

DESCRIPTION

TITLE

DEVICE FOR THE SAFE CLOSURE OF AN OPENING IN A PROTECTIVE STRUCTURE

TECHNICAL FIELD

The present invention relates to a device for the safe and reliable closure of an opening in a protective structure, which can be potentially loaded with load peaks up to several hundred bars of short duration, which occur within a few milliseconds or which rise suddenly, particularly as a result of explosions and with a closing device movable in front of the opening.

Devices of this type are used on the one hand for closing openings in the protective structure in the case of external threats, whilst on the other and in particular for the closing of rooms where, such as e.g. in the case of chambers for explosives or ammunition, violent actions can arise due to explosions of the indicated order of magnitude. The closing device must also be able to withstand articles, fragments or liquids hurled against it. In certain cases gastightness is additionally required.

PRIOR ART

With the solutions e.g. known from civil defence applications, it is not readily possible to withstand the aforementioned, extreme loads. Closure devices for civil defence applications only have to withstand comparatively low loads with an order of magnitude of one to a few bars. They can readily be absorbed by an adequately load-bearing door leaf, which is supported on a door frame anchored in the protective structure and is lockable therewith in the closed state.

If the known civil defence solutions were to be used for applications where the aforementioned extreme loads could arise, the door leaf would have to be made much more load-bearing and therefore thicker and stiffer. As a result its decisive natural oscillation times would be very short and the plasticizability thereof correspondingly low. The door leaf and frame would be subject to high stresses even with load peaks of short duration. This would in particular apply in the case of shear stressing, where plasticization,

prior to fracture, usually only occurs to a very limited extent. For relatively small openings, such as accesses for personnel, it would still be possible to handle these problems. However, for larger openings, through which also vehicles, particularly large trucks could pass, such large door leaf masses would arise, that they could no longer be economically implemented and could scarcely be operationally handled. Therefore, already use has been made of complicated additional measures, such as e.g. additional tunnel lengths or baffle plates upstream of the closing device.

The only reasonably cost-effective solution up to now has been the so-called Klotz device, cf. e.g. "Underground Ammunition Storage", Model Test to Investigate the Strength and Effectiveness of a Selfclosing Concrete Block", Norwegian Defence Construction Service, Oslo, Norway, March 1974, with further supporting documents. This device has been especially developed for securing the environment of underground ammunition stores. In the case of accidental explosions in underground ammunition chambers, the Klotz acts as an automatic closing mechanism. The Klotz essentially comprises a wedge-shaped reinforced concrete block, which is placed in the interior of the storage chamber, in front of the exit, but with an adequate spacing for transportation vehicles. The internal pressure in the case of an accident then hurls it in the manner of a wedge into the facing exit and closes the latter.

The Klotz device suffers from the following disadvantages:

The Klotz mechanism is only activated in the case of relatively severe explosions. No protection is provided for less serious accidents.

In order to satisfy the specific operational requirements of the installation (e.g. necessary access dimensions for vehicles), the Klotz must be located at a significant distance from the exit. Consequently, in certain circumstances, there is an escape of a considerable part of the explosion effects (pressure, gases, fragments, fire), before the Klotz has closed the opening, so that protection is inadequate. With explosives or ammunition chambers there is the additional hazard of undetonated ammunition or explosive fragments being hurled out. This could make much more difficult access

to the closing device, whilst clearing up work would be much more difficult.

The Klotz device provides no protection of effects from the other side and also no protection against unauthorized access, unless additional, complicated closing members are used.

Klotz devices can generally only be used once, because during an explosion the Klotz is jammed in its end position and can only be broken away with considerable effort and scarcely in a non-destructive manner.

Klotz devices alone do not make it possible to implement underground ammunition store complexes having several chambers. Even if each chamber was protected by its own Klotz device, there would be a danger, if an explosion occurred in one of the chambers, of the remaining chambers also blowing up.

DESCRIPTION OF THE INVENTION

The problem of the present invention is to provide a closure device of the aforementioned type, which avoids the indicated disadvantages and ensures the complete, necessary protection in an economically and operationally optimum manner. According to the invention, this problem is solved by a device, as defined in claim 1. The inventive device is consequently characterized in that the closure element is supported elastoplastically in or upstream of the opening with respect to the support areas of the protective structure and that the elastoplastic support permits a deformation path or capacity of at least 50 mm.

