July 22, 1952 M. CARLSON 2,603,818

DOOR CHECK MECHANISM

Filed April 12, 1948 6 Sheets-Sheet 1

Fig. 1

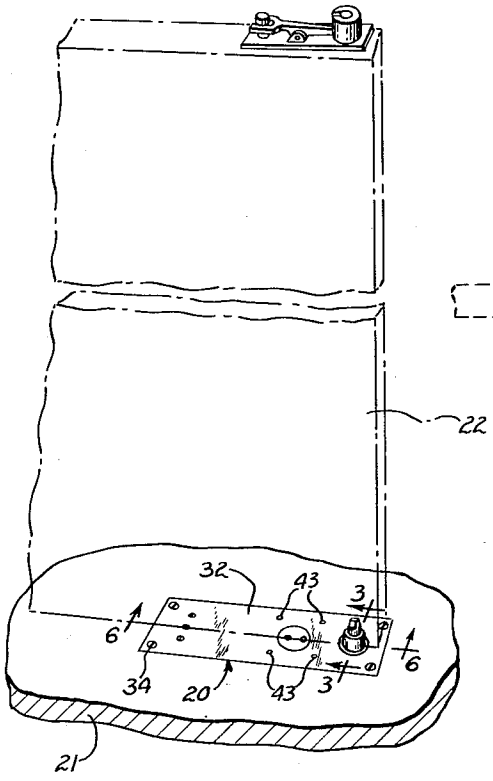


Fig. 2

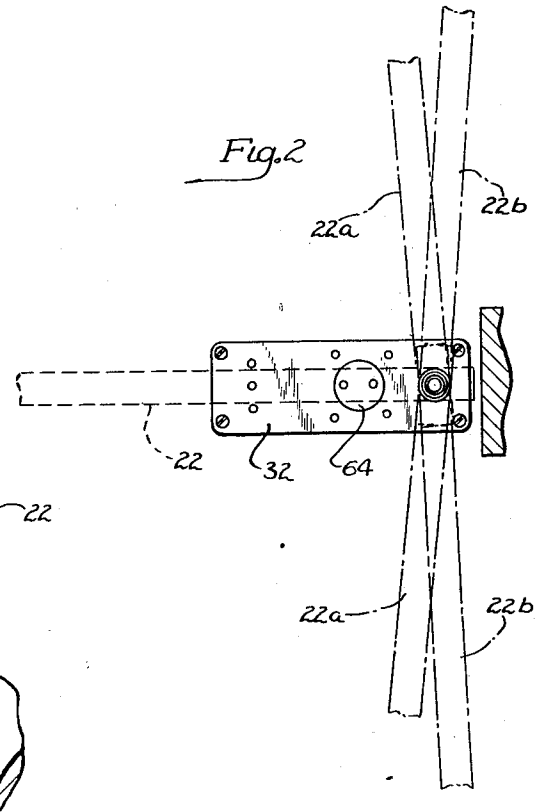


Fig. 3

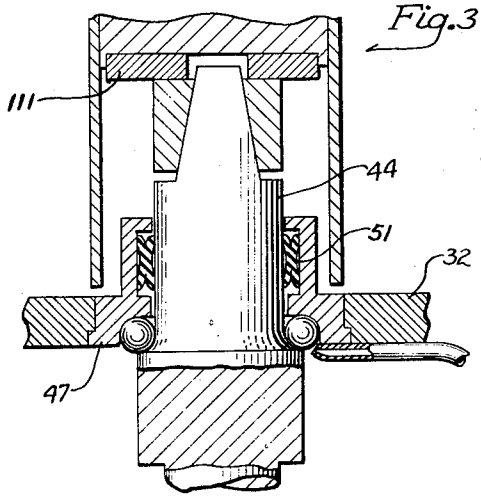
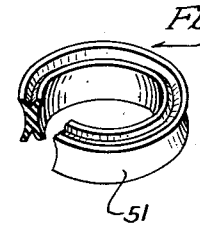


Fig. 4



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DOOR CHECK MECHANISM

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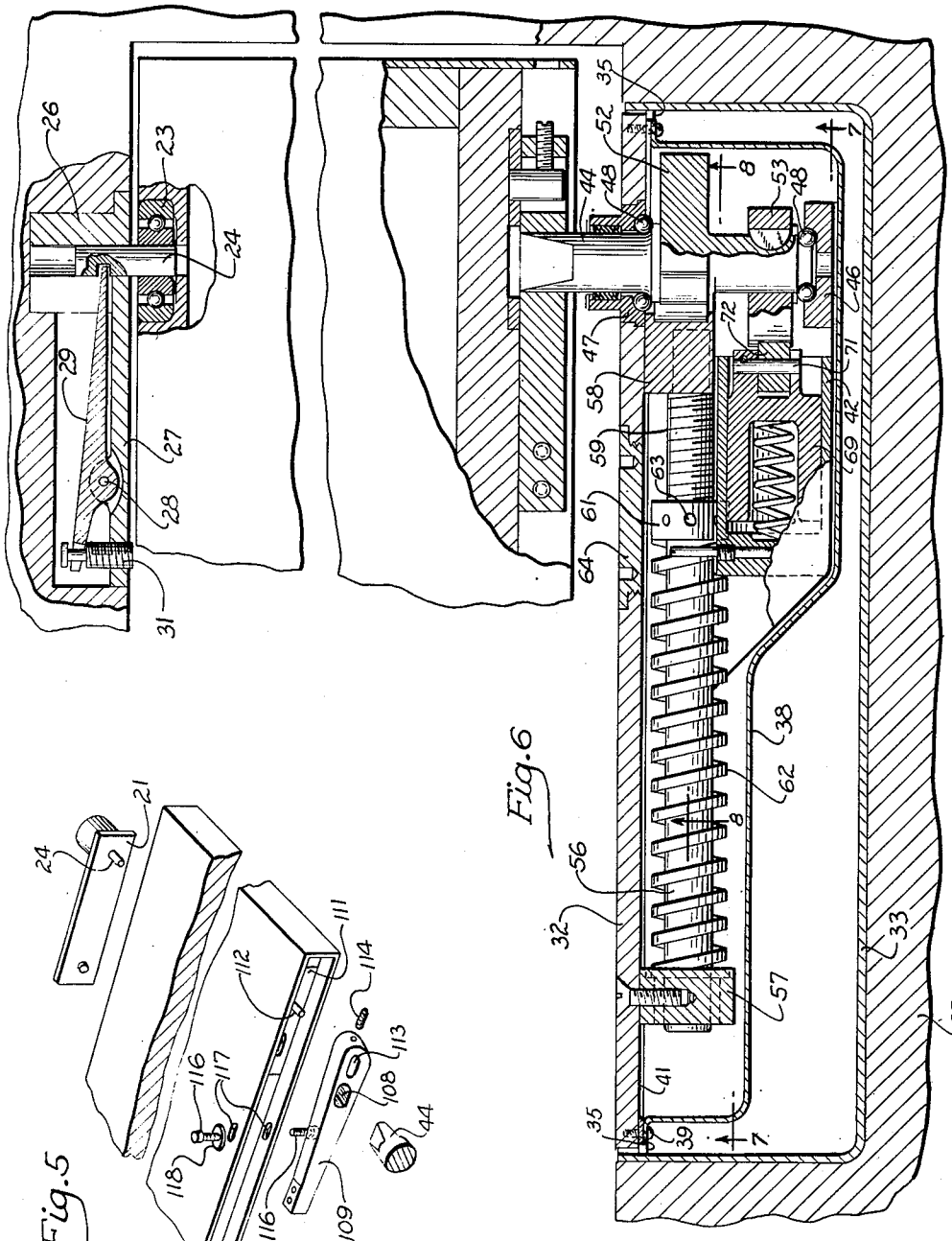


