Sept. 25, 1956 W. BENNETT 2,764,443

DOOR LOCK

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FIG. 1.

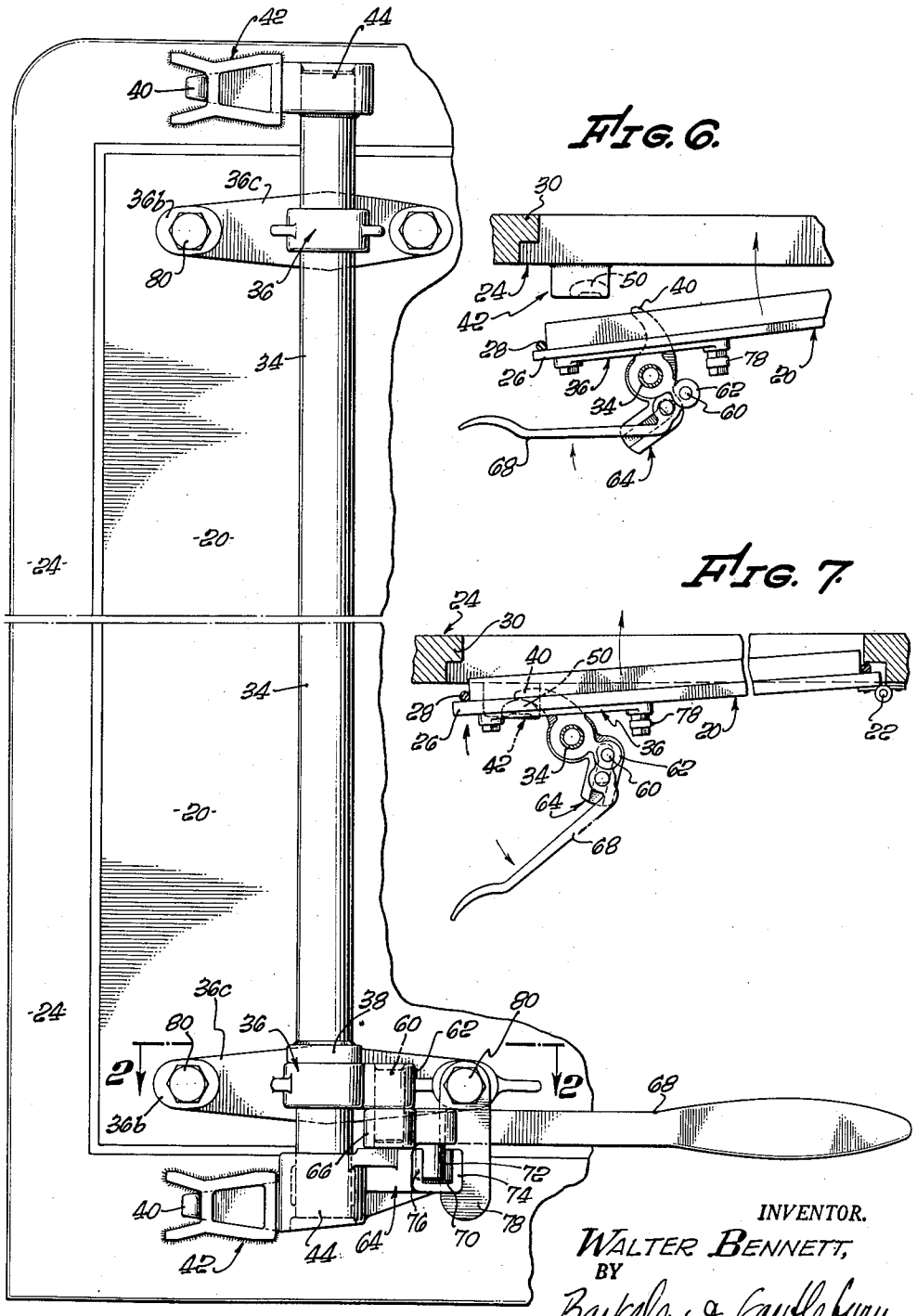



FIG. 6.