Preferred developments of the present invention are characterized in the dependent claims.

As a result of the elastoplastic support, the action of the high, short-duration loads is significantly reduced (up to an order of magnitude), so that, compared with the hitherto known solutions with rigid supports, a technically and economically more advantageous solution is obtained. As closure elements are e.g. usable in part door structures with door leafs and frames, which have door thicknesses and support dimensions, which are of an

acceptable level regarding costs and operation.

The present invention also permits economic, technically convincing, reliable solutions, where up to now with the previously used rigid supports, there were doubts whether it was possible to achieve a valid closure device.

The elastoplastic support of the closure element, compared with the rigid support, leads to the further advantage that the dynamic load factor, which in the case of elastic systems and rapidly rising loads can reach 100%, can be significantly reduced or almost completely eliminated. In addition, the rebound of the closure element, as well as resonance effects, directly following load application, are much lower due to the elastoplastic support.

As a result of the closure device according to the invention a closure element comprising e.g. a door leaf and a door frame, can be effectively protected against overstressing, damage and corresponding deformation. Thus, it is possible to avoid the possibility of the closure device no longer being openable and closable following the explosion, because the unit formed by the door leaf and door frame is unimpaired. For the same reasons, it is possible to bring about a gastightness of the closure device and maintain it even in the case of high loads. Thus, the closure device can also provide protection against fire gases, fire heat, fragments and/or flying debris of all types.

For elastoplastic support purposes use is preferably made of discreet shock absorbers, which have a marked, statically and dynamically predeterminable, checkable, extended dynamic yield plateau in the plastic range, in which the dynamic yield force only changes insignificantly. Obviously the deformation capacity must be adequately dimensioned.

Closure devices of the aforementioned type are admittedly mainly stressed by uniform forces acting perpendicular to the plane of the opening. However, non-uniformly acting forces or those having a component parallel to the door leaf plane, can lead to e.g. distributed, discreet, elastoplastic shock absorbers undergoing a non-uniform deformation and consequently the closure element passes into an angled position with respect to the starting position

and individual shock absorbers can even be overstressed. Therefore the closure element is preferably so installed and mounted, e.g. by a suitable sliding support, that non-uniform and/or lateral deformations of the shock absorbers are avoided.

The invention makes it possible to implement underground ammunition store complexes with several ammunition chambers, because the individual ammunition chambers can always be completely mutually compartmentalized.

It is also possible to use shear keys as elastoplastic supports.

Further advantages and developments of the invention can be gathered from the following description of embodiments with reference to the attached drawings.

BRIEF EXPLANATION OF THE DRAWINGS

In the drawings show:

- Fig. 1 A horizontal section (A-A in fig. 2) through a first embodiment of a protective structure closure device according to the invention with a gas-tight hinged door.
- Fig. 2 A vertical section (B-B in fig. 1) through the arrangement of fig. 1.
- Fig. 3 A horizontal section (C-C in fig. 4) through an embodiment of a protective structure closure device according to the invention, with a gas-tight sliding door.
- Fig. 4 A vertical section (D-D in fig. 3) through the arrangement of fig. 3.
- Fig. 5 A detail of a slip joint.

- Fig. 6 A horizontal section (E-E in fig. 7) through a simplified construction of a protective structure closure device according to the invention, for a non-gas-tight sliding door running on rollers.
- Fig. 7 A vertical section (F-F in fig. 6) through the arrangement according to fig. 6.
- Fig. 8 A vertical section through a possible variant to fig. 7, with respect to the arrangement of the elastoplastic shock absorbers and the sliding guide.
- Fig. 9 The characteristic configuration of a possible load diagram for the protective structure closure device according to the invention.
- Fig. 10 The characteristic configuration of another possible load diagram, the so-called "step function" (very rapid load rise to a specific level).
- Fig. 11 The typical, dynamic load-deformation behaviour of an elastoplastic shock absorber for the protective structure closure device according to the invention.
- Fig. 12 A variant to figs. 7 and 8, where in place of the elastoplastic shock absorbers, use is made of an elastoplastically deformable shear key 25.