Fig. 6

Fig. 5

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DOOR CHECK MECHANISM

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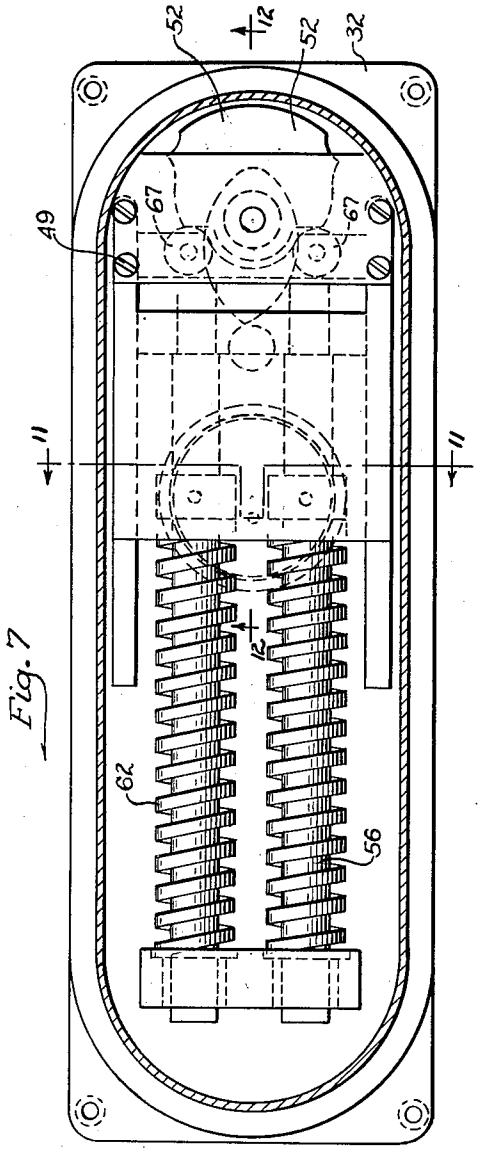


Fig. 7

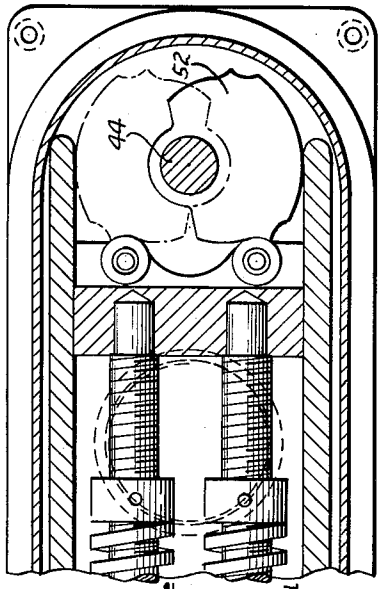


Fig. 9

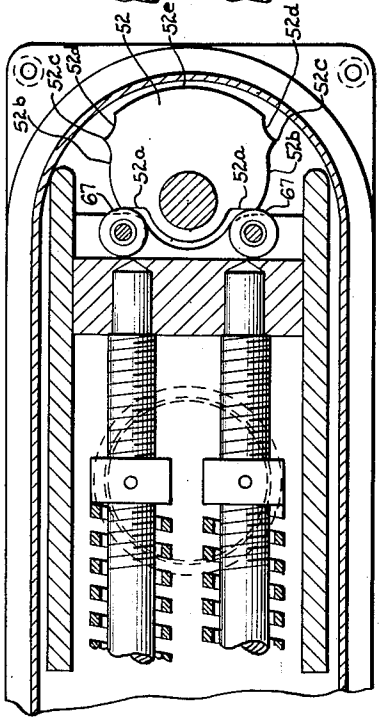


Fig. 8

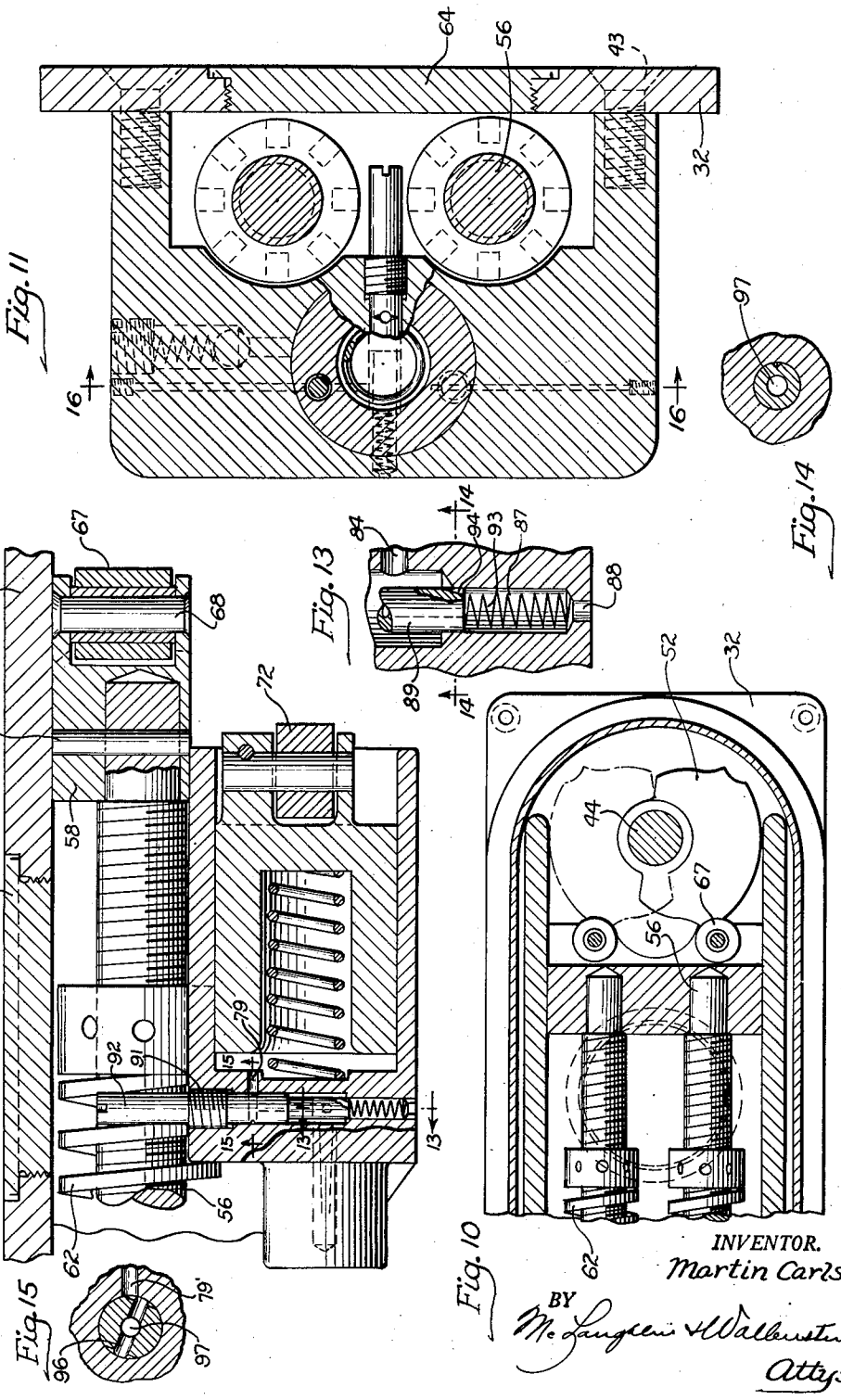
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DOOR CHECK MECHANISM