FIG. 7.




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FIG. 2.

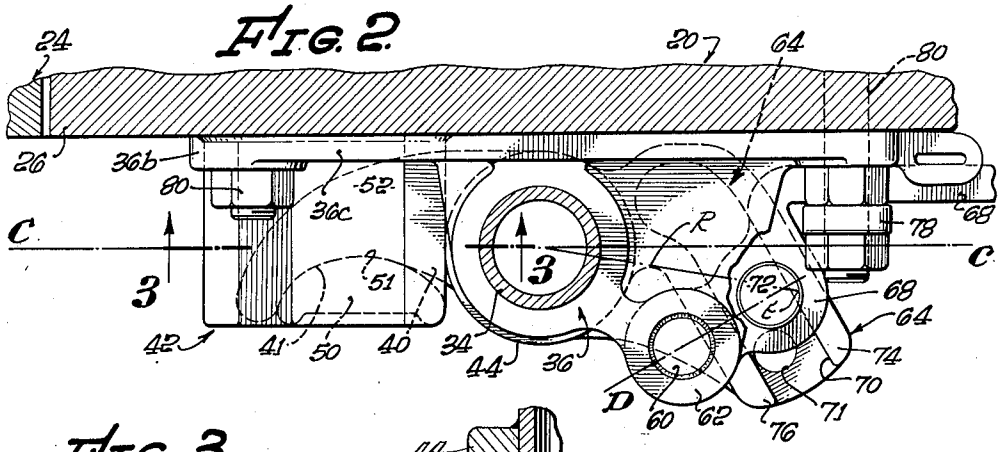



FIG. 3.

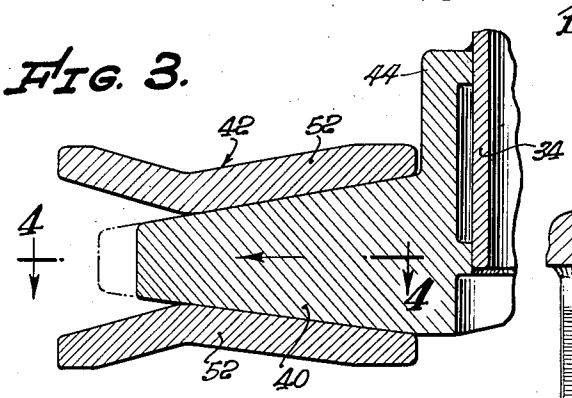



FIG. 4.

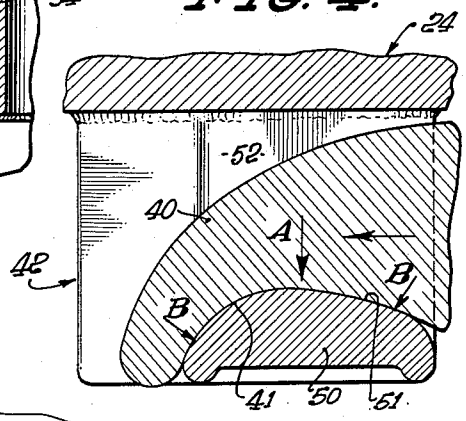
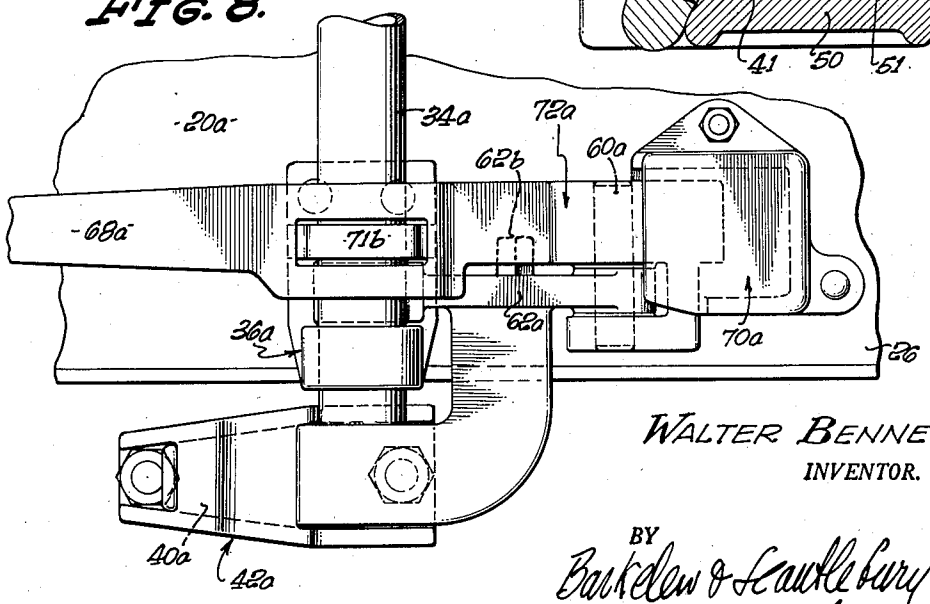



