Jan. 6, 1970 J. J. DE BAAN ET AL 3,487,494

AUTOMATIC DOOR CLOSING APPARATUS

Filed June 15, 1967 4 Sheets-Sheet 1

FIG.1

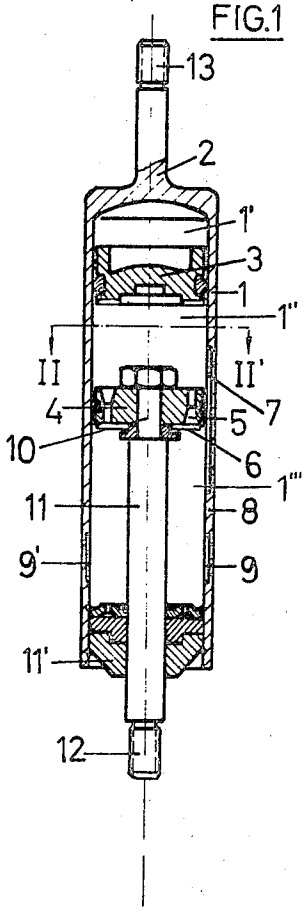


FIG. 2

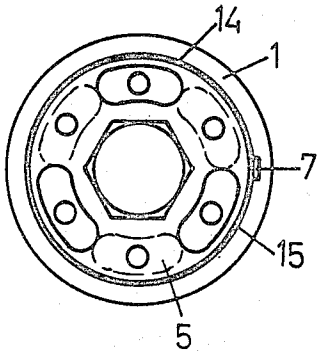
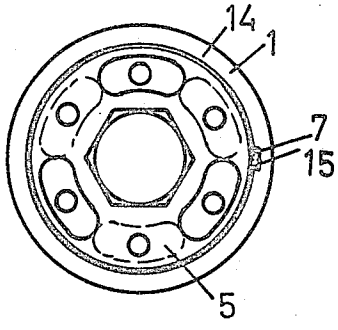


FIG. 3



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AUTOMATIC DOOR CLOSING APPARATUS

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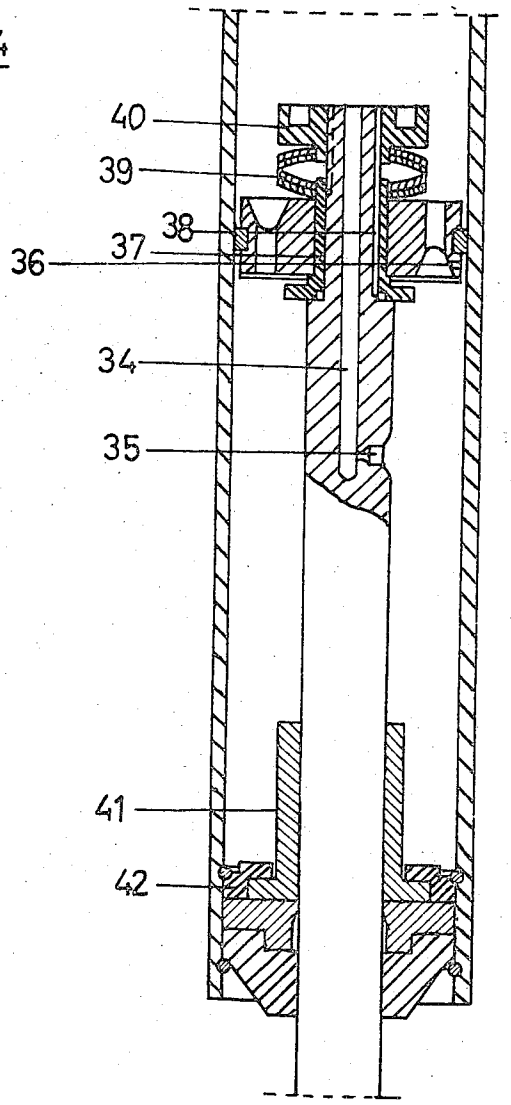
FIG.4



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AUTOMATIC DOOR CLOSING APPARATUS