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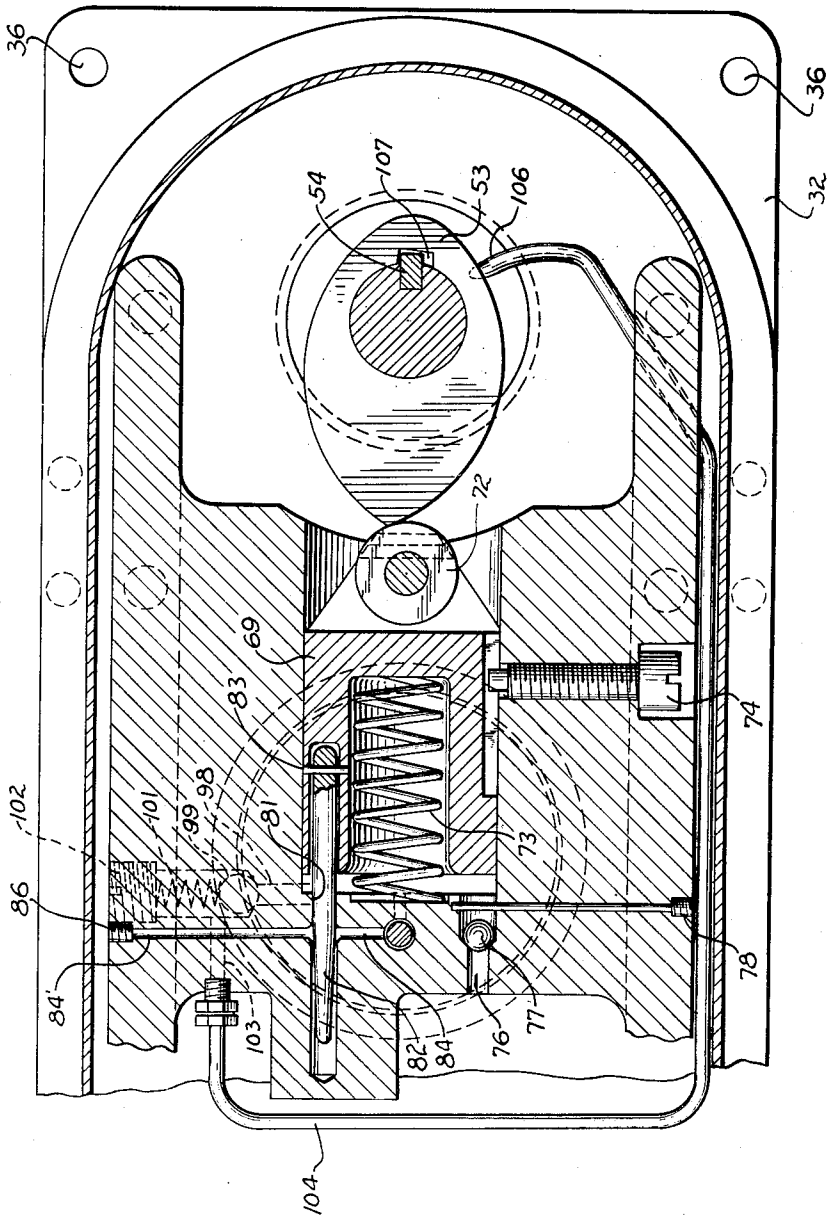


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DOOR CHECK MECHANISM

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Fig. 16



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DOOR CHECK MECHANISM

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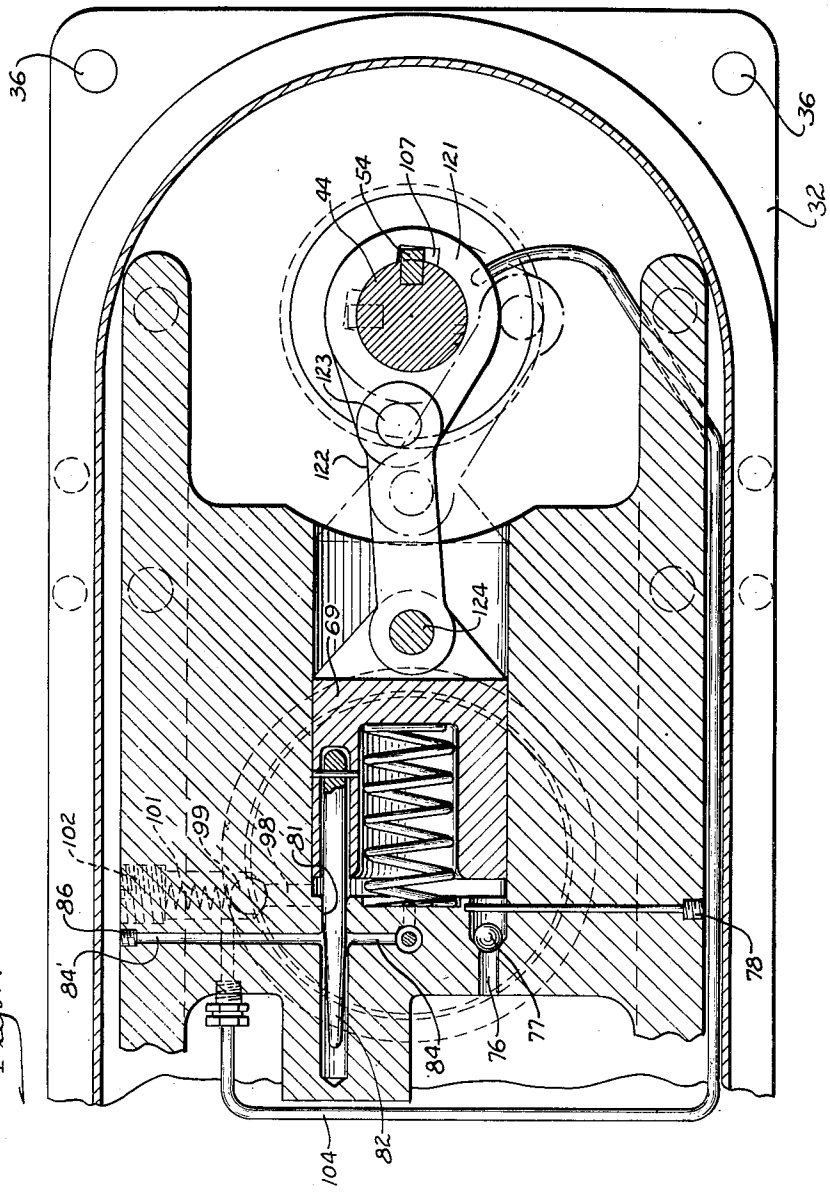


Fig. 17

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UNITED STATES PATENT OFFICE

2,603,818

DOOR CHECK MECHANISM

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Application April 12, 1948, Serial No. 20,515

18 Claims. (Cl. 16—55)

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My invention relates to a door check particularly adapted for controlling the movement of swinging doors which move on both sides of the center or closed position. Some of the features of the invention, however, are adapted to be employed with doors which swing to only one side of the center or closed position.

The principal object of the invention is the provision of a simple door check mechanism which is more positive in its operation and longer lasting under ordinary conditions of use.

Another object is the provision of an improved simple door check mechanism in which wear is positively compensated for and wherein such wear as does occur will not impair the functioning.

Still another object of the invention is the provision of a door check mechanism so constructed and arranged that the door will come back to a center or closed position and will be retained at the center or closed position even though forces, as of the wind blowing against it, are present which would normally tend to move the door back away from center.

Still another object is the provision of an improved simple door check mechanism in which the checking action is effective up to and beyond the center or fully closed position.

A further object is the provision of a simple door check mechanism which will not swing past center as it is closing.