FIG. 8.




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FIG. 5.

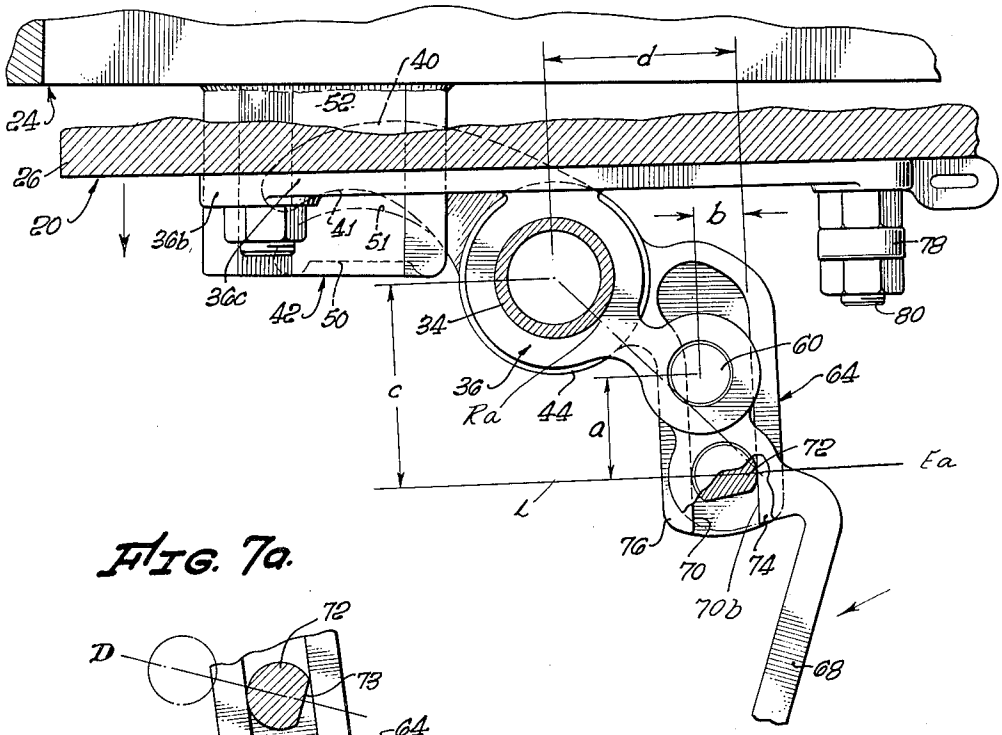
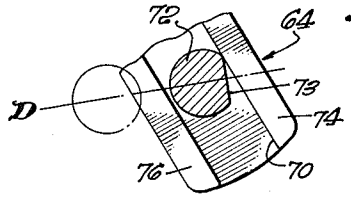



FIG. 7a.




FIG. 7b.



