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DOOR CHECK

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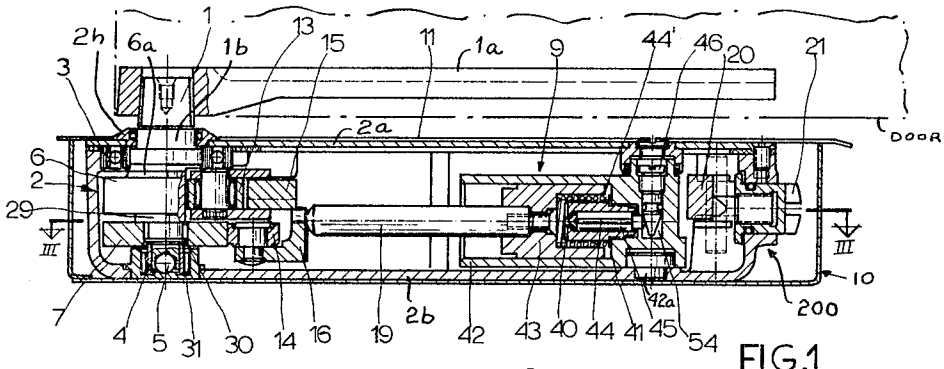

FIG.1

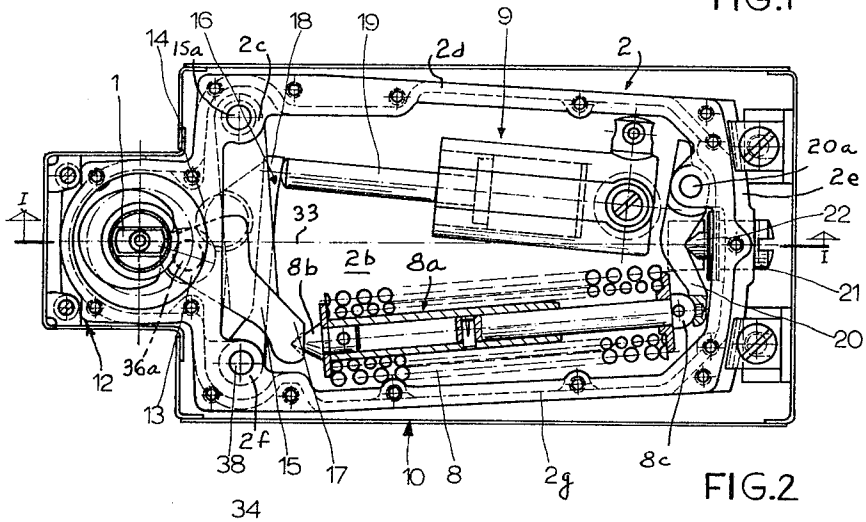

FIG.2

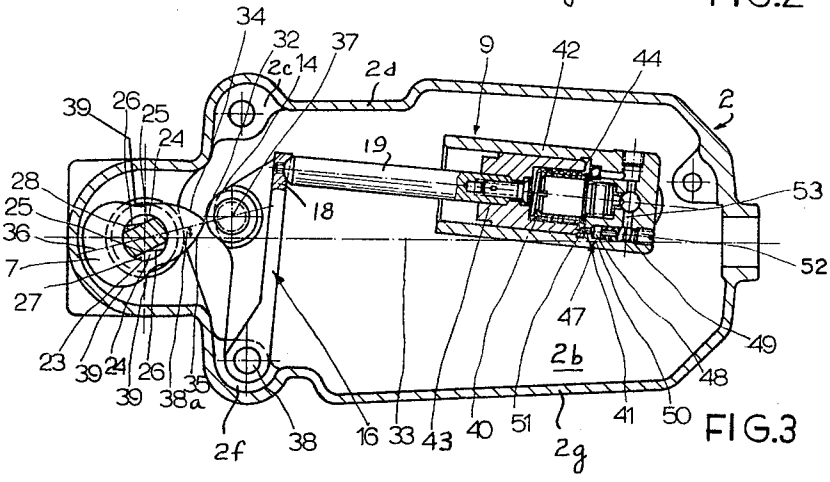

FIG.3

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DOOR CHECK

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19 Claims. (Cl. 16—82)

The present invention relates to door checks for single acting and double acting swinging doors. More particularly, the invention relates mainly to improvements in the construction, mounting and operation of the check and damper mechanism in such devices.

In many conventional types of door checks, the damping action is terminated shortly before the check cam moves to its dead center position, i.e., shortly before the door closes, because the piston of the damper cylinder then reaches the end of its working stroke. A known proposal to avoid this drawback which results is slamming of the door against the frame or in gradually diminishing swinging movements includes the provision of a damper cylinder wherein the pressure of hydraulic fluid causes the customary roller follower to transmit to the check cam a substantial pressure so that the latter "jumps" over the dead center position with resultant noise and substantial wear of its face.

Accordingly, it is an important object of the present invention to provide a door check whose check cam and damper mechanism are constructed and mounted in such a way that the movements of the cam to either side of its dead center position will produce a minimum of noise and will not result in excessive wear on the cam or on the damper mechanism.