A still further object of the invention is the provision of an improved simple door check mechanism in which the initial checking action permits relatively rapid movement of the door and the final checking action before fully closed position permits only slow closing movement of the door.

A still further object is the provision of an improved door check mechanism of a type to permit the door to be pushed rapidly in either direction regardless of whether or not it is at a stationary or in a checking position.

Other specific objects and features of the invention will be brought out in connection with the following detailed description taken with the accompanying drawings wherein:

Fig. 1 is a fragmentary partially schematic perspective view showing the door check mechanism of my invention in conventional position with respect to a swinging door;

Fig. 2 is a plan view of the door check showing several positions of the door;

Fig. 3 is a fragmentary sectional view taken on the line 3—3 of Fig. 1, the view being enlarged with respect to Fig. 1, but the parts being approximately in full scale;

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Fig. 4 is a perspective view of a sealing gasket used to prevent oil leakage;

Fig. 5 is a fragmentary exploded perspective view showing the manner in which the door is hung;

Fig. 6 is a longitudinal sectional view taken on the line 6—6 of Fig. 1, the view also being enlarged with respect to Fig. 3, and parts of the door being broken away for purposes of illustration;

Fig. 7 is a bottom plan section taken on the line 7—7 of Fig. 6, looking in the direction of the arrows;

Fig. 8 is an irregular bottom plan section taken on the line 8—8 of Fig. 6 looking in the direction of the arrows;

Fig. 9 is a view similar to Fig. 8 but illustrating the movement of some of the parts when the door swings fully but just short of the hold-open position;

Fig. 10 is a view similar to Figs. 8 and 9, but showing the position of the parts when the door is in hold-open position;

Fig. 11 is an irregular transverse sectional view taken on the line 11—11 of Fig. 7, looking in the direction of the arrows;

Fig. 12 is a fragmentary vertical sectional view taken on the line 12—12 of Fig. 7;

Fig. 13 is a fragmentary sectional view taken on the line 13—13 of Fig. 12, looking in the direction of the arrows, the section showing the high speed hydraulic exhaust port and indicating the passageway through which oil flows from the slow speed exhaust port;

Fig. 14 is a fragmentary transverse sectional view taken on the line 14—14 of Fig. 13;

Fig. 15 is a sectional view taken on the line 15—15 of Fig. 12 showing the slow speed hydraulic port;

Fig. 16 is a transverse sectional view taken on the line 16—16 of Fig. 11, looking in the direction of the arrows, a portion of the section being slightly irregular in order that the hydraulic piston might be shown substantially in central section for clearness; and

Fig. 17 is a sectional view similar to Fig. 16, but showing a structural modification.

The door check mechanism shown in the main embodiment of the invention comprises an assembly 20 (Fig. 1) adapted to set in the floor 21 and, in a manner to be described, to act as a lower hinge or pivot for a swinging door 22. The manner of attachment between the door and spindle

of the door check will be described later, but various structural arrangements may be employed. The manner of providing for the upper pivot may also vary, but in the drawings I illustrate a generally conventional and simple arrangement in which a radial bearing 23 is set into a recess at the top edge of the door and a pin 24, supported in a bracket 26, engages the center race of the radial bearing to form the pivot. The bracket 26 is recessed and lies flush with a lintel or upper frame cross piece of a doorway and includes a plate 27 which closes the recess in which the bracket is mounted. A pair of gears carry a pin 28 on which a lever 29 is pivoted. The forward end of the lever projects into a side recess of the pivot pin 24 and the opposite end is bifurcated to engage around a narrowed portion of an adjusting screw 31. By means of this construction, the adjusting screw may be retracted to actuate the lever 29 and raise the pivot pin 24 to release the door. Contrariwise, when the screw 31 is turned into the bracket 26, the pivot pin 24 is lowered into engagement with the radial bearing 23 to retain the door in swinging position.

As already noted, the mounting of the door on the door check spindle will be described later.

All of the parts of the door check mechanism are supported on a mounting plate 32, the four corners of which are fastened to inwardly extending ears 35 at the corners of a metal case 33 by screws 34 which extend through openings 36 in corners of the mounting plate. The case 33 is preferably set into cement 37 or other material forming the floor, but, in any case, the case 33 should be firmly secured in position. A housing 38 is secured to the bottom of the mounting plate by screws 39 and a gasket 41 is placed between the bottom of the mounting plate and the flange of the housing to make an oil tight connection. A cylinder block casting 42 is also secured to the bottom of the mounting plate by screws 43. This casting carries the door check mechanism including a hydraulic door check piston, and such casting also extends down into a deeper portion of the housing 38 which thereby acts as an oil sump. When the mechanism is installed, the housing 38 is filled with suitable oil or other hydraulic fluid to a point extending somewhat above the sump portion of the housing, but the arrangement employed is such that even after long periods of use and even if there should be some slight loss of fluid, there will always be enough hydraulic fluid in the sump to assure proper operation of the check mechanism.

A spindle 44 projects vertically from the door check mechanism, being supported at the bottom by a bottom bearing plate 46 and at the top by an upper bearing member 47, each so constructed and arranged as to retain bearing balls 48, the bearing balls also being supported by shouldered and rounded portions of the spindle. The bottom bearing plate 46 is secured to the cylinder block casting 42 by screws 49. The bottom bearing plate 46 is made strong and relatively heavy and is firmly anchored to the cylinder block casting 42, which, in turn, is secured to the mounting plate by screws 43. This plate is, therefore, able to take the full load of the door and the parts are so constructed that the bearing formed by the balls 48 is a combination radial and thrust type so that free movement is assured. The bearing member 47 is a separate member which is press fitted into the mounting plate 32 and it, also, is so shaped as to form part of the combination radial and thrust bearing. By this means a very firm but very free moving support is formed for the spindle 44. A specially formed synthetic rubber packing ring 51 is interposed between the spindle 44 and the inside wall of the bearing member 47. The bearing is thereby sealed against entrance of dirt and loss of oil along the spindle. The door check mechanism is so constructed and arranged that when the door is opened energy is stored into a spring structure to provide means for automatically returning the door to closed position and at the same time hydraulic fluid is drawn into a cylinder, said cylinder having a piston which returns to normal position against a hydraulic head at a controlled rate as the door is returned to closed position by the spring structure. To bring about these operations, I provide an actuating cam 52 which is integral with the spindle 44 and immediately below it a check cam 53 which is supported on the spindle and secured thereto by a key 54 (note Fig. 16) arranged to provide a slight amount of motion (on the order of 10 degrees) between the spindle and said check cam. The end of the cylinder block casting is centrally recessed to provide space for these cams so that they can rotate freely.

Looking first to the spring structure and its relation to the actuating cam 52, I provide a pair of rods 56 which are reciprocable in a guide block 57 mounted to the underside of the mounting plate 32 and have narrowed portions extending into a slide bearing 58 at the ends adjacent the actuating cam 52. The rods 56 are threaded at 59 to receive adjusting nuts 61 and actuating springs 62 are mounted on the rods and compressed between the guide block 57 and the adjusting nuts 61. By turning the adjusting nuts on the screws 59, the initial compression of the springs 62 can be controlled. While the means for turning the adjusting nuts may vary, I have found it suitable to provide peripheral openings 63 which can be reached with a tool by removing a circular closure 64 in the plate 32.

