps or ribs **141** on wall or casing **101** through the medium of a pivot pin **142** and a hinge strap **143.** A guide sleeve **146** embraces pull rod **150** and is rotatably or oscillatably mounted, through the medium of a bearing pin **147,** in a bearing block **148** fixedly connected with damper or cover **103.** The free end of pull rod **150** is provided with a threaded pin **151** and an end plate **152** retained by a nut **153,** and end plate **152** has an abutment face **154.** Between guide plate **146** and end plate **152** there are arranged, successively, a first compression spring **155,** an intermediate disk **156,** and a packet of plate springs forming a second compression spring **157.** The helical compression spring **155** bears against an end face **158** of intermediate disk **156,** while one end of plate spring **157** bears against the opposite end face **159.** It is characteristic of the spring arrangement that, up to a certain opening movement of cover **103,** the spring arrangement rests entirely loosely on pull rod **150,** as is clearly visible from FIG. **1,** by the space between end plate **152** and the uppermost plate spring of the spring **157.**

With damper or cover **103** closed, plate spring packet **115** is charged, in locking device **110,** upon engagement of the convex end **113** of element **11** into the concave detent recess of counter element **130,** by adjustment of screw **121,** to an extent such that the stress on cover or damper **103,** occurring during normal operation of the device closed within casing **101,** will not overcome the holding force. However, when an explosion occurs in the space **100,** the interengaging locking is released by the pressure acting over the entire surface of cover **103.**

At the beginning of the opening of cover or damper **103,** element **112** is displaced, against the bias of compression spring **115,** until convex head **113** moves over the edge of concave detent recess **131.** Immediately thereupon, cover or damper **103** turns about pivot axis **105** at very great speed outwardly into the open position. With increasing opening movement of the cover away from a certain opening point, first compression spring **155** is compressed over a relatively long path. Thereby, the opening speed is decelerated for the first time. Following this compression of compression spring **155,** the remaining deceleration of the opening a movement of cover **103** is provided by compression spring **157** until the movement of cover **103** is completely arrested. In certain cases, this now existing charging of the springs is sufficient to move the cover back toward the closed position.

With the arrangement shown in FIG. **1,** it is possible to relieve the pressure waves of explosions, propagating at great speed (up to 400 m/sec.), in fractions of a second by overcoming small closing forces, into the open-

ing or respectively into the free space surrounding the protected space **100.** Additionally, this damper lock permits repeated use, which is not the case when burst plates are used. The elastic opening movement delimiting device permits braking the opening movement within a relatively long opening path and from the very great opening speed to zero, without this brake work being transformed into deformation work at the cover or at a housing part carrying the cover.

In the embodiment of the invention shown in FIG. **2,** and similarly to the design shown in FIG. **1,** a single cover **103'** is mounted, by straps **105'** in hinge pins **106',** in bearing straps **107'** which are connected with casing or wall **101'.** The limitation of the opening path of cover **103'** is again effected, on the one hand, by the articulated suspension **141', 143'** for pull rod **150'** and, on the other hand, guide sleeve **146'** with bearing pin **147'** engaged in bearing block **148'** connected with cover **103'.** However, for simplification, the springs which are used are not shown.

In contrast to the design according to FIG. **1,** the locking device no longer acts between a counter element **130** at the fixed frame, through detent device **110,** on cover bearings **105, 106, 107,** but by twin arrangement, as will now be described, through a self-enclosed system.

A detent device **110'** is firmly connected with wall or casing **101',** and comprises a housing **111',** a compression spring **115'** arranged in the housing, and a screw **121'** with a head **122',** a lock nut **123'** and a pressure plate **124°** for the adjustment of spring **115'.** A detent ball **163°** is used as the detent element. Directly aligned with the combination comprising screw **121',** spring **115'** and detent ball **163',** and at a given spacing therefrom, there is a tension device **170** also connected with wall or casing **101'.** To determine the spacing, an intermediate detent element **160** is fixedly connected with cover **103'** and extends over the edge of the cover or damper into the zone of detent device **110'** and device **170** aligned therewith. In the zone of devices **110'** and **170,** detent element **160** is provided, on opposite sides, with detent recesses **161,** there being provided, in the instant design, a continuous bore **162** extending from one detent to the other, solely for manufacturing reasons.