WAYS OF IMPLEMENTING THE INVENTION

Fig. 1 shows a typical example of a highly load-resistant and gas-tight hinged door closure device. The function of the door leaf 3 is to protect the area 11 against the effects of an explosion caused by war or accident or any other mechanical violent effects in the area of origin 12, hereinafter called the load side. The door leaf 3 and door frame 2 are together supported on the elastoplastic shock absorbers 1. The latter are so

connected to the door frame 2 and supporting structure 10 (connections 4, 5), that the dynamic yield force $P_{Fl, dyn}$ (fig. 11), as well as possible rebounds can be transmitted. It must naturally be ensured that there is an adequate deformation area 6 (fig. 1) for the elastoplastic shock absorbers 1.

A slip joint 9 is provided between the door frame 2 and the supporting structure, which permits an unhindered, cleanly guided displacement of the door frame 2 in the load direction and prevents jamming in the case of asymmetrical loads. It can be given a largely gas-tight construction and prevents the penetration of air or gas pressure. A closure device is adequately gas-tight, if as a result of the ventilation within the protective structure it is possible to maintain an internal overpressure of approximately 20 to 200 Pa.

The fixing of the door leaf 3 to the door frame 2, as well as the seal between door leaf 3 and door frame 2 can take place in conventional manner, i.e. by means of hinges, door closure and door seal 8, because the door leaf and door frame form a unit and are therefore only subject to very small displacements relative to one another.

In that in the closed state the door leaf 3 is introduced in all-round, non-displaceable manner in the door frame 2, it is also protected against lateral displacements in the case of door-parallel forces, e.g. as a result of the action of fragments.

The connections 4, 5 can optionally also ensure gas-tightness. In cases where neither the specific construction of the elastoplastic shock absorbers 1, nor the slip joint 9 ensure gas-tightness, this function can be fulfilled by a thick plate 7. In addition, cover plates 24 can be provided on the load side 12 to prevent pressure surges penetrating the slip joint 9.

Fig. 2 shows a vertical section through the arrangement of fig. 1, the elastoplastic shock absorbers 1 only being positioned laterally.

A possible alternative to fig. 2 comprises the elastoplastic shock absorbers 1 also being arranged at the top and bottom, i.e. on all four sides, as

shown in fig. 4. Further possibilities, such as e.g. the positioning of elastoplastic shock absorbers 1 at the top and bottom only, on three sides or only at individual locations would also be possible.

Fig. 3 shows an example of a highly load-resistant, gas-tight sliding door closure device. The door leaf 3 is laterally displaceable into a door recess 21 and a floor groove 22 (fig. 4) or rollers provided there serve as a guide. Much as in the case of the hinged door (fig. 1), the door leaf 3 and door frame 2 are supported as a unit on the elastoplastic shock absorbers 1. As a result of a pressing device 13 the door leaf 3 is secured against rebound forces and simultaneously pressed against the door seal 8. An expansion joint 14 is located on the load side 12. A circumferential slip joint 9 ensures that the door leaf 3 and door frame 2 can be moved in freely and cleanly guided manner against the elastoplastic shock absorbers 1.

Fig. 4 shows the arrangement of fig. 3 in vertical section. The elastoplastic shock absorbers 1 are also located here at the top and bottom, i.e. on all four sides. Alternatives, as shown in fig. 2, are also possible. In cases where (comparatively low) loads from the other side of the closure device must be expected, the pressing device 13 and the door leaf 3 are to be designed for the corresponding forces on the basis of a mainly rigid system. Naturally, also for this case, shock absorbers 1 can be placed in the expansion joint 14, should this prove necessary and economic, possibly in the form of intermediate foam layers 18. This leads to a closure device, which, as desired, can protect the area 11 against an event in area 12, or can protect area 12 against an event in area 11.

In figs. 3 and 4 there are additional cover plates 24 acting against laterally penetrating pressure surges. As a shock protection measure, i.e. as a measure for the case that the environment of the door is moved in shock-like manner, in fig. 4 the engagement dimension d_1 of the door leaf 3 in the door frame 2 is greater than the clearance d_2 of the door leaf 3 in door frame 2 necessary for displacement purposes.

Fig. 5 shows a possible construction of the slip joint 9. It is important that the sliding faces have an adequate planarity, so that a clean guidance

is ensured and the door frame cannot jam in the slip joints. This can e.g. be achieved with correspondingly stiffened steel plates 19. A slip layer 20, e.g. of graphite or grease between the plates 19 reduces the sliding resistance to a necessary level.