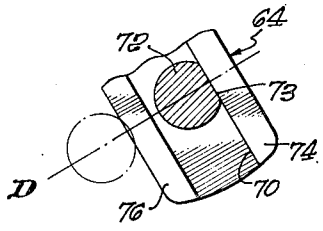




FIG. 7c.

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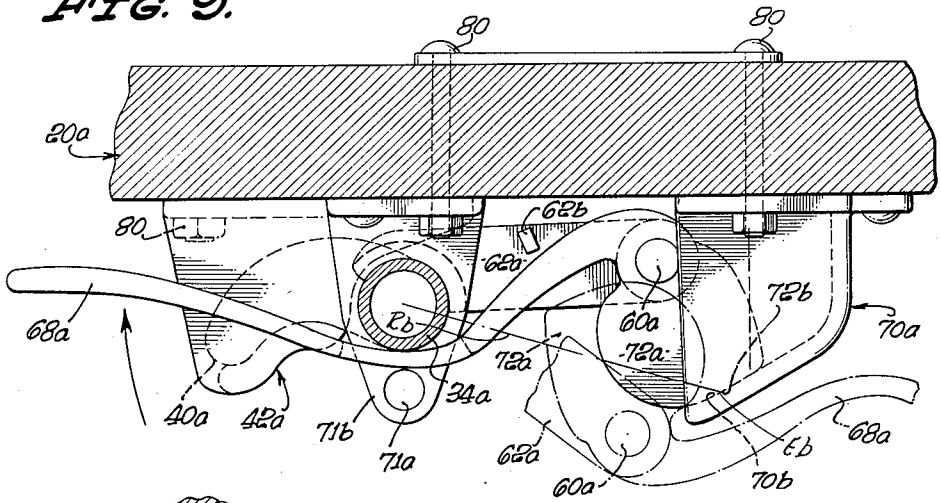
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FIG. 9.



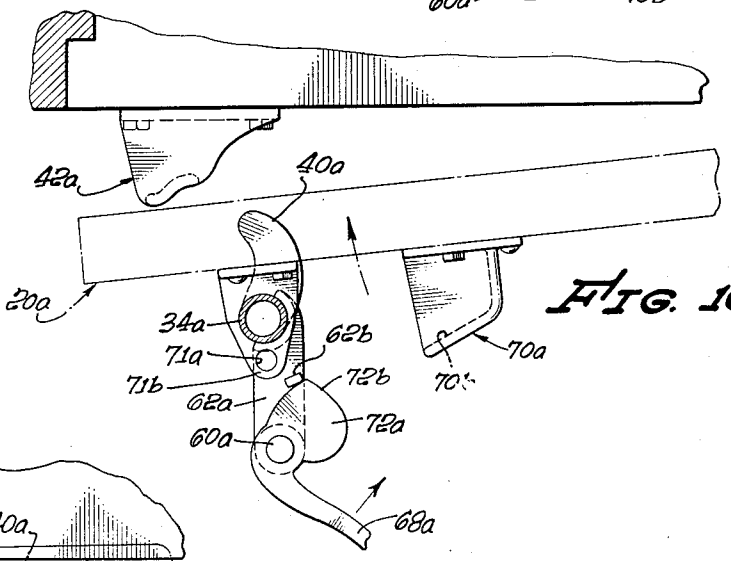




FIG. 10.

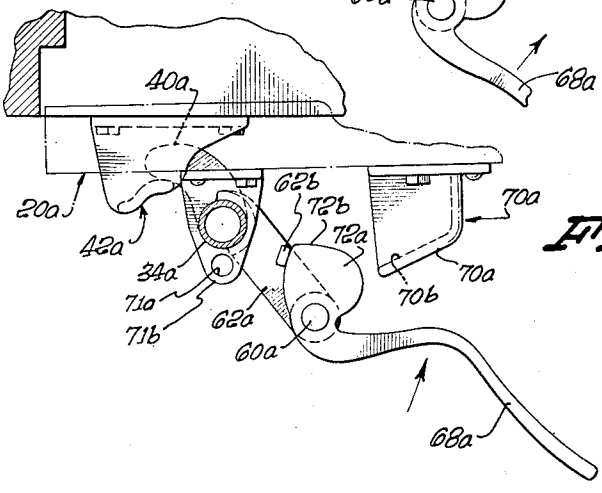



FIG. 11.