The relation of the guide rods 56 to the slide bearing 58 is such that they move together, and this is preferably accomplished by providing a press fit between the narrowed ends of the guide rods and the holes in the slide bearing, pins 66 being utilized also to assure holding the rods in place. The slide bearing 58 engages below the mounting plate 32 and against the sides and top portion of the cylinder block 42 within the upright portion thereof as shown in Figs. 8 and 9. As a result, the slide bearing 58 and guide rods may be moved as a unit against the compression of the actuating springs 62, even though pressure may be applied a one side or the other of center. The slide bearing carries two rollers 67 on pins 68 at opposite sides of center, such rollers adapted to engage the actuating cam 52 to perform several functions which will be pointed out. A roller is shown (in section in Fig. 12) as comprising a plural part structure to facilitate fabrication and provide for wear resistance at critical areas. Suitably, the pin 68 is relatively soft and carries a tight hardened bushing against which the hardened exterior bushing comprising the roller rotates. At least one of the rollers 67 engages an actuating cam 52 at all times and when the door is at the center or closed position, both of the rollers engage the shoulders 52–*a* (note particularly Fig. 8) which are contiguous to cam portions 52–*b*. The cam portions terminate in points 52–*c* with hold-open recesses 52–*d* con-

tiguous thereto and an arcuate portion 52–*e* interconnecting the two hold-open recesses. Keeping in mind that the spindle and actuating cam rotate about the center of the spindle as the door is opened, it will be noted that movement in either direction (see Fig. 9) moves the guide bar assembly in such a position as to further compress the actuating springs, and that the cam portions 52 are so shaped that there is a continuously greater movement as the door is opened wider. There are some additional features with respect to the shape of the cam, particularly as to the hold-open function, but such features will be explained further in connection with the operation. It is sufficient to note here that since the compression springs are increasingly compressed in response to opening movement of the door, release of the door permits the springs to continuously urge the door to closed position until a point is reached at which the two sliding rollers rest against the shoulders 52–*a*. During the return movement of the door, the spring action is damped by the hydraulic check mechanism which will now be described

The cylinder block is provided with a cylindrical portion in which a hydraulic piston or ram 69 is reciprocable. The exterior end of the hydraulic piston is shaped to receive a pin 71 carrying a roller 72 which is adapted to engage the check cam 53. As may be seen most clearly by reference to Figs. 6, 15 and 16, the check cam is symmetrical as to its two sides and generally comprises an eccentrically mounted oval with a point at the end facing the check roller 72 so that as the door is returned to closed position, from either side, the hydraulic piston 69 will be forced into the cylinder. A piston expanding spring 73 is disposed in a hollow portion of the piston and engages against the cylinder head to retract the piston as the check cam moves away from the check roller 72. A stud 74 (Fig. 16) has a narrowed end portion projecting into a side slot of the piston to prevent complete withdrawal of the piston and also to prevent rotatory movement thereof.

As the piston is withdrawn by the action of the spring 73, hydraulic fluid is drawn into the cylinder, and as the piston is forced back into the cylinder, the hydraulic fluid is forced from the piston through control orifices to perform a checking or damping function. The oil is drawn through an intake passageway 76 in which a check valve 77, in the form of a ball engaging against a seat, is provided. A ball retainer 78, in the form of a narrow rod, having a threaded enlarged end portion, is provided to prevent removal of the ball. The check valve functions to permit entrance of hydraulic fluid through the inlet 76 on the suction stroke or retracting movement of the piston, but prevents escape of hydraulic fluid through the intake port on the return movement.

The escape of hydraulic fluid during the return movement of the piston is controlled so that at first there is a relatively rapid flow and later a much slower flow so that at first the checking action permits relative rapid movement of the door and the final movement or closing is relatively slower. To produce this function, I provide a low speed passageway 79 and a high speed passageway 81, both communicating with the inside of the cylinder so that hydraulic fluid may be forced thereinto. A tapered valve stem 82 is secured within the side wall of the piston by a pin 83, the parts being relatively loose so that some wobbling of the valve stem is permitted for alignment in the high speed passageway. The high speed passageway communicates with another passageway 84 running at right angles thereto, and just before the high speed passageway meets the passageway 84, the high speed passageway is restricted to engage the largest portion of the valve stem 82 somewhat snugly. The passageway 84 forms a part of the high speed passageway and the result of this arrangement is such that when the piston is substantially fully retracted the tapered portion of the valve stem 82 permits free flow of oil around it to the passageway 84; but when the return movement of the piston has been partially completed the largest portion of the valve stem 82 functions with the wall of the passageway as a valve to substantially shut off further flow of hydraulic fluid through the high speed passageway. Looking at Fig. 16, it will be noted that the passageway 84 has an extension indicated by the reference character 84'. Those skilled in the art will understand that this is merely a device for drilling the passageway 84. Closure of the passageway extension 84' by a plug 86 prevents discharge of hydraulic fluid in any direction except through the control valve which will now be described.

Running at right angles to each of the passageways heretofore referred to, is passageway 87 terminating at 88 in an outlet or exhaust port through which the hydraulic fluid is returned to the sump. Within a continuation of the passageway 87, is disposed a valve member 89 which performs the function of controlling release of hydraulic fluid through both the high speed and low speed passageways. The valve member 89 is adjustably threaded in the cylinder block at 91 and it has an upper extending portion 92 conveniently positioned below the circular closure 64 so as to be adjustable upon removal of said closure. A spring 93 is placed in the passageway 87 and compressed against the end of the valve member 89 to supply enough resistance so that the valve member 89 will be held in any position to which it is adjusted. As will be noted particularly by reference to Figs. 12, 13 and 16, the passageway 84 discharges into an enlarged portion of the passageway 87 and exterior of the valve member 89. The valve member 89, however, has a tapered edge recess 94 (note particularly Figs. 13 and 14) at its lower end just at the point where the enlarged portion of the passageway 87 is narrowed down to fit snugly against the exterior of the valve member 89. The edge recess 94, therefore, forms the only outlet for hydraulic fluid from the passageway 84 to the exhaust port 88. This passageway is larger or smaller, depending upon how far the valve member 89 extends into the narrowed portion of the passageway 87, immediately adjacent to the exhaust port 88. Since this position is readily controlled by turning the valve member on its threads 91, adjustment of rate of flow through the high speed passageway and high speed port is readily adjusted. It is not necessary for the service attendant to be able to see the exact adjustment of the port because the adjustment is on a functional basis. If the first movement of the door is too rapid, he merely tightens the valve member until the proper rate of flow is obtained. If there should be wear at the high speed port, this is automatically compensated for when the device is adjusted during routine servicing.

The low speed passageway 79 communicates

with the passageway 87 (note Figs. 12 and 15) at a point where the valve member 89 is enlarged immediately adjacent the threaded portion 91 so that the only escape for hydraulic fluid from the passageway 79 is through a radial port 96 in the valve member and an axial bore 97. The radial bore 96 extends entirely through the valve member and the exterior surface of the valve member is preferably slightly notched at the outer ends of the port, as shown in the drawings, to increase the number of positions of the valve member at which communication can be established between the passageway 79 and the interior bore of the valve member. It will be noted that there are two positions in the rotation of the valve member at which maximum flow is permitted through the low speed passageway and four positions at which more restricted but identical rate of flow is permitted through such passageway. By placing the screw driver slot or other tool engaging formation or separate identifying point on the upwardly projecting portion 92, the position of the radial port 96 can be established and only slight manipulation by the service attendant is necessary to control the movement through the axial port which, of course, comprises the controllable orifice for the low speed passageway. Slight rotation of the valve member for adjusting the low speed port is without substantial effect on the adjustment made with respect to the area of the high speed port.