Figs. 6 and 7 show an example of an extremely high-resistant closing device for cases where no gas-tightness is required. In this case, there is a rolling door 3 running on rollers 23. Fig. 6 shows the door leaf 3 in the closed state. In this case, the elastoplastic shock absorbers 1 are fixed in the lateral, vertical door recesses 21. The small gap 15 between the elastoplastic shock absorbers 1 and the door leaf 3 is kept to a minimum, so that it is possible to just respect the expected installation and operational tolerances. A possible alternative for the arrangement of the elastoplastic shock absorbers 1 consists of fitting the latter to the door leaf 3, instead of to the door recesses 21.

The described arrangement indicates that there can be a certain "leakage" of explosion gases through the gaps 16 between the door leaf 3 and door recesses 21, i.e. a completely tight closure device is not obtained. In this example, there is also no clean guidance of the door leaf 3 and/or door frame, as is achieved in the first example (figs. 1 to 5) by means of the slip joints 9. This naturally simplifies the design, but means that a possible jamming of the door leaf 3 must be accepted if asymmetrical loads occur, which although not rendering impossible door opening following an extreme load, certainly makes it more difficult. However, this limitation is acceptable and appropriate for many practical applications.

In cases, where it is necessary to absorb loads from the other side of the closure device, it is possible to have further shock absorbers 7, as indicated in fig. 6. They are used optionally additionally for absorbing rebound forces. Using further elastoplastic shock absorbers, the closure device can also be made completely symmetrical with respect to the areas 11 and 12. This also applies in the case of other embodiments shown in the drawings.

The drawings do not show the closures or locking means for the door leaves,

which lock the door in the closed state. They can also be given an elastoplastic construction, so as to protect them appropriately against shocks generated by the explosion action.

As alternatives fig. 8 shows elastoplastic shock absorbers 1 at the top and bottom. This type of arrangement is advantageous where the height of the door leaf is much smaller than its width and where simultaneously a coverable floor groove 22 causes no operational difficulties. When the door leaf shape is approximately square, it may prove economic to provide elastoplastic shock absorbers 1 on all four sides, i.e. on both sides, as well as at the top and bottom.

Fig. 9 shows a typical load diagram P/t , which essentially comprises a short-duration (up to t_s , a few ms) and extremely high load peak with a peak pressure P_s (up to several hundred bars) and a following, longer (up to t_g , a few 100 ms) load P_g at a much lower level (up to several 10 bar). With a large $P_s:P_g$ ratio, which is often the case in practice, the design with respect to the dynamic bearing loads becomes critical if rigid supports are provided and often leads to uneconomic solutions.

This problem is counteracted in an optimum manner by the elastoplastic shock absorbers. The extreme load peak (P_s , t_s) accelerates the (flexibly mounted) door frame and/or door leaf with the mass m in the load direction to the velocity v . The kinetic energy $mv^2/2$ is absorbed by the elastoplastic shock absorbers and is then converted into deformation work $P_{Fl,dyn} \cdot \delta$ and then into heat, $P_{Fl,dyn}$ representing the dynamic yield capacity and δ the deformation capacity of the shock absorbers. The latter, like the door leaf, can be dimensioned in such a way that with their dynamic yield capacity they can absorb smaller, quasi-static loads (P_g , t_g) without significant deformation. The shear and bending stresses of the door leaf and door frame are reliably limited. The bearing loads can never be chosen greater than the sum of the dynamic yield capacities of the shock absorbers, provided that the latter are given an adequate deformation capacity (fig. 11).

Fig. 10 shows another typical load configuration, the so-called "step function". It essentially comprises a load P very rapidly rising (theoretic-

ally: suddenly, $t_r = 0$) to a maximum value P_{max} , which is maintained for a certain time or at least only decreases slowly. If such loads are applied to linear-elastic systems, dynamic load factors up to max 100% occur. The advantage of the closure device system according to the invention is that these dynamic load factors can be reduced or completely avoided. For example, as shown in fig. 10, the dynamic load factor can be reduced to 10%, in that the shock absorber dynamic yield capacity $P_{Fl,dyn}$ is fixed at 1.1 P_{max} .