Another object of the invention is to provide a spindle which cooperates with the check cam in a novel way to allow for noiseless movement of the cam from its dead center position.

A further object of the present invention is to provide a novel damper cylinder which may be utilized in a door check of the above outlined character.

An additional object of the invention is to provide an improved casing for use in our door check and to construct the casing in such a way that it affords convenient access to all such component parts which might require adjustment or inspection when the door check is installed in a door frame or in the floor beneath a swinging door.

Still another object of the invention is to provide a door check which is of simple, compact and rugged design, which can accommodate a very strong closing spring, and wherein the closing and/or the damping action may be regulated in a simple manner.

Briefly stated, one feature of our invention resides in the provision of a door check which comprises a housing, a spindle rotatably mounted in and having an end extending from the housing so that it may be coupled to a swinging door, a control cam mounted on the spindle in the housing, a spring-biased follower for tracking and for normally holding the control cam in an angular position in which a swinging door connected to the spindle is closed, a check cam angularly movably mounted on the spindle in the housing and having a portion cooperating with a portion of the spindle to determine the extent of relative angular movement therebetween, a second follower for tracking the check cam, and a damper mechanism provided in the housing and operative to bias the second follower against the check cam.

Another feature of our invention resides in the provision of a hydraulic damper mechanism which includes a relief valve which opens to reduce the pressure in the

cylinder just before the check cam reaches a dead center position with reference to the second follower.

The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims. The improved door check itself, however, both as to its construction and its mode of operation, together with additional features and advantages thereof, will be best understood upon perusal of the following detailed description of a specific embodiment with reference to the accompanying drawings, in which:

FIG. 1 is a longitudinal central vertical section through a door check which embodies our invention, the section being taken in the direction of arrows substantially as seen from the line I—I of FIG. 2;

FIG. 2 is a top plan view of the door check with the lid of the housing and the door-engaging arm removed; and

FIG. 3 is a horizontal section substantially as seen in the direction of arrows from the line III—III of FIG. 1.

Referring to the drawings, there is shown a check for single acting or double acting swinging doors which comprises an outer casing **10** adapted to be embedded in the floor structure beneath a swinging door, not shown. The casing **10** accommodates a metallic housing **200** which includes a pan **2** and a lid **2***a*. The casing **10** also comprises a cover plate **11** which overlies the lid **2***a* and provides room for an upwardly extending annular sleeve **2***h* which is fixed to the lid **2***a* and surrounds a median portion of a vertical spindle **1** (also called check shaft) whose upper end portion is nonrotatably but detachably secured to a horizontal arm **1***a*. The arm **1***a* may be attached to or recessed into the underside of a swinging door so that the arm and the spindle **1** then constitute the lower hinge of the door.

The spindle **1** is journalled in three antifriction bearings including a radial ball bearing **3** which is mounted in the lid **2***a*, a needle bearing **4** which is mounted in the bottom wall **2***b* of the pan **2**, and a thrust bearing including a ball **5** which is surrounded by the needle bearing **4**. Intermediate the bearings **3** and **4**, the spindle **1** carries two radial cams or plate cams including a control cam or closing cam **6** and a check cam or damper cam **7** located at a level below the control cam. The periphery of the control cam **6** is tracked by a roller follower **13** which is mounted on a rockable lever **15**. This lever is mounted on a pivot pin **15***a* which is supported in one or more lugs **2***c* provided at the inner side of one side wall or lateral wall **2***d* of the pan **2** and close to the front portion **12**. The axis of the pin **15***a* is parallel to the axis of the spindle **1**. The free end **17** of the lever **15** is engaged by a power rod **8***a* comprising two telescopically connected sections which are biased apart by a strong closing spring **8**, called power spring. The front section of the power rod **8***a* is provided with a conical tip **8***b* which extends into a complementary conical recess in the free end **17** of the lever **15**, thus enabling the lever to rock about the pin **15***a* while the rod **8***a* remains free to pivot about its rear end portion **8***c*. The bias of the power spring **8** is adjustable by a lever **20** which is secured to the rear wall **2***e* of the pan **2**, as at **20***a*, and may be pivoted by the tip **22** of a regulating screw **21** which is accessible upon detachment of the cover plate **11**.