I provide means for by-passing both the high and low speed passageways so that there may be a more rapid discharge of hydraulic fluid, if a person going through a door should force it in a closing direction at a more rapid speed than would be normal to ordinary automatic closing movement. To this end, I provide a passageway 98 normally closed by a valve 99 which is forced against its seat by a spring 101, in an enlarged portion of the passageway 98 by a plug 102. Passageway 98, at its enlarged portion communicates with side passageway 103 to which tubing 104 is connected, the tubing 104 extending around and discharging at the point 106 against the spindle 44, immediately adjacent the upper ball bearing. Spring 101 is made strong enough so that in ordinary operation, the ball 99 will be retained against its seat, but when more than usual pressure is applied against a door to force the piston 69 into the cylinder, pressure of hydraulic fluid within the cylinder will force the ball 99 away from its seat and discharge hydraulic fluid through the tubing 104. I project the hydraulic fluid so discharged against the upper part of the mechanism to assure continued oiling thereof. It is, of course, obvious that when pressure is released there will be no further discharge through the passageway 98, and the rate of discharge is more or less directly proportional to the pressure applied against the door and the extent to which the ball is forced away from its seat.

In employing the terms "high speed passageway" and "high speed port" as contrasted with "low speed passageway" and "low speed port" it should be borne in mind that these terms are employed to explain a function and not necessarily the relative size of the passageways and ports involved. What I have called a high speed passageway is the one which is open only during the relatively rapid return movement of the door, it being understood that the low speed passageway and low speed port are open during the entire door movement. In other words, the construction is such that both ports are functionally open during the first part of the door movement to permit rapid closure, but one of the ports is closed before the other so that the rate of flow from the cylinder is decreased and the final door movement is reduced in speed. I wish to note that while I have referred to "by-passing" the high and low speed ports to permit oil to flow through the tube 104, only a portion of the hydraulic fluid takes this route since one or both of the ports will continue to pass hydraulic fluid even at the time hydraulic fluid is being delivered through the tube 104.

In an early part of the specification, I referred to the provision of a slight amount of movement between the check cam 53 and the spindle 54. This is brought about suitably by providing a relatively wide keyway 107 for the key 54, as shown particularly in Fig. 16. The check cam is sufficiently loose on the spindle so that except for the key 54 it would rotate with respect thereto and suitable means is utilized to maintain the check cam in horizontal alignment with the roller 72. When the actuating cam and spindle are returned to center position, therefore, the drive between the spindle and check cam 53 is through the key 54, and the cam, therefore, lags slightly behind the spindle. The result is that when the door, spindle and actuating cam have returned to center or closed position, the check cam is still slightly short of dead center. The spring 73 which, of course, is much weaker than the two actuating springs is now compressed substantially its maximum amount but, as will be noted in Fig. 16, there is still room for continued slight movement of the piston. To move the piston forward, however, the spring 73 would have to be compressed and it cannot be compressed by the further action of the actuating springs 62 because at this time the actuating springs and actuating cam are in the position shown in Fig. 8. It would, therefore, be necessary to apply some force to the door to move it past dead center and compress the spring 73. When the door has been opened in one direction, it is prevented from swinging past dead center by this construction, and the construction also prevents the door being moved by the action of wind or the like. When a swinging door is caused to move by the action of the wind, a rhythm is set up so that the door frequently oscillates on both sides of dead center. If, by any chance, a strong wind should blow the door in a direction such that the spring 73 would not be compressed by it, the action is such that the door would swing back and establish such a relationship of parts that further swinging movement would be prevented.

I referred in an earlier part of the specification to the use of the spindle 44 as the lower hinge or pivot upon which the door pivoted. While various constructions may be employed to mount the door on the spindle (separate mounting means may, of course, be employed and the spindle merely actuated by door movement), I indicate in Figs. 1, 3, 5 and 6 one suitable arrangement. Here the spindle is flattened to project into a slot 108 on a hinge member 109 which engages in a recess at the bottom of the door. The door has a steel plate 111 with a downwardly extending pin 112 which engages in a slot 113. A set screw 114, which is threaded in the end of the hinge member, positions the hinge member and pin 112 with respect to each other. The weight of the door is such that the pin 112 tends to bear against the end of the set screw 114. Thus, the hinge member 109 is fixed with respect

to the spindle, but the door can be adjusted slightly with respect to its hinge to raise or lower the outer end with respect to the floor. The hinge member 109 is held loosely in the recess at the bottom of the door by screws 116 which engage in elongated slots 117 partly covered by washers 118. Thus, while the hinge member is retained in position, adjustable movement with respect to the door is permitted. By this means, the door can be hung and adjusted without moving the door check mechanism after it has been permanently positioned in the concrete or other material comprising the floor.

In the form of the invention shown in Fig. 17, I employ a link arrangement instead of the check cam 53 and roller 72, but the functioning of the device is substantially the same as in the main embodiment. In this form of the invention, an arm 121 is loosely supported on the spindle 44 in the same general manner as the check cam 53 with a lost motion connection between the spindle and arm provided by means of the key 54 and enlarged keyway 107. A link 122 is pivoted to the arm 121 by means of a pin 123, and the link 122, in turn, is pivoted to the piston 69 by means of a pin 124. Any conventional means for retaining the parts in assembled relation and providing for free pivoting movement around the pins 123 and 124, may be utilized. The end of piston 69 is bifurcated as in the first described form so that the link 122 fits between the two bifurcations. A similar construction can, of course, be employed to advantage for the arm 121. The remaining parts of the mechanism are identical with those described in the preceding embodiment as may be noted by comparison with Fig. 16. The reference numbers are applied thereto for identification and detailed description of the remaining parts is unnecessary.

The construction, installation, use and maintenance of the device of the door check mechanism of my invention are simple and result in the accomplishment of the objects of the invention. The parts may be constructed substantially exactly in accordance with the structural dimensions shown in the drawings by means of conventional production tools, and, in discussing the construction of the mechanism, I shall assume that the parts have been produced and are ready for assembly. The cylinder block and its parts are first assembled as a sub-assembly, and all of the parts, including the guide rods, springs and associated parts, except the spindle assembly, are assembled on the mounting plate 32. The spindle with the integral actuating cam and check cam is then brought to position, with the bearing member 47, packing member 51, ball bearings, etc., and the spindle is held in position by application of the bearing plate 46. Any suitable fixture is employed to restrain the slide bearing 58 and piston 69 against spring action during assembly of the spindle parts. The housing 38 is then attached and the mechanism is ready for installation. In the actual installation, the case 33 is suitably embedded in the floor and the entire mechanism is assembled and attached to the mounting plate. The door is then mounted in position and the circular closure removed and hydraulic fluid introduced into the housing. A standard adjustment will have been given to the parts during assembly, but the operation, after installation, is tested and such adjustments as will be necessary made to provide proper performance of the door. This may involve increasing or decreasing the initial compression of the actuating springs 62 or adjustment of fluid flow through the high speed or low speed orifices.

The installation having been properly made, as explained, the mechanism will function in the intended manner to secure the objects of the invention. Normally, the door will stand in the position shown by the reference character 22 in Fig. 2. Up to the positions indicated by the reference characters 22–*a* in Fig. 2, progressively greater effort is required to move the door because one or another of the rollers 67 will be riding along the cam surface 52–*b* which provides for a gradually increasing radius and, thereby, continued further compression of the actuating springs. Just short of the point 52–*c*, there is a markedly increased curvature with a lengthened radius line as noted particularly in Fig. 9 in which the parts correspond generally to the door position 22–*a* of Fig. 2. At this point, because of the increased curvature referred to, markedly increased pressure is required to force the rollers past the points 52–*c* and into the hold-open depressions 52–*d*. The hold-open positions of the actuating cam are shown in Fig. 10 and these positions of the cam correspond with the door positions 22–*b* of Fig. 2. There is, therefore, a marked increased effort necessary to move the doors from the position 22–*a* to 22–*b* and as a result there is less possibility of accidentally forcing the doors to hold-open position, and when they reach hold-open position there is less possibility of their accidentally becoming dislodged from this position. The raised portion of the cam just before the point 52–*c*, heretofore referred to, therefore, has a definite checking action as the doors are moved to open position. A similar action is also to be noted if an attempt should be made to push the doors beyond the normal hold-open position. To push the doors beyond the hold-open position requires still greater effort than to push them to hold-open position, so that if a door should be located near an obstruction, there is a greatly reduced possibility of swinging the door so far beyond normal hold-open position as to cause a bumping action. It should be noted, however, that in the form of the invention shown in Figs. 1–16, the door could, if suitably mounted, be completely rotated through 360 degrees without deleteriously affecting the check mechanism. Occasionally, there are instances in which such an arrangement is desirable and in the event of such an arrangement, it will be noted that while movement can be permitted through 360 degrees, a checking action due to hydraulic fluid will occur during approximately the last 90 degrees of movement. Mechanism constructed in accordance with Fig. 17 functions in an identical manner except that it is impossible to rotate the spindle through 360 degrees when a link mechanism of the type shown is employed.