Fig. 11 shows the typical, dynamic load-deformation behaviour of an elastoplastic shock absorber, as used in the closure device system according to the invention. It is important to ensure that it has a marked, checkable, extended yield plateau, which can also be predetermined for a high deformation velocity, and that the dynamic yield capacity $P_{Fl,dyn}$ in the plastic deformation range only changes insignificantly. This ensures a reliable forecast of the behaviour of the closure device system under the design load. It must obviously be ensured that the plastic deformation capacity δ_{max} is adequate. This can readily amount up to several 100 mm and can e.g. be designed for up to 500 mm. If this is not the case, there is a hard impact of the door on the support with shock absorber failure. It can then still absorb limited further loads until its load carrying capacity is exhausted.

Finally, fig. 12 shows a variant relative to figs. 7 and 8. In place of the elastoplastic shock absorbers 1, use is made of an elastoplastically deformable shear key 25, which is embedded on the one hand in the door leaf 3 and on the other runs in a guide groove 26. A corresponding arrangement is provided at the top. The shear key can be a steel plate with a thickness of one to a few centimetres. The gap 16 between the door leaf 3 and the structure 10 must be at least roughly twice the thickness of the shear key 25. The guide groove 26 must be roughly twice as wide as the thickness of the shear key 25. In the case of a load, plastic deformation paths between 50 and 100 mm or more can be implemented (cf. dotted line representation of the deformed shear key).

All the drawings are at a scale of 1:100. However, this does not mean that the implementation of the invention is restricted to this scale. The

indication of the scale is merely intended to provide an impression of the possible or usual size of the closure devices according to the invention.

LIST OF REFERENCE NUMERALS

1	Elastoplastic shock absorber
2	Door frame
3	Door leaf
4	Connection to supporting structure
5	Connection to door frame
6	Deformation area
7	Thick plate
8	Door seal
9	Slip joint
10	Supporting structure
11	Area to be protected
12	Area of origin or load side
13	Pressing device
14	Expansion joint
15	Gap
16	Gaps
17	Further shock absorbers
18	Intermediate foam layers
19	Steel plates
20	Slip layer
21	Door recess
22	Floor groove
23	Rollers
24	Cover plates
25	Shear key
26	Guide groove



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CLAIMS

1. Device for the safe closure of an opening in a protective structure (10), which is potentially loaded by loads having peaks up to several hundred bars, which are of short-duration, occurring within a few milliseconds or which suddenly rise and are in particular caused by explosions, with a closure element (2, 3) movable in front of the opening, characterized in that the closure element (2, 3) is elastoplastically supported in or in front of the opening with respect to support areas of the protective structure (10) and that the elastoplastic supports permit a deformation capacity of at least 50 mm.
2. Device according to claim 1, characterized in that the closure element (2, 3) is constructed in a substantially rigid manner, i.e. is substantially dimensionally stable with respect to the indicated loads.
3. Device according to claim 1, characterized in that the closure element (2, 3) is elastoplastically supported by means of individual, discreet, elastoplastic shock absorbers (1).
4. Device according to claim 3, characterized in that the elastoplastic shock absorbers (1) have a load-deformation behaviour with a marked yield plateau in the plastic range.
5. Device according to one of the claims 1 to 4, characterized in that the closure element (2, 3) is elastoplastically supported on all sides, on three sides or on two parallel, facing sides.
6. Device according to one of the claims 1 to 5, characterized in that the closure element comprises a door leaf (3), which is elastoplastically supported with respect to the support areas of the protective structure (10).
7. Device according to claim 6, characterized in that the support areas are formed by a door frame rigidly anchored in the protective structure (10).
8. Device according to one of the claims 1 to 5, characterized in that the

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closure element comprise a door leaf (3) and a door frame (2), the door leaf (3) being supported substantially rigidly relative to the door frame (2) and the door frame (2) is elastically supported relative to the support areas of the protective structure (10).

9. Device according to claim 8, characterized in that a seal (8) is provided between the door leaf (3) and door frame (2).

10. Device according to one of the claims 6 to 9, characterized in that the door leaf (3) is constructed as a hinged, sliding or rolling door or as a vertically or sloping-movable door.

11. Device according to one of the claims 1 to 10, characterized in that a gap is provided between the closure element (2, 3) and the support areas of the protective structure (10) and said gap is bridged and sealed by a deformable sealing element (7).