The front portion **12** of the pan **2** is of reduced width, see particularly FIGS. 2 and 3. The width of this front portion is just sufficient to accommodate the cams **6**, **7**. The housing **200** including the pan **2** and cover **2***a* comprises two mirror symmetrical halves which are located at the opposite sides of a central vertical symmetry plane **33** passing through the axis of the spindle **1** and preferably (but not necessarily) through the axis of the regulating screw **21**. It will be noted that the lugs **2***c* are located at one side of the symmetry plane **33** directly opposite sim-

ilar lugs 2*f* which form part of the other side wall 2*g* of the pan 2 and accommodate a vertical pivot pin 38 for a lever 16 whose free end 18 is engaged by the piston rod or push rod 19 of a damper device 9 which is constructed in accordance with an important feature of our invention. The pin 38 is adjacent to the front portion 12 and the lever 16 carries a roller follower 14 which tracks the periphery of the check cam 7. The push rod 19 is connected to a piston 43 which is reciprocable in a cylinder 42, the latter being pivotable about a pin 42*a* which is secured to the bottom wall 2*b* of the pan 2. Thus, the tip of the push rod 19 may follow all angular movements of the free end 18 of the lever 16 when the latter is rocked in response to rotation of the check cam 7. A comparatively weak helical expansion spring 40 operates between the bottom wall 41 of the cylinder 42 and the piston 43 to maintain the tip of the push rod 19 in permanent engagement with the free end 18 of the lever 16 and to slightly bias the follower 14 against the check cam 7.

The upper cam 6 is held against axial movement with reference to the spindle 7 by a washer 6*a* which is inserted below a collar 1*b* on the spindle. The lower cam 7 is fixed in selected axial position by a first washer 29 which abuts against the underside of the cam 6 and by a second washer 30 which is fixed by a split ring 31 extending into a circumferential groove provided in the periphery of the spindle 1. The cam 6 need not rotate with reference to the spindle.

That portion of the spindle 1 which extends through the bore 23 of the cam 7 is provided with two cutouts 27 which are located diametrically opposite each other and whose innermost zones are bounded by two flat and comparatively large parallel peripheral faces 28. The cam 7 is provided with two triangular projections 24 which are also located diametrically opposite each other and are bounded by mutually inclined flat internal surfaces 25, 26. The two surfaces 25, 25 and 26, 26 are respectively parallel to each other. Each surface 25 makes with the corresponding surface 26 an obtuse angle and the shortest distance between the planes of the surfaces 25, 25 or 26, 26 corresponds to the distance between the peripheral faces 28. In FIG. 3, each face 28 abuts against one of the internal surfaces 25. The projections 24 need not extend throughout the full axial length of the bore 23, see FIG. 1. When the surfaces 25 are substantially parallel to the symmetry plane 33, the surfaces 26 enclose with this plane an angle of approximately 15 degrees. The surfaces 25 are substantially parallel to the plane 33 when the door is closed.

When the door is being opened by swinging in a counterclockwise direction, as viewed in FIG. 3, the peripheral faces 28 of the spindle 1 first abut against the internal surfaces 25 of the check cam 7. In the closing position of the door, the tip 32 of the pointed lobe on the check cam 7 is located below the symmetry plane 33 as the parts appear in FIG. 3, i.e., the follower 14 abuts against the flank 34 of the cam 7. If the user then swings the door in a counterclockwise direction, the peripheral faces 28 continue to abut against the internal surfaces 25 until the spindle 1 and the cam 7 reach the angular positions which are actually shown in FIG. 3 in which only the tip 32 of the cam lobe is engaged by the follower 14. This is the dead center position of the cam 7. If the user continues to swing the door in a counterclockwise direction, the follower 14 begins to track the flank 35 of the cam lobe and imparts to the check cam an impulse which causes it to turn with reference to the spindle 1 until the internal surfaces 26 reach the peripheral faces 28.

In the dead center position of FIG. 3, the symmetry plane 36 of the check cam 7 extends through the axis 37 of the follower 14. The axis 37 is located at a comparatively large distance from the axis of the pivot pin 38 so that the arc described by the axis 37 is a flat curve which deviates only slightly from the symmetry plane 36. The angle 38*a* enclosed by the symmetry planes 33, 36 is about 15 degrees, i.e., it can be said that the curve described by the axis 37 of the follower 14 (when the latter is rocked by the flank 34 on the lobe of the cam 7) also encloses with the symmetry plane 33 an angle which approximates 15 degrees. The check cam 7 comprises two mirror symmetrical halves which are located at the opposite sides of the symmetry plane 36 and which are respectively provided with flanks 34 and 35. Each of these flanks is configurated in such a way that, if tracked by the follower 14, the axis 37 of the follower moves closer to the axis of the spindle 1 if the cam 7 is rotated in a sense to cause the follower to travel away from the tip 32. After an angle of about 90 degrees, the flanks 34, 35 move away from the axis of the cam 7, as at 39, so that the axis 37 then begins to move away from the spindle 1. The outward deflection of flanks 34, 35 at 39 is rather sudden so that the axis 37 is rapidly moved away from the spindle in response to relatively small angular displacement of the cam 7. When the follower 14 engages the cam 7 at one of the points 39, the door is turned through about 90 degrees from its open position and the piston 43 then reaches the end of its suction stroke so that the cylinder 42 accommodates a maximum quantity of fluid.