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United States Patent Office 2,764,443 Patented Sept. 25, 1956



2,764,443

# DOOR LOCK

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Application May 4, 1953, Serial No. 352,925

7 Claims. (Cl. 292—240)

The present invention has reference to locks, and, although applicable to any relatively movable member, is particularly applicable and effective when used on swinging doors. The invention also has certain features which make it particularly effective when applied to the swinging door or doors commonly used to close the rear end of a van-type transport body. The invention will be described and its action explained with particular reference to such doors and body; but without implying that the invention is limited to any such specific use.

A primary objective feature of the present invention lies in its provision of a locking means, operable by a manual handle, which applies an increasing torque to the door as it approaches more and more closely to its final closed position; so that the door may be, by easy manual actuation, forced closed or open, under heavy pressure. And, in connection with that feature, it is also a characteristic of the locking mechanism of my invention that, in its final position in which it holds the door closed under great force, the operating handle is not subject to any force tending to move it in an opening direction. When the door is being held closed under pressure, the operating handle is "dead."

There are many other objective features and corresponding accomplishments of the invention, all of which will be best understood as they are explained in connection with the specific and preferred illustrative embodiments of the invention set out in illustrative detail in the following description and shown in the accompanying drawings in which:

Fig. 1 is a fragmentary elevation showing one illustrative preferred form of my present invention, with the parts shown in their closed positions;

Fig. 2 is an enlarged horizontal section on line 2—2 of Fig. 1, with the parts in their closed positions;

Fig. 3 is a further enlarged detail section on line 3—3 of Fig. 2;

Fig. 4 is a detail section on line 4—4 of Fig. 3;

Fig. 5 is a schematic view similar to Fig. 2 but showing the parts in positions approaching the closed position;

Figs. 6 and 7 are diagrammatic views showing other progressive positions of the locking mechanism;

Figs. 7*a*, 7*b* and 7*c* show details of progressive positions of the locking mechanism;

Fig. 8 is a fragmentary elevation showing a modified form of the invention with the lock in closed position;

Fig. 9 is a plan section of the parts shown in Fig. 8; and

Figs. 10 and 11 are diagrams showing progressive positions of the locking mechanism of Figs. 8 and 9.

In the drawings a typical swinging door is shown at **20**, hinged at one vertical edge on hinges **22** (see Fig. 7) in a door framing **24** which may be of any type and structure. The door itself is shown as having a rabbeted flange **26** which may either serve to trap another door of a pair, or may, through packing **28**, seat directly on a shoulder **30** in the door frame structure **24**. The present



lock mechanism is applicable to any such door. As explained later, the door here shown, whether it is a single door or the right hand door of a pair, acts as a gusset to brace the door frame.

The physical structure of the presently preferred form of the lock mechanism is best shown in Figs. 1 to 5 and will first be explained with reference to those figures. As there shown, a vertical lock shaft **34**, preferably formed of tubing or pipe, is rotatively mounted in two journal members **36** which are rigidly secured to the outer face of the door at its swinging side near its top and bottom. A collar **38** or other shoulder formation rigidly attached to the shaft rests on one of the journals to support the shaft and its carried parts in proper position to cooperate with other parts mounted on the door frame structure. That door frame structure may, for instance, be the rear end framing of a vehicle body.