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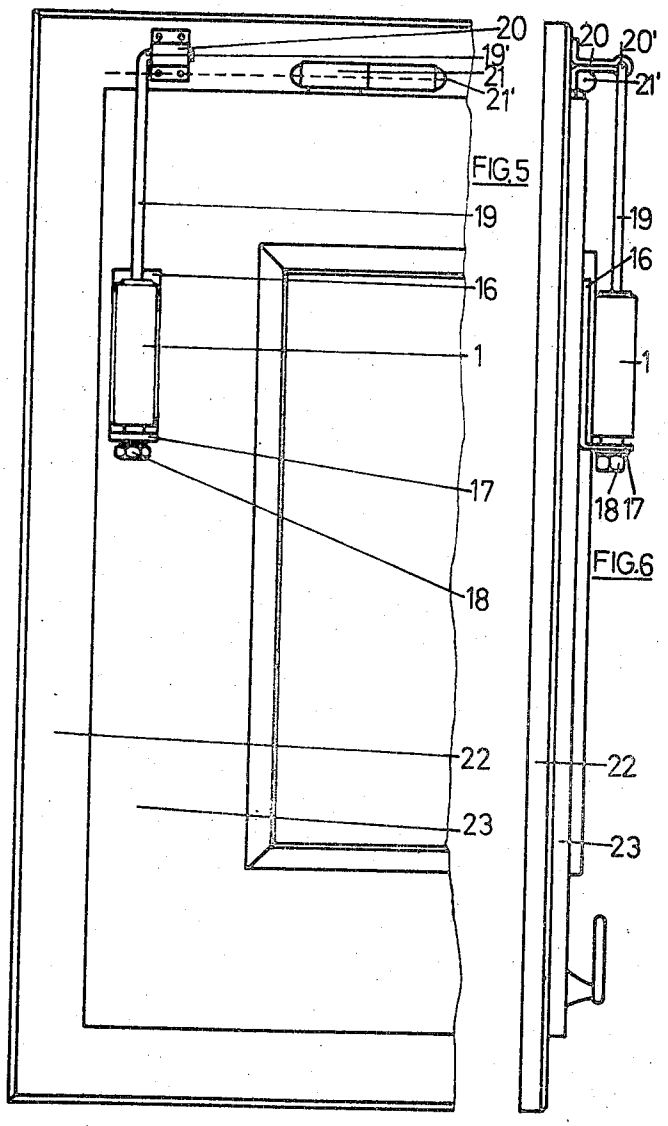

FIG. 5

FIG. 6

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FIG. 7

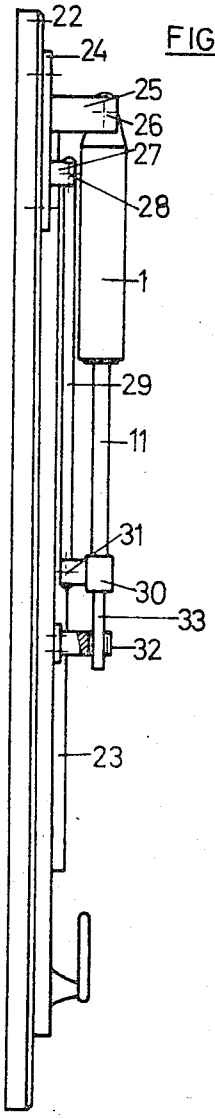
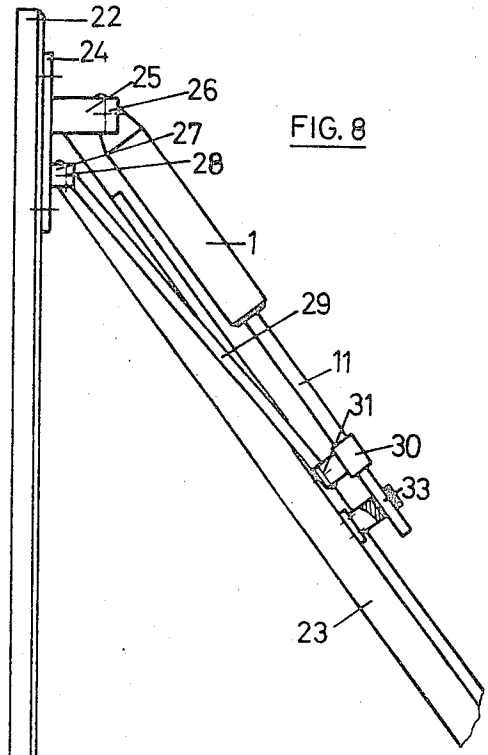


FIG. 8



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3,487,494

AUTOMATIC DOOR CLOSING APPARATUS

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Int. Cl. E05f 3/04
U.S. Cl. 16—51 16 Claims

ABSTRACT OF THE DISCLOSURE

The invention relates to an automatic door closing apparatus having a shock-absorbing plunger, which is displaceable in a tubular body engaging a pivotable door and a door frame thereof and which is fixed at the end of a plunger rod, and an energy-storing means which absorbs energy expended in opening the door and liberates this energy when the door is being closed.