The moment or impetus which is needed to cause the check cam 7 to leave the dead center position of FIG. 3 is furnished by the expansion spring 40 in the cylinder 42 of the damper device 9. The spring 40 transmits the necessary force through the piston 43, push rod 19, lever 16 and follower 14. During closing of the swinging door, i.e., when the spindle 1 rotates in a clockwise direction as the parts appear in FIG. 3, the end face 44′ of the piston 43 will move toward the bottom wall 41 of the cylinder 42. The chamber between the piston 43 and the bottom wall 41 is filled with oil or another suitable hydraulic liquid which is then compelled to escape through a system of ducts including a channel 44 provided in a pin 45. The outflow of liquid through the channel 44 is regulatable by a needle valve 46 which can be reached with a screwdriver or a similar tool through suitable apertures provided in the lid 2*a* and cover plate 11, see FIG. 1. The resistance offered to the escaping liquid in the channel 44 and by the needle valve 46 is undesirable when the check cam 7 approaches its dead center position because such resistance results in high compression of the liquid and in substantial angular acceleration of the check cam as soon as it can move beyond the dead center position.

In order to avoid such rise in pressure of liquid which is entrapped between the bottom wall 41 of the cylinder 42 and the end face 44′ of the piston 43, we provide a normally closed relief valve 47 which is shown in FIG. 3 and which is operated by the piston 43. The relief valve 47 comprises a reciprocable valve member 48 which is biased by a helical spring 49 so as to normally abut against an annular valve seat 50 machined into the bottom wall 41 of the cylinder 42 and surrounding a relief passage 51 which communicates with the cylinder chamber between the bottom wall 41 and the end face 44′ of the piston 43. The head of the valve member 48 comprises a projection which extends through the passage 51 and into the path of the end face 44′ on the piston 43. The bias of the spring 49 may be regulated by a screw 52 which is threaded into a tapped bore machined into the outer side of the bottom wall 41. The bias of the spring 49 is adjusted in such a way that, in normal operation, the valve member 48 remains in sealing engagement with the seat 50 and moves away from the seat only when its projection is engaged by the end face 44′ of the piston 43 or in the event of faulty operation, i.e., if the pressure prevailing in the chamber of the cylinder 42 rises beyond a maximum permissible value at a time the projection of the valve member 48 is not engaged by the piston 43. In other words, the relief valve 47 also performs the function of a safety valve, for example, to prevent damage when the door is swung open or closed by a strong gust of wind or

for another reason. The passage **51** is free to communicate with a passage **53** which leads into the interior of the pan **2** as soon as the head of the valve member **48** is moved away from the seat **50**. Thus, whenever the relief valve **47** opens in response to bodily impact of the piston **43** against a portion of the valve member **48**, liquid can escape via the regular route (namely, through the channel **44** and the channel **54** which receives the tip of the needle valve **46**) and via the second route defined by the passages **51** and **53**. The diameters of the passages **51** and **53** are preferably selected in such a way that the liquid pressure in the chamber of the cylinder **41** drops to zero as soon as the valve **47** opens so that the follower **14** is then biased solely by the rather weak spring **40**. This takes place shortly before the cam **7** reaches the dead center position of FIG. 3. Therefore, the check cam **7** is accelerated only negligibly even though the follower **14** moves from engagement with the flank **34** into engagement with the flank **35**, or vice versa. This reduces the noise and results in greatly reduced wear on the check cam **7**, follower **14**, lever **16** and damper device **9**. It is clear that the chamber of the cylinder **42** is filled automatically (via needle valve **46**) as soon as the piston **43** begins to perform a forward stroke by moving away from the bottom wall **41**. The interior of the pan **2** is at least partially filled with liquid.

Due to the fact that the check cam **7** is free to perform limited angular movements with reference to the spindle **1**, we insure that the follower **14** abuts against the flank **34** or **35** whenever the door is closed because the cam **7** has not as yet moved to the dead center position of FIG. 3. This holds true regardless of the direction in which the door swings to open position. Some damping force always remains because the door is closed at a time when the piston **43** has not as yet completed its rearward or compression stroke.

FIG. 2 shows that the outline of the casing **10** follows the outline of the pan **2**. Thus, the casing **10** also comprises a front portion which is of reduced width. This is of particular advantage in connection with single acting swinging doors and normal doors because the casing **10** need not be located beneath the frame and no special cutouts are needed therefor. Despite such configuration of the casing **10** and pan **2**, the lever **15** can be made large enough to transmit from the power spring **8** a strong closing force without undue stressing of the bearings for the spindle **1**. The construction shown in the drawings can be used, without any changes in connection with single acting swinging doors which open in a clockwise or counterclockwise direction as well as in connection with double acting swinging doors.