Tensioning device **170** comprises the housing **111''** having a compression spring **115''** arranged therein, and a detent ball **163''.** For the purpose of tensioning spring **115''** through detent ball **163''** relative to detent recess **161** in element **160,** a toggle lever tensioning system is provided. This toggle lever tensioning system comprises a mounting element **171,** firmly connected with casing or wall **101',** a tensioning lever **172** pivoted in mounting **171** by a bearing pin **173,** a toggle joint pin **174** articulatedly connecting lever **172** with an intermediate strap **175,** a strap pin **176** pivotally connecting strap **175** with the head **177** of a pressure bolt **178,** a pressure plate **180** engaging compression spring **115',** and a slide bearing **181** connected with support **171** for slidably mounting pressure pin **178.**

Functionally, that is, as far as the closing safety under normal operation and the opening upon explosions is concerned, there is no basic difference in the design of FIG. **2** from that of FIG. **1.** However, in the construction of the embodiment of FIG. **2** and, as a result thereof, in the response sensitivity for opening of the damper or cover, there are differences. Thus, the action and reaction forces in the locked state are no longer closed by the detent device through the cover suspension and the fixed housing. Instead, there exists a closed circle of forces between the two detent and tensioning devices **110'** and **170,** through the intermediate detent element **160** and the fixed housing **101'.** Thus, cover suspension **105', 106', 107'** is relieved of these forces.

Tensioning device **170,** having the toggle lever system, permits, after completed opening of cover **103',** a very simple reclosing in that tensioning device **170** can be released very simply by lifting tensioning lever **172** and hence by corresponding relief of compression spring **115'',** which consists of a plate spring packet, to close the damper. It is only then that the locking force is again built up to the predetermined value, namely exactly the same as before, by pivoting tension lever **172** to its abutment against end stop **182.** It is advantageous to use similar tensioning devices **170** on both sides of the intermediate detent element **160.**

The opening path limiting device embodying the pull rod **150'** and the springs arranged therein, as shown in FIG. **1,** can be used without change and, it is advantageous to arrange these limiting devices in pairs, one on each side of the cover. Thus, in the embodiment of FIG. **2,** there is provided a solution where, for opening of the cover, no additional bearing friction forces originating from the locking device need be overcome during the opening process, which latter must occur very rapidly, in that these, as stated, are no longer present as reaction forces.

The embodiment of the invention shown in FIG. **3** is substantially analogous to that shown in FIG. **2,** and includes two cooperating covers **103''** and **103'''** with respective packing strips **104''** and **104''',** for closing larger relief apertures. The suspensions of the covers **103''** and **103'''** are effected, in the same manner as in FIGS. **1** and **2,** through straps **105'', 105''',** hinge pins **106'', 106'''** and bearing straps **107'', 107'''.**

In the same manner as in FIG. **2,** tensioning device **170** is arranged double so that, through casing or wall **101'',** a closed force system is present. Consequently, two tensioning devices **170'** and **170''** are firmly connected with casing or wall **101''** which contains the explosion-relief aperture to be closed by covers **103'', 103''',** and in turn these tensioning devices consist of the same parts as in FIG. **2,** including the toggle lever system. The two devices are positioned on the same axis, and are so disposed that the detent recesses of intermediate detent element **160',** which is secured to the lower damper **103'''** and projects over the edge thereof, fit between the balls **163'''** and **163''''** of the respective tensioning devices **170'** and **170''.** Thus, in contrast to FIG. **2,** two tensioning devices with toggle lever systems are used.

While the locking system of FIG. **3** differs insignificantly from that shown in FIG. **2,** there is a difference in the opening path limiting device. Near the lateral edges of covers **103''** and **103'''** there are fixed respective bearing blocks **148''** and **148'''** at approximately equal distances from the pivot axes of the respective covers. By correspondingly correlated bearing pins **147''** and **147'''',** guide sleeves **146''** and **146''',** for pull rod **150'',** are rotatably mounted in the respective bearing blocks. At the two ends of pull rod **150''** there are, in the same manner as in FIGS. **1** and **2,** arranged, from the center outwardly, but shown as a whole only

at the top, first compression springs **150'**, **150''**, then plate spring packets **157'** serving as compression springs, and furthest out the nuts **153'** which permit adjustment of the opening paths of the covers. In principle, this opening path limitation involves the same system as in FIGS. **1** and **2**, with the difference that pull rod **150''**, which is articulated to covers **103''** and **103'''**, is no longer mounted on casing or wall **101''** but is guided in parts secured on covers **103''** and **103'''**.