The invention has the object of providing a door closing apparatus of the kind described above and which is of particularly compact dimensions, so that it can be used in association with practically any door, i.e., both house doors and doors inside apartments or other forms of dwelling. The novel apparatus must have available a resilient force which is equal to the forces acting on the door to close it at any given time; the shock-absorbing door closing apparatus must also be susceptible of appropriate adjustment of its damping or shock-absorbing power. Furthermore, it is necessary that the apparatus should be capable of installation by unskilled personnel, and should be extremely reliable in its operation.

According to the invention these requirements are broadly satisfied by the provision of a door closing apparatus which is characterised in that the energy-storing means is pressurised gas which is contained in a cylinder which is provided with a base and with a displaceable, tight-sealing, inner plug or stopper, and the cylinder contains two chambers which are charged with a shock-absorbing liquid and are defined by a shock-absorbing plunger which is formed with a one-way valve, one of these chambers being provided with a stuffing box which provides a tight seal in the region in which the plunger rod passes through the wall of the cylinder, and the cylinder and the plunger rod being respectively hinge-connected to the door and to the door frame. An automatic door closing apparatus constructed in this way not only requires an extremely small volume for accommodating the energy-storing means but can operate with a very short working stroke of its damping (shock-absorbing) plunger. The gas which is maintained under high pressure, e.g., about ten atmospheres, is further compressed when the door is being opened and the plunger rod inwardly thrust into the associated cylinder, this additionally compressed gas exerting on the displaceable, tight-sealing plug or stopper element a pressure such that the plunger rod is automatically pushed out of the cylinder and thereby closes the door. Temperature fluctuations occurring in the different seasons of the year have practically no effect on the operation of the novel door-closing apparatus as defined above. For an external diameter of the cylinder of about 2.5 cms., the cylinder can have an overall length of about 10 cm., whereas in the prior art constructions the cylinders have been about 0.75 m. in length with greater external diameters than are used in the case of the present invention.

A convenient form of construction of the invention consists in arranging that the shock-absorbing plunger

has longitudinal bores whose openings located closer to the plunger rod are closed off by an annular plate which is capable of limited axial movement and which is of smaller cross-section than the shock-absorbing plunger. Further, it is desirable to provide means for the passage of the shock-absorbing liquid whose cross-section can vary in the region of the working stroke of the plunger so as thereby to ensure a speed of withdrawal of the plunger from the cylinder which, during the pivotal motion of the door and according to the particular conditions prevailing at any given time, will be either smaller or greater than that occurring while the door is being urged into the lock. The door can always be actuated with a very small resistance owing to the provision of a displaceable plate which is lifted during the opening of the door so as to uncover the bores in the plunger. The speed of the door during opening thereof is thus preferably controlled by appropriately varying the cross-section of the ducts available for flow-through of the shock-absorbing liquid. For this purpose the door-closing apparatus may be so constructed that there is provided, in the cylinder wall, a longitudinal groove which extends along the region of the working stroke of the damping plunger, this groove forming with a sealing element of the damping plunger a liquid flow cross-section which is smaller than that of the bores in the damping plunger. This longitudinal groove may, for example, be interrupted for part of its length or a number of these grooves may be provided in places. It is expedient to arrange for a resilient annular sealing element to engage this longitudinal groove, this said sealing element being prevented from turning relative to the plunger and the gap provided therein being capable of being turned together with the plunger, so that the effective flow resistance of the openings available for flow-through of the damping liquid may be varied so as to obtain a differing degree of absorption of shocks occurring. It is possible to control the apparatus for differing extents of shock-absorption by arranging an angular scale on the cylinder, in the region thereof in which the plunger passes through its wall, a co-operating mark on the piston rod pointing to this scale. In this way the apparatus can be set for different damping effects which may, for example, be a function of different ambient temperatures.