The extent of noise which is generated when the check cam **7** moves beyond its dead center position depends to some degree on the area of cooperating faces and surfaces on the spindle **1** and the check cam but particularly on the speed at which the surfaces **25** or **26** of the cam strike against the faces **28** of the spindle. The angular speed of the cam **7** with reference to the spindle **1** depends on the magnitude of forces which act upon the cam at the time it leaves the dead center position of FIG. 3, and such forces are reduced in a fully automatic way because the relief valve **47** opens shortly before the piston **43** reaches the end of its stroke so that the pressure prevailing in the chamber of the cylinder is reduced in a fully automatic way and the force necessary to move the cam **7** over the dead center position is furnished exclusively (or nearly exclusively) by the expanding spring **40**. The liquid which escapes through the channel **44** must overcome a substantial resistance and such resistance could allow the pressure in the cylinder to build up so that the check cam **7** would be subjected to substantial turning forces which would cause noisy impact of surfaces **25** or **26** against the faces **28** of the spindle **1**. It was found that, when surfaces **25** or **26** impact against the internal faces **28** solely in response to the bias of the spring **40**, the resulting noise is minimal and definitely much less than in conventional door checks of which we have knowledge at this time. Furthermore, the wear on the check cam **7** and on the spindle is negligible so that the door check may be used for long periods of time without necessitating any attention on the part of the owner. The cooperating surfaces **25**, **26** and faces **28** are sufficiently large to insure that the check cam **7** is properly and strongly guided and journalled on the spindle. The areas of such surfaces and faces should be large enough to insure that the cam **7** follows all angular movements of the spindle as soon as the faces **28** abut against the faces **25** or **26**.

The extent of noise also depends to some degree on the configuration of the cams **6** and **7**. On the other hand, the configuration of the cams depends on the direction of movement of the followers **13**, **14**, and such movement depends on the mounting of levers **15**, **16**. It was found that the space in the pan **2** may be utilized with great advantage if the followers **13**, **14** and the levers **15**, **16** are mounted in a manner as shown in FIG. 2, i.e., that the pivot pin **15***a* and the point where the follower **13** engages the cam **6** are located at the opposite sides of the symmetry plane **33**, and also that the pivot pin **38** and the point of engagement between the follower **14** and cam **7** are also located at the opposite sides of this symmetry plane. Such mounting allows for use of large levers **15**, **16** which, in turn, insures that the arcs described by the axes of the followers **13**, **14** deviate only slightly from straight lines. It is preferred to construct not only the check cam **7** but also the control cam **6** in such a way that it comprises two mirror symmetrical halves. When the door is closed, the symmetry planes of the cams **6**, **7** are respectively parallel or nearly parallel to the paths in which the axes of the followers **13**, **14** move during rotation of the corresponding cams. In other words, and referring to FIG. 3, the symmetry plane **36** is then substantially parallel (but actually tangential) to the flat arc described by the axis **37** of the follower **14** when the latter oscillates about the pin **38** in response to rotation of the check cam **7**. The same holds true for the cam **6** and follower **13**. This insures that the operation of the door check is the same regardless of the direction in which the door swings from the closed position. As shown in FIG. 3, the symmetry plane **36** of the cam **7** passes through the axes of the spindle **1** and follower **14** and makes with the symmetry plane **33** an angle of about 15 degrees. This angle is located at that side of the plane **33** which faces away from the pivot pin **38** for the lever **16** on which the follower **14** is mounted. FIG. 2 shows that the symmetry plane **36***a* of the control cam **6** makes with the symmetry plane **33** a similar angle but that this angle is located at the other side of the plane **33**, i.e., at the side facing away from the pivot pin **15***a* on which the lever **15** for the follower **13** is mounted.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it for various applications without omitting features which fairly constitute essential characteristics of the generic and specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. In a door check, a housing containing a supply of hydraulic fluid; a spindle rotatably mounted in and having an end extending from said housing; a control cam mounted on the spindle in said housing; a spring-biased follower for tracking and for normally holding said control cam in an angular position in which a swinging door connected to the end of said spindle is closed; a check cam angularly movably mounted on the spindle in said housing, said spindle and said check cam having cooperating portions for determining the extent of relative angular movement therebetween; a second follower

for tracking said check cam; and a damper mechanism provided in said housing and operative to bias said second follower against said check cam, said damper mechanism comprising a cylinder member and a piston member one of which is operatively connected with said second follower and the other of which is secured to said housing, said piston member being reciprocable in said cylinder member to respectively expel and draw fluid from said housing, and relief valve means provided in said cylinder member and arranged to open shortly before said check cam reaches a dead center position with reference to said second follower while said piston member moves in a direction to expel fluid from said cylinder member.

2. In a door check, a housing containing a supply of hydraulic fluid; a spindle rotatably mounted in and having an end extending from said housing; a control cam mounted on the spindle in said housing; a spring-biased follower for tracking and for normally holding said cam in an angular position in which a swinging door connected to the end of said spindle is closed; a check cam angularly movably mounted on the spindle in said housing, said spindle and said check cam having cooperating portions for determining the extent of relative angular movement therebetween and said check cam further comprising a lobe having a tip and two flanks located at the opposite sides of said tip; a second follower for tracking said check cam, said second follower engaging the tip of said lobe when the check cam assumes a dead center position and said second follower engaging one of said flanks when the door is closed; and a damper mechanism provided in said housing and operative to bias said second follower against said check cam so that the check cam automatically turns with reference to the spindle when it is rotated by the spindle in a sense to move the second follower from engagement with said one flank into engagement with the other flank or vice versa, said damper mechanism comprising a cylinder member and a piston member one of which is operatively connected with said second follower and the other of which is secured to said housing, said piston member being reciprocable in said cylinder member to respectively expel and draw fluid from said housing, and relief valve means provided in said cylinder member and arranged to open shortly before said check cam reaches a dead center position with reference to said second follower while said piston member moves in a direction to expel fluid from said cylinder member.