12. Device according to one of the claims 1 to 11, characterized in that for absorbing loads from different, opposing directions, the closure element (2, 3) is elastically mounted on its two sides relative to support areas of the protective structure (10).

13. Device according to one of the claims 1 to 12, characterized in that the closure element (2, 3) is guided in the expected load direction by means of a guide, said guide preferably being constructed in the form of several, substantially gas-tight slip joints (9) and is preferably so constructed that a jamming of the closure element is impossible, even with asymmetrical and/or partly door-parallel load components.

14. Device according to one of the claims 8 to 13, characterized in that there is an elastic locking with a corresponding clearance, particularly of the door leaf (3) relative to the door frame (2).

15. Device according to one of the claims 8 to 14, characterized in that the door leaf (3) is constructed as a hinged door and is embedded in a manner secured against lateral displacement in the door frame (2) in the

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closed state.

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16. Device according to one of the claims 8 to 14, where a joint (9, 14) is provided between the door frame and the supporting structure, characterized in that said joint is covered on the load side with cover plates (24).

17. Device according to claim 10, characterized in that the door leaf (3) is constructed as a sliding or rolling door or as a vertically or sloping-movable door and parallel to the door leaf plane and in particular perpendicular to the displacement direction has a certain clearance (d2) in a door frame (2) or a door recess (21) and that said clearance (d2) is smaller than the engagement dimension (d1) of the door leaf (3) in the door frame (2) or door recess (21).

18. Device according to one of the claims 1 or 2, characterized in that in the case of a sliding or rolling door, the closure element (3) is elastically supported with one or more shear keys (25) anchored therein and guided in one or more guide grooves (26) in the supporting structure (10).

19. Device according to claim 18, characterized in that between the closure element (3) and the supporting structure (10) is provided a gap (16) bridged by the shear key or keys, the thickness of the shear key (25) is smaller than the dimension of the gap (16) and the guide groove is roughly twice as wide as the thickness of the shear key.

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ABSTRACT

The device according to the invention is used for closing openings in protective structures, which are subject to the action of dynamic loads with high, short-duration load peaks and/or a very rapid load rise. The device is also suitable for the closing or sealing of rooms, where explosions or other mechanical violent actions are to be expected and for the safe and reliable enclosing or sealing in of the actions and subsequent effects of such events. In the case of the device according to the invention the closure element (2, 3) closing the opening is supported by elastoplastic shock absorbers (1) with respect to support areas of the protective structure (10). Preferably guides (9) are provided with regards to the displacement of the closure element expected in the case of a load. The inventive structure can be in the form of a hinged, rolling or sliding door and can optionally even be gas-tight. It can also be constructed so as to act in opposite load directions. Elastoplastic locking means and clearances between the door leaf and door frame preferably ensure that the closure element is protected against the effects of a shock, occurring during an explosion, or during an earthquake or the like.

(Fig. 1)

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CLAIMS

1. Device with a closure element (2, 3) and a support positioned outside the closure element (2, 3) for the safe closure of an opening in a protective structure (10), which is potentially loaded by loads having peaks up to several hundred bars, which are of short-duration, occurring within a few milliseconds or which suddenly rise and are in particular caused by explosions, the closure element (2, 3) being movable in front of the opening, characterized in that the closure element (2, 3) is elastoplastically supported in or in front of the opening with respect to support areas of the protective structure (10) and that the elastoplastic support permits a deformation path of at least 50 mm.
2. Device according to claim 1, characterized in that the closure element (2, 3) is constructed in a substantially rigid manner, i.e. is substantially dimensionally stable with respect to the indicated loads.
3. Device according to claim 1, characterized in that the closure element (2, 3) is elastoplastically supported by means of individual, discreet, elastoplastic shock absorbers (1).
4. Device according to claim 3, characterized in that the elastoplastic shock absorbers (1) have a load-deformation behaviour with a marked yield plateau in the plastic range.
5. Device according to one of the claims 1 to 4, characterized in that the closure element (2, 3) is elastoplastically supported on all sides, on three sides or on two parallel, facing sides.