According to a further feature of the invention it is possible to provide for the variation of the effective liquid flow cross-section, which varies according to the particular portion of the working stroke of the damping plunger, by modifying the proposed apparatus in such a way that plunger rod of the shock-absorbing plunger has a longitudinal groove starting from its end surface located closer to the plunger, and there is provided a tubular stuffing box which extends into the chamber of the cylinder and surrounds the plunger rod, the longitudinal bore having a length corresponding to that of the stuffing box and being in communication at its end with a transverse bore which passes through the plunger rod, and the plunger is also provided with a continuously operative opening for the passage of the liquid therethrough, the cross-section of this opening being smaller than that of the longitudinal or transverse openings. By this arrangement it is ensured that the door, when being closed, will first move with great speed because the damping liquid can be distributed, via the longitudinal and transverse bores which have a relatively large flow cross-section, between the two chambers of the cylinder, very little resistance being thus presented to the flow of the shock-absorbing liquid for achieving this controlled distribution. As soon as the door has reached the vicinity of the door lock, the stuffing box seals off the transverse bore, so that the shock-absorbing liquid must then pass through the continuously effective opening which is of smaller cross-section, with the result that the speed of the movement of the door is re-

duced and the door can be gently urged into its lock. The continuously effective opening may conveniently be located, as a transverse bore, in the cylindrical outer wall of the shock-absorbing plunger between the sealing element of the latter and the edge of the annular surface of the plunger located closer to the stuffing box, and may communicate with bores which are formed in the plunger and are closed off during closure of the door by the above-mentioned displaceable annular plate. It may be necessary to take precautions to prevent overloading and thus damage being caused to the apparatus when, for example, it is attempted to thrust the door into its lock by hand. These precautions may conveniently take the form of arranging for the plunger to be mounted on a sleeve which is shiftable on a neck portion of the plunger rod having reduced cross-section this bushing being shiftable against the biasing force of a spring supported from the end of the plunger rod so as to thereby absorb inadmissibly great forces applied from outside with a view to closing the door, and to uncover a longitudinal groove disposed in the said neck portion of reduced cross-section of the plunger rod; when this longitudinal groove is thus uncovered by the shiftable plunger the flow of shock-absorbing liquid will be increased. When this provision is made, it is practically impossible for the door-closing apparatus to be overloaded and thus damaged.

The small length and special construction of the novel door-closing apparatus, and also the necessity of providing a general assembly of the equipment which is as compact and space-saving as possible, make it necessary to install the apparatus between the door and door frame in different manner from that practised with conventional door-closing apparatuses. A particularly suitable arrangement designed to satisfy this requirement is characterised in that the cylinder is capable of executing limited pivotal movement in a horizontal plane relative to the door, and the plunger rod is so articulated to the door frame, by way of a part constituting an extension of the plunger rod, that the sum of the projections of the distance of a swivel joint from the axis of the door hinge on to the plane of the door frame and on to the plane which is perpendicular to the plane of the door frame, and which intersects the axis of the door frame, is approximately equal to the working stroke of the shock-absorbing plunger. In this way the cylinder can be so attached to the door, by way of a threaded nut, that the cylinder can be brought into various positions within an overall range of angular (pivotal) adjustment, and can be locked in the angular position thus selected, thus modifying the damping or shock-absorbing characteristic of the apparatus in accordance with particular circumstances.

According to a further feature of the invention the plunger rod can be moved by means of an arm hingedly connected both to the rod and to the door frame, and a triangular structure is formed by two arms which are hingedly interconnected by means of joints connected to the door frame, one of these arms comprising an extension passing beyond an element which interconnects the plunger rod to a swivel supporting element for the swivel mounting, this said extension being shiftable, approximately parallel to the plane of the door, within a guide sleeve fixed to the door. If this particular form of construction is adopted there will be no possibility that the force exerted by the pressurised gas will lead to the production of a torque such as will act on the mountings or hinges of the door and thereby overload them. What will actually occur will be that the forces exerted by the said pressurised gas will be, insofar as they are directed parallel to the plane of the door, practically entirely absorbed by the arm articulated to the plunger rod. These forces cannot be transmitted because the extension of the plunger rod which passes, in the direction of the plane of the door, beyond the swivel joint connection element can move practically without resistance within its guide sleeve. These forces which are thus directed perpendicularly to the plane of the door will be almost entirely transmitted to the door, and can be utilized for closing the latter.

Embodiments of the invention are described below with reference to the accompanying drawings, in which:

FIG. 1 is a first embodiment of the novel door closing apparatus, in longitudinal section.

FIG. 2 is a plan view of the plunger of the apparatus shown in FIG. 1 as seen from the level of section line II–II'.

FIG. 3 is a plan view similar to that of FIG. 2 in which the shock-absorbing plunger has been rotated so as to assume a different position of adjustment.