3. In a door check, a housing; a spindle rotatably mounted in and having an end extending from said housing; a control cam mounted on the spindle in said housing; a spring-biased follower for tracking and for normally holding said cam in an angular position in which a swinging door connected to the end of said spindle is closed; a check cam angularly movably mounted on the spindle in said housing, said spindle and said check cam having cooperating portions for determining the extent of relative angular movement therebetween and said check cam further comprising a lobe having a tip and two flanks located at the opposite sides of said tip; a second follower for tracking said check cam, said second follower engaging the tip of said lobe when the check cam assumes a dead center position and said second follower engaging one of said flanks when the door is closed, said portion of said spindle comprising two peripheral faces located substantially diametrically opposite each other and said portion of the check cam comprising two pairs of mutually inclined internal surfaces one pair of which abuts against said faces when the second follower engages one of said flanks and the other pair of which abuts against said faces when the second follower engages said other flank; and a damper mechanism provided in said housing and operative to bias said second follower against said check cam so that the check cam automatically turns with reference to the spindle when it is rotated by the spindle in a sense to move the second follower from engagement with said one flank into engagement with the other flank or vice versa.

4. A structure as set forth in claim 3, wherein said faces are located in flat parallel planes and wherein the surfaces of each pair are also located in flat parallel planes at a distance from each other corresponding substantially to the distance between the planes of said faces so that the inclination of said pairs of surfaces with reference to each other determines the extent of relative angular movement between said spindle and said check cam.

5. A structure as set forth in claim 4, wherein said pairs of surfaces are inclined with reference to each other to such an extent that the check cam and the spindle can rotate with reference to each other through an angle approximating 15 degrees.

6. In a door check, a housing comprising two substantially mirror symmetrical halves located at the opposite sides of a longitudinally extending symmetry plane; a spindle rotatably mounted in and having an end extending from said housing, the axis of said spindle being located in said plane at one end of said housing; a control cam mounted on the spindle in said housing; a spring-biased follower for tracking and for normally holding said cam in an angular position in which a swinging door connected to the end of said spindle is closed; a check cam angularly movably mounted on the spindle in said housing, said spindle and said check cam having cooperating portions for determining the extent of relative angular movement therebetween, said portion of the spindle comprising two peripheral surfaces located substantially diametrically opposite each other in flat planes which are parallel to the axis of said spindle and said portion of the check cam comprising two pairs of mutually inclined internal surfaces, each pair of internal surfaces being located in two flat planes parallel with the axis of said spindle and the distance between the planes of each pair of surfaces corresponding to the distance between the planes of said faces, one pair of said surfaces abutting against said faces and being substantially parallel with said symmetry plane when the door is closed and the other pair of said surfaces then enclosing with said symmetry plane an angle of approximately 15 degrees, said check cam further comprising a lobe having a tip and two flanks disposed at the opposite sides of said tip; a second follower for tracking said check cam, said second follower engaging one of said flanks when the door is closed and said second follower engaging said tip when the check cam is moved angularly to a dead center position; and a damper mechanism provided in said housing and operative to bias said second follower against said check cam so that the check cam automatically turns with reference to said spindle when it is rotated by the spindle in a sense to move the second follower from engagement with said one flank into engagement with said other flank or vice versa.

7. In a door check, a housing having a pan arranged to accommodate a supply of hydraulic fluid; a spindle rotatably mounted in and having an end extending from said housing; a control cam non-rotatably secured to the spindle in said housing; a spring-biased follower for tracking and for normally holding said cam in an angular position in which a swinging door connected to the end of said spindle is closed; a check cam angularly movably mounted on the spindle in said housing, said spindle and said check cam having cooperating portions for determining the extent of relative angular movement therebetween and said check cam having a lobe provided with a tip; a second follower for tracking said check cam and engaging said tip when the check cam is turned by the spindle to assume a dead center position; and a hydraulic damper mechanism provided in said housing and operative to bias said second follower against said check cam with a force which increases when the second follower approaches said tip from either side of said lobe, said damper mechanism comprising a hydraulic cylinder

having an internal chamber and provided with flow restricting channel means connecting said chamber with the interior of said pan so that the chamber is filled with hydraulic fluid, a piston reciprocably received in said chamber and operatively connected with said second follower to bias the same with an increasing force when the piston reduces the volume of said chamber by expelling fluid through said chanel means while the check cam turns in a sense to move the second follower toward the tip of said lobe, and a normally closed relief valve provided in said cylinder and extending into the path of said piston to open automatically when the second follower engages the tip of said lobe so that the bias of said second follower decreases.