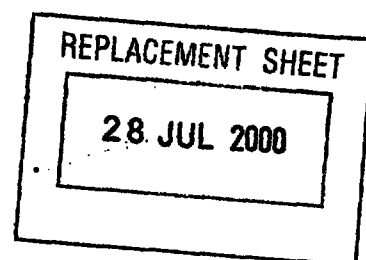
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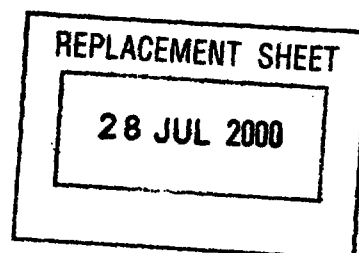
CLAIMS

1. Device for the safe closure of an opening in a protective structure (10), which is potentially loaded by loads having peaks up to several hundred bars, which are of short-duration, occurring within a few milliseconds or which suddenly rise and are in particular caused by explosions, with a closure element (2, 3) movable in front of the opening, characterized in that the closure element (2, 3) is elastoplastically supported in or in front of the opening with respect to support areas of the protective structure (10) and that the elastoplastic supports permit a deformation capacity of at least 50 mm.
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5. Device according to one of the claims 1 to 4, characterized in that the closure element (2, 3) is elastoplastically supported on all sides, on three sides or on two parallel, facing sides.





6. Device according to one of the claims 1 to 5, characterized in that the closure element comprises a door leaf (3), which is elastoplastically supported with respect to the support areas of the protective structure (10).
7. Device according to claim 6, characterized in that the support areas are formed by a door frame rigidly anchored in the protective structure (10).
8. Device according to one of the claims 1 to 5, characterized in that the closure element comprise a door leaf (3) and a door frame (2), the door leaf (3) being supported substantially rigidly relative to the door frame (2) and the door frame (2) is elastoplastically supported relative to the support areas of the protective structure (10).
9. Device according to claim 8, characterized in that a seal (8) is provided between the door leaf (3) and door frame (2).
10. Device according to one of the claims 6 to 9, characterized in that the door leaf (3) is constructed as a hinged, sliding or rolling door or as a vertically or sloping-movable door.
11. Device according to one of the claims 1 to 10, characterized in that a gap is provided between the closure element (2, 3) and the support areas of the protective structure (10) and said gap is bridged and sealed by a deformable sealing element (7).
12. Device according to one of the claims 1 to 11, characterized in that for absorbing loads from different, opposing directions, the closure element (2, 3) is elastoplastically mounted on its two sides relative to support areas of the protective structure (10).





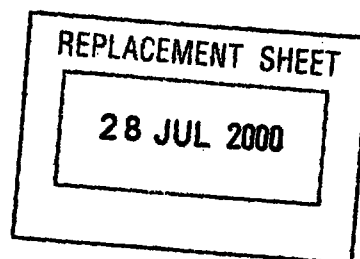
13. Device according to one of the claims 1 to 12, characterized in that the closure element (2, 3) is guided in the expected load direction by means of a guide, said guide preferably being constructed in the form of several, substantially gas-tight slip joints (9) and is preferably so constructed that a jamming of the closure element is impossible, even with asymmetrical and/or partly door-parallel load components.

14. Device according to one of the claims 8 to 13, characterized in that there is an elastoplastic locking with a corresponding clearance, particularly of the door leaf (3) relative to the door frame (2).

15. Device according to one of the claims 8 to 14, characterized in that the door leaf (3) is constructed as a hinged door and is embedded in a manner secured against lateral displacement in the door frame (2) in the -closed state.

16. Device according to one of the claims 8 to 14, where a joint (9, 14) is provided between the door frame and the supporting structure, characterized in that said joint is covered on the load side with cover plates (24).

17. Device according to claim 10, characterized in that the door leaf (3) is constructed as a sliding or rolling door or as a vertically or sloping-movable door and parallel to the door leaf plane and in particular perpendicular to the displacement direction has a certain clearance (d2) in a door frame (2) or a door recess (21) and that said clearance (d2) is smaller than the engagement dimension (d1) of the door leaf (3) in the door frame (2) or door recess (21).





18. Device according to one of the claims 1 or 2, characterized in that in the case of a sliding or rolling door, the closure element (3) is elastically supported with one or more shear keys (25) anchored therein and guided in one or more guide grooves (26) in the supporting structure (10).

19. Device according to claim 18, characterized in that between the closure element (3) and the supporting structure (10) is provided a gap (16) bridged by the shear key or keys, the thickness of the shear key (25) is smaller than the dimension of the gap (16) and the guide groove is roughly twice as wide as the thickness of the shear key.