FIG. 4 is a modified version of the apparatus shown in FIG. 1 and shows the portion lying below the section line II–II' of FIG. 1.

FIG. 5 is a view as seen from the front of an arrangement by which the novel door closing apparatus is assembled on the door and door frame.

FIG. 6 is a plan view of the embodiment shown in FIG. 5.

FIG. 7 shows a different manner of mounting the novel door closing apparatus from the door and door frame, and is shown in plan view with the door closed.

FIG. 8 is a view corresponding to that of FIG. 7 when the door is open.

The door closing apparatus shown in FIG. 1 consists of the cylinder **1** which is closed off at one end by the base **2**, the cylinder **1** initially containing a volume of gas occupying the space **1'**. The shiftable plug or stopper **3** determines the area occupied by the pressurized gas according to its position within the cylinder at any given time. In the region of the cylinder adjacent to the plug or stopper **3** the shock-absorbing plunger **4** divides the available space into the two chambers **1''** and **1'''** both of which are filled with pressurised liquid. When the shock-absorbing plunger is thrust inwardly into the cylinder to bores **5** formed in the plunger **4** are freed by the annular plate **6** which is capable of limited axial movement, whereas these bores **5** are closed off by plate **6** when the plunger is being retracted from the cylinder. A longitudinal groove **7** is located in the first portion of the working stroke of the shock-absorbing or damping plunger; this groove **7** is interrupted in an intermediate region **8** and in the last portion of the working stroke of the damping plunger is continued by the short longitudinal groove **9**, opposite which is provided an additional longitudinal groove **9'** serving to widen the effective flow cross-sectional area available for flow of the damping liquid.

The plunger rod **11** has at its inner end a narrowed neck portion **10** serving for attachment of the damping plunger **4**. Movement of the plunger rod **11** in and out of the cylinder is guided by the stuffing box **11'** which is formed in conventional manner. The end of the plunger rod **11** which projects from the cylinder terminates in a threaded pin **12**. In analogous manner the base **2** of the cylinder **1** is fitted with a threaded pin **13**.

It is clear from FIG. 2 that the resilient annular sealing element **14** is compressed so as to define a narrow, free gap **15** when the plunger is in its inwardly thrust position relative to the cylinder **1**; in FIG. 2 this gap **15** is located at an angle of about 30° relative to the longitudinal groove **7** formed in the cylinder **1**. As has been explained above, this adjustment corresponds to a resistance to the flow of the shock-absorbing liquid suitable when the latter is of average viscosity and for mean ambient temperatures. The greatest flow-restricting effect is imposed on the shock-absorbing liquid when the free gap **15** lies directly opposite the longitudinal groove **7**, whereas the least flow resistance is obtained when the free gap **15** acts to increase the effective cross-section of the longitudinal groove **7** (FIG. 3). When air or some other gas is used instead of shock-absorbing liquid, the flow cross-sectional areas affecting the passage of the

shock-absorbing medium must be reduced by an appropriate amount.

In the embodiment of the invention shown in FIG. 4 the alteration in the flow cross-section available to the pressurised shock-absorbing medium is obtained by virtue of the fact that the piston rod has a longitudinal bore **34** in its front region and a transverse bore **35** located at the end of this longitudinal bore. The transverse bore **35** is rounded-off in the region in which its opens out in the wall of the plunger rod, so that the stuffing box **41** cannot damage this transverse bore **35** when it arrives in the region of the stuffing box **41**, which extends inwardly in tubular manner. The stuffing box **41** is made of a smooth-surfaced material having a good resistance to the pressurised liquid used, i.e., it is made of brass or of a synthetic plastics material for example. The foot or base of the stuffing box is pressed by a locking ring **42** against a resilient sealing element which in turn abuts against an annular closure cap closing off the cylinder.

Whereas the path of liquid flow defined by the bores **34** and **35** is sealed off by the stuffing box **41** shortly before the door is in its fully closed position, the path of liquid flow defined by the bore **36** formed in the side wall of the plunger and by the plunger bore **5** is maintained continuously in the open condition. In this way it is ensured that the door will close slowly and thus gently. When the door is thrust to with some degree of violence, a large liquid pressure is exerted on the annular plate **6**, whereby the plunger, together with the bushing carrying it and which surrounds the neck portion **10** of the plunger rod, is thrust, against the biasing force of the packet of annular plate springs **39**, in the direction of the nut **40** which serves as an abutment defining the working stroke of the plunger. Abrupt movements of the door are thus resiliently damped. At the same time entrance into the longitudinal groove **38** is freed, thereby providing an additional cross-sectional area for compensation of pressure alterations occurring within the cylinder.