8. In a door check, a housing having a pan arranged to accommodate a supply of hydraulic fluid; a spindle rotatably mounted in and having an end extending from said housing; a control cam nonrotatably secured to the spindle in said housing; a spring-biased follower for tracking and for normally holding said cam in an angular position in which a swinging door connected to the end of said spindle is closed; a check cam angularly movably mounted on the spindle in said housing, said spindle and said check cam having cooperating portions for determining the extent of relative angular movement therebetween and said check cam having a lob provided with a tip; a second follower for tracking said check cam and engaging said tip when the check cam is turned by the spindle to assume a dead center position; and a hydraulic damper mechanism provided in said housing and operative to bias said second follower against said check cam with a force which increases when the second follower approaches said tip from either side of said lobe, said damper mechanism comprising a hydraulic cylinder having an internal chamber and provided with flow-restricting channel means connecting said chamber with the interior of said pan so that the chamber is filled with hydraulic fluid, a piston reciprocably received in said chamber and operatively connected with said second follower to bias the same with an increasing force when the piston reduces the volume of said chamber by expelling fluid through said channel means while the check cam turns in a sense to move the second follower toward the tip of said lobe, and a normally closed relief valve provided in said cylinder and extending into the path of said piston to open automatically when the second follower engages the tip of said lobe so that the bias of said second follower decreases, said cylinder being further provided with a passage which is normally sealed by said relief valve and which is dimensioned in such a way that the pressure in said chamber decreases substantially to zero when said relief valve opens, said damper mechanism further comprising a relatively weak spring which biases said piston in a sense to maintain said second follower in compressive engagement with said check cam whereby said spring furnishes the force necessary to turn the check cam with reference to said spindle when the second follower engages the tip of said lobe.

9. A structure as set forth in claim 8, wherein said relief valve comprises a reciprocable valve member provided in said passage and having a projection normally extending into said chamber and into the path of said piston, a valve seat provided in said cylinder, and resilient means for biasing said valve member against said valve seat, said piston engaging said projection to move said valve member against the bias of said resilient means so that the fluid may escape through said passage when the second follower engages the tip of said lobe.

10. A structure as set forth in claim 9, further comprising means for adjusting the bias of said resilient means upon said valve member.

11. A structure as set forth in claim 9, wherein said resilient means comprises a helical spring which opposes the fluid pressure in said chamber when the piston is spaced from the projection of said valve member.

12. In a door check, a housing containing a supply of hydraulic fluid comprising a pair of substantially mirror symmetrical halves located at the oposite sides of a longitudinally extending symmetry plane; a spindle rotatably mounted in and having an end extending from said housing, the axis of said spindle being located in said plane at one end of said housing; a control cam fixed to the spindle in said housing; a first lever pivotally secured to said housing at one side and extending to the other side of said plane; a first roller follower mounted on said lever at the other side of said plane; an elongated power spring mounted in said housing for biasing said first follower against and for normally holding said cam in an angular position in which a swinging door connected to the end of said spindle is closed; a check cam angularly movably mounted on the spindle in said housing, said spindle and said check cam having cooperating portions for determining the extent of relative angular movement therebetween; a second lever pivotally secured to said housing at said other side and extending to said one side of said plane; a second roller follower mounted on said second lever at said other side of said plane; and an elongated hydraulic damper mechanism mounted in said housing adjacent to said power spring and operatively connected with said second lever for biasing the second follower against said check cam, said damper mechanism comprising a cylinder member and a piston member one of which is operatively connected with said second follower and the other of which is secured to said housing, said piston member being reciprocable in said cylinder member to respectively expel and draw fluid from said housing, and relief valve means provided in said cylinder member and arranged to open shortly before said check cam reaches a dead center position with reference to said second follower while said piston member moves in a direction to expel fluid from said cylinder member.

13. In a door check, a housing comprising a pair of substantially mirror symmetrical halves located at the opposites sides of a longitudinally extending symmetry plane, each of said halves including a side wall; a spindle rotatably mounted in and having an end extending from said housing, the axis of said spindle being located in said plane at one end of said housing; a control cam fixed to the spindle in said housing; a first lever pivotally secured to one of said side walls at one side and extending to the other side of said plane; a first roller follower mounted on said lever at the other side of said plane; an elongated power spring mounted in said housing for biasing said first follower against and for normally holding said cam in an angular position in which a swinging door connected to the end of said spindle is closed; a check cam angularly movably mounted on the spindle in said housing, said spindle and said check cam having cooperating portions for determining the extent of relative angular movement therebetween; a second lever pivotally secured to the other side wall at said other side and extending to said one side of said plane, said levers being pivotable about axes which are parallel to the axes of said spindle; a second roller follower mounted on said second lever at said other side of said plane; and an elongated hydraulic damper mechanism mounted in said housing adjacent to said power spring and operatively connected with said second lever for biasing said second follower against said check cam.

14. A structure as set forth in claim 13, wherein each of said cams comprises two mirror symmetrical halves separated from each other by symmetry planes, the symmetry planes of said cams coinciding substantially with the paths of the respective followers when the spindle is located in an axial position in which the door is closed, said followers describing such paths in response to rocking of the respective levers when the cams rotate with said spindle.

15. A structure as set forth in claim 14, wherein said paths are flat curves which are inclined through about 15 degrees with reference to the symmetry plane of said housing and are located at the opposite sides of said last named symmetry plane.