Functionally, there results slight differences from the first two variants. In the closed position of the two covers, the upper cover is held by the packing strip of the lower cover. Pull rod **150''**, by its dead weight and the lower springs guided thereon, slides down far enough to be retained in an end position through springs **150'** and **157'**, correlated to the guide sleeve **146''**, as well as the nut **153'**.

In case of an explosion, the explosive pressure acts largely uniformly on both covers **103''** and **103'''**. Through the packing strip correlated with damper or cover **103'''**, which seals the upper cover, this explosive pressure acts also on tensioning devices **170'** and **170''** which, through intermediate detent element **160'** with the two detent recesses **161'**, hold the covers in the closed position. For the opening of the covers, the spring forces of both tensioning elements **170'** and **170''** must be overcome, and then both covers pivot outwardly about their bearings. During the opening movement, pull rod **150''** slides up through the lower guide sleeve **146'''**. It is only when the lower spring **150''** bears against guide sleeve **146'''** that the elastic limitation of the opening movement commences, in that the two springs **155'** and **155''** are tensioned, substantially alike, simultaneously. Subsequently, there occurs the elastic deceleration of the cover opening movement by the plate spring packets. Instead of the arrangement of covers **103''** and **103'''** one above the other, these may alternatively be mounted with vertical pivot axes **106''** and **106'''** horizontally side-by-side on the housing, for the same mode of operation.

Despite the functionally minor difference of the embodiment of FIG. **3** from that of FIGS. **1** and **2**, it is nevertheless notable inasmuch as, with very simple means, a large explosion-relief aperture can be provided and securely closed, and no disadvantageous forces must be overcome during the opening movement, especially in the bearings.

It will be clear that various structural elements and structural measures may also be used, which are different from those shown in the drawings, so that equivalent structure elements may be regard as coming within the scope of the invention. The essential feature for the invention is the safe closure in normal service and the rapid opening of the damper or cover when an explosion occurs. Because of the high opening speed, it is advantageous to use, in addition to the locking system, an elastic limitation for the opening path.

While specific embodiments of the invention have been shown and described in detail to illustrate the application of the principles of the invention, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. An apparatus for closing an aperture, in a rigid machine housing enclosing a space, by utilizing a cover opening under explosive pressure and cooperating with the machine housing, the improvement comprising, in combination, respective structural parts correlated with the boundary of the aperture formed in the machine housing and with the cover; an elastically releasable locking device installed between such respective structural parts and constructed and arranged so that, responsive to an explosive pressure within the machine housing, the initial restraining force of the locking device is overcome and the cover is abruptly moved from a stable, closed position to a tension-free open position clearing the aperture in the machine housing; said locking device comprising two detent elements elastically displaceable relative to each other; one element being connected with the cover and the counter element being connected with that portion of the machine housing bounding the aperture; the cooperating ends of the two elements being respectively convex and concave for interengagement with each other; an articulated suspension mounting the cover on the machine housing; a guide sleeve pivotally mounted on the cover between the articulated suspension and the opposite edge of the cover and extending perpendicularly to the articulated suspension; a pull rod slidably engaged in said guide sleeve; a compression spring embracing said pull rod between said guide sleeve and an end plate adjacent one end of said pull rod; and a pivot suspension at the other end of the pull rod mounted on another part delimiting the aperture.

2. An apparatus for closing an aperture, as claimed in claim **1**, in which said pivot suspension is mounted on the machine casing at the periphery of the aperture.

3. An apparatus for closing an aperture, as claimed in claim **1**, in which said pivot suspension is mounted on a second cover cooperating with the first-mentioned cover to close the aperture.

4. An apparatus for closing an aperture, as claimed in claim **3**, in which said pivot suspension comprises a pivotal guide sleeve displaceably embracing said pull rod; and a second compression spring embracing the pull rod between said last-named guide sleeve and said other end of said pull rod.

5. An apparatus for closing an aperture, as claimed in claim **1**, in which, when the cover is closed, said compression spring rests loosely on said pull rod and is tensioned to a certain value at a predetermined maximum opening of the cover.

6. An apparatus for closing an aperture, as claimed in claim **1**, in which said compression spring has a progressive spring force characteristic.

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