Owing to the shortness of the working stroke of the damping plunger of the novel door closing apparatus, it is possible to dispense with angled or hinged linkages. In the arrangement shown in FIGS. 5 and 6 it suffices to hingedly attach the cylinder **1** to the door in such manner that the cylinder is pivotable to a certain extent in a horizontal plane; an angled element **16** is attached to the door and comprises a bent arm **17** in which a bore is formed through which passes the threaded pin **13** of the cylinder **1** secured by the threaded nut **18**. The bore is of sufficient size to allow play to accommodate the pivotal movements of the cylinder **1**, whose slight positional alterations may be compensated by means of a resilient plate for example. The part **19** forming an extension of the plunger rod **11** is hingedly connected to the door frame **22**. The joint **20'** thus formed is so arranged, relative to the axis **21'** of the door hinge **21**, that the sum of the projections of the distance of joint **20'** from the axis **21'** of the door hinge on to the plane of the door frame, and on to the plane which is normal to the said plane of the door frame and which intersects the axis **21'** of the door hinge, is approximately equal to the working stroke of the shock-absorbing plunger. In the approximately right-angled open position of the door the shock-absorbing plunger is at its extreme inwardly thrust position within the cylinder, whereas when the door is released the plunger is thrust out of the cylinder by the expansion of the pressurised gas so as to thereby shut the door. If the door **23** is slightly pivoted beyond its maximum position of opening, this will cause the open position of the door to be maintained.

In the simplest form of construction the part **19** is formed with an arm **19'** which is angled off so as to extend vertically and to engage in the hinge mounting or socket **20** fixed to the door frame **22**. Alternatively, it would be possible to use a lug as closure element, through which is inserted a pivot pin which in turn passes through two angled elements fixed to the door frame **22**.

The extended part **19** is conveniently connected to the threaded pin **12** of the plunger rod by means of an element formed with a complementary screw threading, so that the extent of the working stroke of the shock-absorbing plunger **4** can be varied, to suit conditions prevailing at any given time, by varying the degree of threaded engagement of these parts.

In the embodiment of the invention shown in FIGS. 1 to 3 it is also possible to adjust the shock-absorbing action of the apparatus in addition to the provision made, as described above, for varying the length of the working stroke of the shock-absorbing plunger; this additional form of adjustment is effected by turning the cylinder **1** at the angled arm **17** and maintaining the position assumed by means of the threaded nut **18**, the ability of the cylinder **1** to perform pivotal motion remaining unimpaired. The part intermediate between the base **2** of cylinder **1** and the threaded pin **13** may for example be of polygonal shape, and may be inserted into an opening of complementary cross-sectional shape formed in the angled arm **17**. As the novel door closing apparatus together with the means necessary for mounting it in position for use are of modest dimensions, it is possible not only to mount it on the upper edge of a door as shown in FIG. 5 but also on the lower edge of the door. If this additional mounting is provided, it will have the appearance of a mirror image of FIG. 5. This provision of additional shock-absorbing means for mounting the door has the advantage that the moments of force operative on the mountings of the door are less than would otherwise be the case because the door closing apparatus then produces a torque which is opposed to the torque consequent upon the intrinsic weight of the door.

Improved means for relieving the mountings of the door are shown in the embodiment of the invention represented in FIGS. 7 and 8. In this figure a base plate **24** is fixed by a number of screws to the upper, transverse strip of the door frame **22**, which strip carries the two swivel mounting supporting elements **25** and **27** which are spaced from each other in a substantially horizontal plane and are provided with the swivel mountings **26**, **28**. The swivel mounting **26** has a greater vertical distance from the plane of the door frame than the swivel mounting **28**. Cylinder **1** is disposed in swivel mounting **26**, and arm **29** in swivel mounting **28**. The plunger rod **11** of the cylinder **1** carries at its end remote from the cylinder **1** the swivel mounting attachment element **30** which is rigidly connected to the plunger rod **11**. This connection is preferably arranged to be a releasable one so that adjustment can be made of the shock-absorbing action of the apparatus and also of the length of the working stroke of the plunger. The swivel mounting connecting element **30** also comprises the swivel mounting **31** provided for the articulated connection of the arm **29**. In this way there is formed a triangular structure extending between the joints **26**, **28** and **31**, the sides of this triangular structure which extend between joints **26** and **28** and between joints **28** and **31** being of invariable length, whereas the side located between the joints **26** and **31** is variable in length because it is defined by the cylinder **1** together with its plunger rod **11**. The extension **33** located on the swivel joint connection element **30** is shiftable within a guide sleeve **32**, which is fixed to the door **23** in the region of the upper edge thereof. When the door is opened from its position shown in FIG. 7 into position as shown in FIG. 8, the plunger rod **11** is inwardly thrust into the cylinder **1**, thus absorbing energy expended in opening the door. When the door is then released, the plunger rod **11** is thrust out of the cylinder again under the action of the gas contained in the cylinder the extension **33** at the same time sliding in the guide