16. In a door check, a housing containing a supply of hydraulic fluid; a spindle rotatably mounted in and having an end extending from said housing; a control cam mounted on the spindle in said housing; a spring-biased follower for tracking and for normally holding said cam in an angular position in which a swinging door connected to the end of said spindle is closed; a check cam angularly movably mounted on the spindle in said housing, said spindle and said check cam having cooperating portions for determining the extent of relative angular movement therebetween and said check cam further comprising a lobe having a tip and two flanks located at the opposite sides of said tip; a second follower for tracking said check cam, said second follower engaging the tip of said lobe when the check cam assumes a dead center position and said second follower engaging one of said flanks when the door is closed, each of said flanks having a first portion extending through an angle of about 90 degrees and converging toward the axis of said spindle and a second portion merging into the respective first portion and diverging sharply from the axis of said spindle; and a damper mechanism provided in said housing and operative to bias said second follower against said check cam so that the check cam automatically turns with reference to the spindle when it is rotated by the spindle in a sense to move the second follower from engagement with said one flank into engagement with the other flank or vice versa, said damper mechanism comprising a cylinder member and a piston member one of which is operatively connected with said second follower and the other of which is secured to said housing, said piston member being reciprocable in said cylinder member to respectively expel and draw fluid from said housing, and relief valve means provided in said cylinder member and arranged to open shortly before said check cam reaches a dead center position with reference to said second follower while said piston member moves in a direction to expel fluid from said cylinder member.

17. A structure as set forth in claim 16, wherein said cylinder member has a bottom wall and defines a fluid-filled internal chamber, said piston member being operatively connected with said second follower and being located at a maximum distance from said bottom wall when the second follower engages one of said flanks at a point intermediate the first and second portions of such flank, said relief valve means being arranged to open while said piston member approaches said bottom wall.

18. In a door check, a housing having a pan arranged to accommodate a supply of hydraulic fluid; a spindle rotatably mounted in and having an end extending from said housing; a control cam non-rotatably secured to the spindle in said housing; a spring-biased follower for tracking and for normally holding said cam in an angular position in which a swinging door connected to the end of said spindle is closed; a check cam angularly movably mounted on the spindle in said housing, said spindle and said check cam having cooperating portions for determining the extent of relative angular movement therebetween and said spindle having a lobe provided with a tip; a second follower for tracking said check cam and engaging said tip when the check cam is turned by the spindle to assume a dead center position; and a hydraulic damper mechanism provided in said housing and operative to bias said second follower against said check cam with a force which increases when the second follower approaches said tip from either side of said lobe, said damper mechanism comprising a hydraulic cylinder having an internal chamber and provided with flow restricting channel means connecting said chamber with the interior of said pan so that the chamber is filled with hydraulic fluid, a piston reciprocably received in said chamber and operatively connected with said second follower to bias the same with an increasing force when the piston reduces the volume of said chamber by expelling fluid through said channel means while the check cam turns in a sense to move the second follower toward the tip of said lobe, and a normally closed relief valve provided in said cylinder and extending into the path of said piston to open automatically when the second follower engages the tip of said lobe so that the bias of said second follower decreases, said relief valve comprising a spring-biased valve member which normally seals a passage provided in said cylinder for escape of hydraulic fluid from said chamber and which open automatically against the spring bias when the pressure in said chamber exceeds a permissible maximum value so that said relief valve simultaneously functions as a safety valve.

19. A door check, comprising a housing containing a supply of hydraulic fluid; a spindle rotatably mounted in and having an end extending from said housing; a control cam mounted on the spindle in said housing; a power spring mounted in said housing; a follower provided in said housing to track said control cam in response to the bias of said power spring and to normally hold the cam in an angular position in which a swinging door connected to the end of said spindle is closed; a check cam angularly movably mounted on the spindle in said housing, said spindle having at least one peripheral face movable into and out of engagement with said check cam to limit relative angular movement between the spindle and the check cam, said check cam having a lobe provided with a tip and a pair of flanks disposed at the opposite sides of said tip; a second follower engaging one of said flanks when the door is closed and while said peripheral face holds the check cam against relative movement in one direction; and a damper mechanism provided in said housing for yieldably biasing said second follower against said check cam, said second follower being compelled to move over the tip of said lobe and to track the other flank of said check cam when the door is swung in a sense to move from said closed position and to increase the bias of said damper mechanism, said damper mechanism comprising a cylinder member and a piston member one of which is operatively connected with said second follower and the other of which is supported by said housing, said piston member being reciprocable in said cylinder member to respectively expel and draw fluid from said housing, and relief valve means provided in said cylinder member and arranged to open while said piston member moves to expel fluid from said cylinder member when said second follower tracks one of said flanks close to said tip.

References Cited by the Examiner

UNITED STATES PATENTS

1,085,192	1/1914	Brucker	16—51
2,603,818	7/1952	Carlson	16—55

FOREIGN PATENTS

1,269,893 7/1961 France.

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