Two curved locking tongues **40** are rigidly mounted on the upper and lower ends of shaft **34** in positions respectively just above and below the upper and lower edges of the door. These locking tongues, in their locking position, engage in keepers **42** which are mounted on the door frame structure just above and below the door opening. The two tongue and keeper units are duplicates, so a detailed showing and description of the lower unit will suffice for both. As here shown in preferred form, the shaft-mounted hub **44** of the lower tongue **40**, in addition to carrying the tongue also carries one element of the lock operating cam mechanism. However the lower tongue **40** might have its own hub **44** like the upper tongue; and the cam mechanism element could be mounted on its own individual hub on shaft **34** and that hub and the cam mechanism could be spaced along the shaft from the lower tongue just as it is spaced from the upper tongue. This is spoken of particularly for the purpose of pointing out later that, in finally locked condition, the shaft **34** may be put in torsional stress between the camming mechanism and both locking tongues, as well as only the upper locking tongue as here specifically shown.

As will appear, the camming mechanism rotates the shaft and its tongues between such an open position as shown in Fig. 6, and the final locked position shown in Figs. 1 and 2, passing through intermediate positions such as shown in Figs. 7 and 5. The shaft and tongues are rotated through about 90° between the open position of Fig. 6 and the finally locked position of Fig. 2; and as will appear from the successive positions shown in Figs. 6, 7, 5 and 2, the tongue enters the box-like keeper **42** by a swinging movement from the right to the left in the drawings. In thus entering the keeper the tongue has a component of movement toward the left in the keeper as well as a component of movement outward, away from the door frame. Those two movement components are indicated by arrows in Figs. 3 and 4.

The keeper **42** is a box-like structure with an outer wall **50** presenting an inner face **51** that is convex as viewed in horizontal section as in Fig. 4. The tongue **40** is curved as viewed in plan (Figs. 2 and 4) and has an outer concave face **41** which, in the final locked position of Figs. 2 and 4, fits the convex keeper face **51**. In that final locked position the tongue is being forced in the direction of the arrow A of Fig. 4 and its concave face is therefore pressing against keeper face **51** not only in direction A but also in direction B. In consequence, the tongue, thus engaging the keeper, is forcibly pressed in the door closing direction, opposite to A; and is also held from displacement in the plane of the door. As the tongue in locked position is being held rigid with relation to the door, the door is also held rigidly with relation to the frame.

The box-like keeper has upper and lower walls that

present inner faces converging toward the left; and the tongue, in the aspect of Fig. 3, is correspondingly tapered. Consequently, as the tongue forcibly enters the keeper in the direction of the arrow in Fig. 3, the interengagement of the tapering and converging faces will correct any relative vertical displacement that may exist between the tongue and keeper. This action is of some practical importance where the door and/or door frame structure are liable to become deformed. For instance, the rear end framing of a transport body which has a rear door opening substantially as large as the body itself, may be very liable to warpage to rhomboidal shape when the vehicle is standing on uneven ground. The frame door opening then, at the swinging edge of the door, stands vertically displaced from that edge of the door. Assuming that the door itself is stiff in its own plane and held at its hinged edge with no loosenesses either horizontally or vertically, and assuming that shaft **34** and the tongues are vertically immovable on the swinging end of the door then the forcible entry of the tapered tongues into the tapering keeper boxes will force the vertically displaced door framing into its proper rectangular shape as the tongues move to their final locked positions of Figs. 2, 3 and 4.

As stated before, collar **38** or an equivalent shoulder holds shaft **34** up in the bearings **36**. Another such shoulder under either journal **36** could be used to hold shaft **34** and the tongues from moving up relative to the door. But the camming mechanism now to be described provides the necessary upwardly bearing thrust in the specific design here shown.

In this specific illustrative embodiment of the invention the lower journal member **36** carries a rigid pivot pin **60** projecting downwardly from mounting lug **62**. Pivoted on that pin and confined vertically between lug **62** and a cam slot member **64**, is the pivoted end **66** of a manual lever handle **68**. Cam slot member **64** is rigidly mounted on shaft **34**. In this particular design, as mentioned before, it is mounted on and integral with hub **44** of the lower locking tongue. The confinement of **66** between **64** and **62** makes those parts perform a thrust function to hold shaft **34** down in its journals.