sleeve 32. No force applied in a direction parallel to the plane of the door 23 will be transmitted to the door 23; only the force component directed perpendicularly to the door 23 is absorbed by the guide sleeve 32 and acts to close the door. A limited play may be provided, for example in the swivel mounting 26, so as to compensate small deviations of the position of the cylinder 1 and its plunger rod 11 from a line parallel to the plane of the door 23.

Many modifications may be made to the details described above within the context of the invention. The use of the novel closure device is, for example, of value for casement or hinged windows which can be thereby brought into their closed position by compensation of their intrinsic weight, or held—by a suitable modification of the apparatus—in their opened position against the force of air pressure acting on them and in such manner that they are protected against unintended closure. A further advantage resides in the fact that one and the same form of construction can be used for doors closing both in the left-hand and in the right-hand direction; in this way manufacture and assembly of the apparatus is facilitated.

In the proposed from of construction for mounting the door closing apparatus the force exerted by the pressurised gas, which pressure varies with the angle of opening of the door, is exploited with particular advantage in that a gradually decreasing force is required when opening the door, whereas the force continuously increases while the door is closing.

What we claim is:

1. Automatic door closing apparatus having a shock-absorbing plunger, which is displaceable in a tubular body engaging a pivotable door and a door frame thereof and which is fixed at the end of a plunger rod, and an energy-storing element which absorbs energy expended in opening the door and liberates this energy when the door is being closed, characterised in that the energy-storing element is pressurised gas (1') which is contained in a cylinder (1) which is provided with a base (2) and with a displaceable, tight-sealing, inner plug or stopper (3) and the cylinder (1) contains two chambers (1''), (1''') which are charged with a shock-absorbing liquid and are defined by a shock-absorbing plunger (4) which is formed with a one-way valve, the latter (1''') of the chambers being provided with a stuffing-box (11') which provides a tight seal in the region in which the plunger rod passes through the wall of the cylinder, and the cylinder and the plunger rod being respectively hinge-connected to the door (23) and to the door frame (22).

2. Door closing apparatus according to claim 1, characterised in that the shock-absorbing plunger (4) has longitudinal bores (5) whose openings located closer to the plunger rod (11) are closed off by an annular plate (6) which is capable of limited axial movement and which is of smaller cross-section than the shock-absorbing plunger (4), and in the cylinder wall there is provided a longitudinal groove (7) which extends along the region of the working stroke of the damping plunger, this groove (7) forming with a sealing element of the damping plunger (4) a liquid flow cross-section which is smaller than that of the bores in the damping plunger.

3. Door closing apparatus according to claim 2, characterised in that the longitudinal groove (7) is interrupted in a central portion (8) of the working stroke of the shock-absorbing plunger, and in the region in which the plunger rod (11) passes through the wall of the cylinder (1) is formed with an increased liquid flow cross-section, preferably by the provision of two longitudinal grooves (9, 9') in the cylinder wall.

4. Door closing apparatus according to claim 3, characterised in that the longitudinal grooves (9, 9') are located in one peripheral half of the cylinder wall, and the shook-absorbing plunger (4) has a resilient annular sealing element which surrounds the plunger except for a narrow gap (15) and which is secured against rotation relative to the shock-absorbing plunger (4) and the said gap (15) in the sealing element can be brought into different positions relative to the longitudinal grooves (7, 9, 9') by rotating the shock-absorbing plunger (4) by means of the plunger rod (11).

5. Door closing apparatus according to claim 4, characterised in that the cylinder carries, in the region in which the plunger rod (11) passes through the wall thereof, an angle-indicating scale, and the plunger rod (11) is provided with a marking pointing to this scale.