In the manner in which the embodiment of the invention shown in the drawings may be modified while still securing the objects of the invention, in general, should be clear to those skilled in the art. The parts may be constructed of suitable materials usually employed for similar purposes, as, for example, the packing ring 51 should be formed of material resistant to too rapid attack from the hydraulic fluid used. If the hydraulic fluid is an ordinary hydrocarbon, for example, a synthetic rubber resistant to attack by hydrocarbons should be employed. In connection with this packing ring, it should be noted, however, that the construction of retaining casing therefor is relatively very simple but

still adequate to prevent introduction of appreciable quantities of dust and dirt and loss of hydraulic fluid.

The door return springs preferably operate in compression and, in a sense, are opposed by spring **73** which is also in compression. The principal function of spring **73** or other means employed to retract the piston **69** is to maintain contact with the check cam **53**. This is part of the construction which secures the objects of the invention having to do with wear of the parts, it being obvious that even after continued use the door will never have a point at which there is lost motion between the spring action and checking action. The hydraulic checking action, in other words, always opposes the return spring action even after long continued use.

While I have described my invention in considerable detail so that those skilled in the art may understand the manner in which the same is practised, the scope of the invention is defined by the claims.

What I claim as new and desire to protect by Letters Patent of the United States is:

1. In a door check of the character described, a spindle rotated by door movement, an actuating cam carried by the spindle, spring means engaging the actuating cam for return the same to normal position, a hydraulic cylinder, a piston reciprocable therein, a check cam carried by the spindle, spring means urging said piston against the check cam, the parts being so constructed and arranged that the piston is retracted as the door is opened, means to draw hydraulic fluid into the cylinder as the piston is retracted, adjustable port means for restricting expulsion of said hydraulic fluid, said door returning spring means being checked by restriction of said hydraulic flow, and a lost motion connection between the spindle and check cam.

2. In a door check of the character described, a spindle rotated by door movement, an actuating cam carried by the spindle, spring means engaging the actuating cam for returning the same to normal position, a hydraulic cylinder, a piston reciprocable therein, spring means urging said piston out of the cylinder, lost motion means associated with the spindle for returning the piston into the cylinder, the parts being so constructed and arranged that the piston is retracted as the door is opened, means to draw hydraulic fluid into the cylinder as the piston is retracted, and adjustable port means for restricting expulsion of said hydraulic fluid, said door returning spring means being checked by restriction of said hydraulic flow.

3. In a door check of the character described, a spindle on which the door is adapted to be mounted for swinging in either direction, an actuating cam integral with the spindle, a spring assembly including at least one spring under compression and a roller engaging against the said actuating cam, a cylinder body mounted below the said spring assembly, a piston within the cylinder, a spring within the cylinder urging the piston out of the cylinder, a check cam on the spindle, means providing a lost motion connection between the check cam and spindle, a roller carried by the piston riding on the check cam, a casing forming a hydraulic fluid sump around the cylinder, an inlet port and outlet port between the said sump and cylinder, and means to control discharge of fluid through the said outlet port.

4. In a door check of the character described, a spindle on which the door is adapted to be mounted for swinging in either direction, an actuating cam integral with the spindle, a spring assembly including at least one spring under compression and a roller engaging against the said actuating cam, a cylinder body mounted below the said spring assembly, a piston within the cylinder, a spring within the cylinder urging the piston out of the cylinder, lost motion means associated with the spindle for returning the piston into the cylinder, a casing forming a hydraulic fluid sump around the cylinder, an inlet port and outlet port between the said sump and cylinder, and means to control discharge of fluid through the said outlet port.

5. In a door check of the character described, a mounting plate adapted to be set flush with the floor near a door opening, a cylinder block secured to the bottom of the mounting plate, a spindle projecting upwardly through the mounting plate and having upper and lower bearings carried by the mounting plate and cylinder block, respectively, an actuating cam on the spindle below the mounting plate and above the cylinder block in a centrally recessed portion thereof, a slide bearing below the mounting plate and between upright portions of the cylinder block, a pair of guide rods having their ends secured in the slide bearing and reciprocably supported in a guide block carried by the mounting plate, springs surrounding the guide rods and adjustably compressed against the guide block to force the slide bearing toward the actuating cam, roller means on the slide bearing engaging against the actuating cam, a piston disposed in a cylinder portion of the cylinder block, a spring forcing said piston outwardly, a connection between the spindle and piston for returning the latter into the cylinder including a crank having a lost motion connected to said spindle and pitman means connecting said crank to said piston, a casing for hydraulic fluid secured to the mounting plate and entirely enclosing the structure mounted below the mounting plate, means for drawing hydraulic fluid into the cylinder when the piston is withdrawn, and controllable means for limiting flow of hydraulic fluid from the cylinder.

6. In a door check of the character described, a mounting plate adapted to be set flush with the floor near a door opening, a cylinder block secured to the bottom of the mounting plate, a spindle projecting upwardly through the mounting plate and having upper and lower bearings carried by the mounting plate and cylinder block, respectively, an actuating cam on the spindle below the mounting plate and above the cylinder block in a centrally recessed portion thereof, a slide bearing below the mounting plate and between upright portions of the cylinder block, a pair of guide rods having their ends secured in the slide bearing and reciprocably supported in a guide block carried by the mounting plate, springs surrounding the guide rods and adjustably compressed against the guide block to force the slide bearing toward the actuating cam, roller means on the slide bearing engaging against the actuating cam, a check cam carried by the spindle below the actuating cam, a lost motion connection between the check cam and spindle, a piston disposed in a cylinder portion of the cylinder block, a roller on an exterior portion of the piston, a spring forcing said piston roller into contact with the check cam, a casing for hydraulic fluid secured to the mounting plate and entirely enclosing the said apparatus mounted below the mount-

ing plate, means for drawing hydraulic fluid into the cylinder when the piston is withdrawn, and controllable means for limiting flow of hydraulic fluid from the cylinder.

7. In a door check of the character described, a mounting plate adapted to be set flush with the floor near a door opening, a cylinder block secured to the bottom of the mounting plate, a spindle projecting upwardly through the mounting plate and having upper and lower bearings carried by the mounting plate and cylinder block, respectively, an actuating cam on the spindle below the mounting plate and above the cylinder block in a centrally recessed portion thereof, a slide bearing below the mounting plate and between upright portions of the cylinder block, a pair of guide rods having their ends secured in the slide bearing and reciprocably supported in a guide block carried by the mounting plate, springs surrounding the guide rods and adjustably compressed against the guide block to force the slide bearing toward the actuating cam, roller means on the slide bearing engaging against the actuating cam, a check cam carried by the spindle below the actuating cam, a key carried by the spindle in an enlarged keyway on the cam whereby to form a lost motion connection, a piston disposed in a cylinder portion of the cylinder block, a roller on an exterior portion of the piston, a spring forcing said piston roller into contact with the check cam, a casing for hydraulic fluid secured to the mounting plate and entirely enclosing the said apparatus mounted below the mounting plate, means for drawing hydraulic fluid into the cylinder when the piston is withdrawn, and controllable means for limiting flow of hydraulic fluid from the cylinder.