6. Door closing apparatus according to claim 4, characterised in that the cylinder (1) is so connected to the door, by means of a threaded nut (18) which engages a threaded pin (13) located on the base (2) of the cylinder (1), that the cylinder can be brought into different angular positions, and locked in these positions, within its limited range of horizontal, pivotal movement.

7. Door closing apparatus according to claim 1, characterised in that the plunger rod (11) of the shock-absorbing plunger (4) has a longitudinal groove starting from its end surface located closer to the plunger, and there is provided a tubular stuffing box (41) which extends into the chamber (1''') of the cylinder and surrounds the plunger rod (11), the longitudinal bore (34) having a length corresponding to that of the stuffing box (41) and being in communication at its end with a transverse bore which passes through the plunger rod (11) and the plunger is also provided with a continuously operative opening (36) for the passage therethrough of liquid, the cross-section of this opening being smaller than that of the longitudinal or transverse openings (34, 35).

8. Door closing apparatus according to claim 7, characterised in that a continuously operative opening (36) is formed in the cylindrical outer wall of the shock-absorbing plunger (4) between the sealing element thereof and the outer edge of its annular surface located closer to the stuffing box (41) this opening (36) debouching into a bore (5) of the shock-absorbing plunger (4), and the said bore (5) is closed off by an annular plate (6) which is capable of performing limited axial movement, during the outwardly directed movement of the plunger rod (11).

9. Door closing apparatus according to claim 8, characterised in that the shock-absorbing plunger (4) is arranged on a bushing (37) which is axially displaceable on a reduced-diameter neck portion (10) of the plunger rod (11), against the biasing force of a spring supported from the end of the plunger rod (11), the neck portion (10) of the plunger rod being formed with a longitudinal groove (38).

10. Door closing apparatus according to claim 1, characterised in that the cylinder (1) is capable of executing limited pivotal movement in a horizontal plane relative to the door, and the plunger rod (11) is so articulated to the door frame (22), by way of a part (19) constituting an extension of the plunger rod, that the sum of the projections of the distance of the swivel joint (20') from the axis of the door hinge (21') on to the plane of the door frame and on to the plane which is perpendicular to the plane of the door frame, and which intersects the axis (21') of the door frame, is approximately equal to the working stroke of the shock-absorbing plunger (4).

11. Door closing apparatus according to claim 1, characterised in that the part (19) forming an extension of the plunger rod (11) is bent over at a right-angle, its vertically extending arm (19') being pivotably mounted in a sleeve (20) fixed to the door frame (22).

12. Door closing apparatus according to claim 1, characterised in that the part (19) constituting an extension of the plunger rod (11) terminates in a lug through which a pivot pin is inserted which passes through two angled elements fixed to the door frame.

13. Door closing apparatus according to claim 1, characterised in that the plunger rod (11) can be moved by means of an arm (29) hingedly connected both to the rod (11) and to the door frame (22) and a triangular structure is formed by two arms which are hingedly inter-

connected by means of joints connected to the door frame, one of these comprising an extension passing beyond an element (30) which interconnects the plunger rod (11) to a swivel supporting element for the swivel mounting (31), this said extension (33) being shiftable, approximately parallel to the plane of the door, within a guide sleeve (32) fixed to the door (23).

14. Door closing apparatus according to claim 13, characterised in that the cylinder (1) and the arm (29) are pivotable within swivel mountings (25, 27) which are attached to the door frame (22) and project beyond the upper edge of the door (23) and the cylinder (1) and the arm (29) form the two pivotable arms defining a triangular structure, the swivel mounting connecting element (30) of this triangular structure being fixed to the end of the plunger rod (11) and being provided with a swivel mounting (31) for the arm (29) and the swivel mounting connecting element (30) carries the extension (33) which is guided in a guide sleeve (33) fixed to the upper edge of the door.

15. Door closing apparatus according to claim 14, characterised in that the swivel mountings (25, 27) are arranged on a common plate (24) which is fixed by screws to the door frame (22).

16. Door closing apparatus according to claim 1, characterised in that a part (19) constituting an extension of the plunger rod (11) is connected to the plunger rod (11) by means of complementary threaded parts on these two elements, adjustment of these co-operating threaded parts serving to control the length of the working stroke of the shock-absorbing plunger (4).

References Cited

UNITED STATES PATENTS

1,471,560	10/1923	Langford	16—84 XR
1,482,917	2/1924	Durno	16—51
1,818,250	8/1931	Harrah et al.	16—84
3,059,269	10/1962	Selinger et al.	16—84 XR
3,266,080	8/1966	Spencer	16—84 XR

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