8. In a door check of the character described, a mounting plate adapted to be set flush with the floor near a door opening, a cylinder block secured to the bottom of the mounting plate, a spindle projecting upwardly through the mounting plate and having upper and lower bearings carried by the mounting plate and cylinder block, respectively, an actuating cam on the spindle below the mounting plate and above the cylinder block in a centrally recessed portion thereof, a slide bearing below the mounting plate and between upright portions of the cylinder block, a pair of guide rods having their ends secured in the slide bearing and reciprocably supported in a guide block carried by the mounting plate, springs surrounding the guide rods and adjustably compressed against the guide block to force the slide bearing toward the actuating cam, roller means on the slide bearing engaging against the actuating cam, a check cam carried by the spindle below the actuating cam, a piston disposed in a cylinder portion of the cylinder block, a roller on an exterior portion of the piston, a spring forcing said piston roller into contact with the check cam, a casing for hydraulic fluid secured to the mounting plate and entirely enclosing the said apparatus mounted below the mounting plate, means for drawing hydraulic fluid into the cylinder when the piston is withdrawn, controllable means for limiting flow of hydraulic fluid from the cylinder, and means for delivering hydraulic fluid directly from the cylinder against said upper bearing when closing force is applied against the door substantially above that exerted by said actuating springs.

9. In a door check of the character described, a spindle rotated by door movement, an actuating cam carried by the spindle, spring means engaging the actuating cam returning the same to normal position, a hydraulic cylinder, a piston reciprocably therein, a check cam carried by the spindle, spring means urging said piston against the check cam, the parts being so constructed and arranged that the piston is retracted as the door is opened, means to draw hydraulic fluid into the cylinder as the piston is retracted, and adjustable port means for restricting expulsion of said hydraulic fluid, said door returning spring means being checked by restriction of said hydraulic flow, said actuating cam having a sharply recessed portion at the door at rest position, a cam portion of gradually increasing radius, a recessed door hold-open position, and a sharp rise in the said cam portion immediately before the hold-open position.

10. In a door check of the character described, a spindle rotated by door movement, an actuating cam carried by the spindle, spring means engaging the actuating cam returning the same to normal position, a hydraulic cylinder, a piston reciprocable therein, a check cam carried by the spindle, spring means urging said piston against the check cam, the parts being so constructed and arranged that the piston is retracted as the door is opened, means to draw hydraulic fluid into the cylinder as the piston is retracted, and adjustable port means for restricting expulsion of said hydraulic fluid, said door returning spring means being checked by restriction of said hydraulic flow, said actuating cam having a sharply recessed portion at the door at rest position, a cam portion of gradually increasing radius, a recessed door hold-open position, and a sharp rise in the said cam portion immediately before the hold-open position, and a sharp rise past the hold-open position, so that increased pressure is required to move the door immediately into and past the hold-open position.

11. In a door check of the character described, a spindle on which the door is adapted to be mounted for swinging in either direction, an actuating cam integral with the spindle, a spring assembly including at least one spring under compression and a roller engaging against the said actuating cam, a cylinder body mounted below the said spring assembly, a piston within the cylinder, a spring within the cylinder urging the piston out of the cylinder, a check cam on the spindle, a roller carried by the piston riding on the check cam, a casing forming a hydraulic fluid sump around the cylinder, an inlet port and outlet port between the said sump and cylinder, and means to control discharge of fluid through the said outlet port, said actuating cam having a sharply recessed portion at the door at rest position, a cam portion of gradually increasing radius, a recessed door hold-open position, and a sharp rise in the said cam portion immediately before the hold-open position.

12. In a door check of the character described, a mounting plate adapted to be set flush with the floor near a door opening, a cylinder block secured to the bottom of the mounting plate, a spindle projecting upwardly through the mounting plate and having upper and lower bearings carried by the mounting plate and cylinder block respectively, and actuating cam on the spindle below the mounting plate and above the cylinder block in a centrally recessed portion thereof, a slide bearing below the mounting plate and between upright portions of the cylinder block, a pair of guide rods having their ends secured in

the slide bearing and reciprocably supported in a guide block carried by the mounting plate, springs surrounding the guide rods and adjustably compressed against the guide block to force the slide bearing toward the actuating cam, roller means on the slide bearing engaging against the actuating cam, a check cam carried by the spindle below the actuating cam, a piston disposed in a cylinder portion of the cylinder block, a roller on an exterior portion of the piston, a spring forcing said piston roller into contact with the check cam, said actuating cam having a recess into which said piston roller may drop to provide a hold-open position, said cam being characterized by a sharp rise before and a sharp rise past the said hold-open position, so that increased pressure is required to move the door immediately into and past the hold-open position.

13. In a door check of the character described, a spindle on which a door is adapted to be mounted, spring means tensioned when the spindle is rotated and functioning to return the spindle and door to closed position, a hydraulic piston retracted when the door is opened to withdraw hydraulic fluid from a source of supply when the door is opened and adapted to be returned with a hydraulic check action when the door is closed by the springs, and a lost motion driving connection between the spindle and piston, so that the said checking action extends up to and beyond fully closed position.

14. In a door check of the character described wherein a rotatable cam responsive to door movement energizes a spring for closing the door by radially pushing a cam following member engaging said spring away from the center of rotation of said cam, and wherein closing return movement of said spring is retarded by a hydraulic checking device, said cam being characterized by a gradually expanding radius to tension the spring as the door is opened, the cam having a recessed portion into which the cam following member falls to hold the door open, and a sharp rise on the cam immediately before the hold-open position, so that a definite major effort is required to push the door into the hold-open position.

15. In a door check of the character described, a spindle on which the door is adapted to be mounted for swinging in either direction, an actuating cam integral with the spindle, a spring assembly including at least one spring under compression and a roller engaging against the said actuating cam, a cylinder body mounted below the said spring assembly, a piston within the cylinder, a spring within the cylinder urging the piston out of the cylinder, a link pivoted to the piston, an arm pivoted to the said link, a lost motion driving connection between the said arm and spindle so arranged that when the spindle is fully restored to normal position the piston spring is less than fully compressed, and hydraulic means associated with the piston and cylinder for limiting the speed of return movement of the spindle and actuating cam.

16. In a door check mechanism, a hydraulic check system of the character described, comprising a hydraulic cylinder and piston, a high speed hydraulic discharge passageway communicating with said cylinder, a low speed hydraulic discharge passageway communicating with said cylinder, means for controlling rate of flow through each such passageway, and separate means controlled by the piston for closing the high speed passageway before the piston reaches the end of its return stroke so that the final movement of the piston discharges fluid only through the low speed passageway.

17. The combination defined in claim 16 wherein said last mentioned means includes a tapered valve stem carried by the piston and movable with it into a restricted portion of the high speed discharge passageway which is thereby gradually closed as the piston enters the cylinder.

18. In a door check of the character described, a spindle on which a door is adapted to be mounted, an actuating cam carried by said spindle, spring means including a roller engaging said actuating cam, said cam being characterized by a gradually expanding radius to thereby tension the spring means as the door is opened and provide a spring return therefor, the cam having a recessed portion into which the roller falls to hold the door open, and a sharp rise on the cam immediately before the hold-open position, so that a definite major effort is required to push the door into hold-open position.

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