Attention is now directed particularly to Figs. 2 and 5. For convenience of description the line C—C on Fig. 2, parallel to the face of the door, will be used as a datum. With the parts in the final locked position of Fig. 2, with tongue **40** projecting to the left of shaft **34** into keeper **42**, the cam slot **70** of member **64** in this illustrative embodiment stands at an angle of about 60° to C—C. Pivoted handle **68** carries a cam pin **72** which projects down into cam slot **70** and plays between the two opposite walls **74** and **76** of that slot. In the final locked position of the parts, the line D, determined by the axes of pivot pin **60** and cam pin **72**, lies preferably at right angles to the length of slot **70**, and thus in this particular illustrative embodiment makes an angle of about 30° with C—C. In that position the main length of handle **68** lies back flatly against or close to the door face and is held against accidental displacement by a suitable keeper, such as the one shown at **78** pivoted on an extension of one of the bolts **80** that bolt the lower journal member **36** to the door.

Referring now to the relative magnitudes indicated by *a*, *b*, *c* and *d* in Fig. 5, it can be shown that

$$(1) \qquad \frac{T}{t}=\frac{c+ud}{a+ub}$$

Where *t* represents the input torque about the axis of pivot pin **60**, T represents the output torque about the axis of shaft **34**, and *u* is the coefficient of friction between cam pin **72** and the wall of slot **70**.

The above equation may be explained as follows. Consider F as the force applied by pin **72** to wall **70***b* in a direction normal to that slot wall, the line of force being represented by L which has such relationship with said slot wall. Then the

$$(2) \qquad \text{input torque } t=Fa$$

where *a* is the perpendicular distance between pivot point **60** and line of force L.

The opposite and equal reaction force F acts, of course, along line L, and the

$$(3) \qquad \text{output torque } T \text{ of shaft } 34=Fc$$

where *c* is the perpendicular distance between the shaft center and line L. From (2) it follows that

$$(4) \qquad F=\frac{t}{a}$$

and from (3) it follows that

$$(5) \qquad F=\frac{T}{c}$$

Therefore

$$(6) \qquad \frac{T}{a}=\frac{T}{c} \text{ or } \frac{T}{t}=\frac{c}{a}$$

If we now introduce the friction factor, we have, in place of Equation 2

$$(7) \qquad t=F(a+ub)$$

and, in place of Equation 3

$$(8) \qquad T=F(c+ud)$$

Substituting $(a+ub)$ for *a* and $(c+ub)$ for *c*, in Equation 6, we have

$$\frac{T}{t}=\frac{c+ud}{a+ub}$$

Assuming *u* to be 0.40 the ratio $T/t$ from such a position as shown in Fig. 6 to the final closed position of Fig. 2, varies from about 0.3 to 2.75. That is assuming pin **72** to be of full round shape (no flat as shown). However the presence of the flat face **73** on pin **72** does not materially change the torque ratios. Of course, if *u* is neglected, or is made to be very small (as it can be by, for instnace, using an anti-friction bearing sleeve around pin **72**) the ratio $T/t$ will approach infinity as the closed position of Fig. 2 is reached.

That changing ratio of the torques of course means that, from a starting position of the handle such as in Fig. 6 substantially parallel to the plane of the door, a given small angular movement of the handle (e. g. to the position of Fig. 7) throws the locking tongue through a relatively large angle; approximately 60° as seen by comparing Fig. 6 with Fig. 7. The remaining large angular throw of the handle from the position of Fig. 7 to the finally closed position of Fig. 2 (approximately 150°) moves the locking tongue through a very small angle (compare Fig. 7 with Fig. 2) under relatively great torque with the result of finally forcing the door closed with great force.

As the door is finally forced closed, the relative positions of the locking parts may be such that shaft **34** is finally put under torsional strain to keep the door tightly closed in spite of slight variations in the relative locations and dimensions of parts of the locking mechanism, and of the door and its frame. The overhanging portions of the shaft, between bearings **36** and the tongues **40** at the shaft ends, may also at the same time be put under elastic bending stress. Elastic deformation of other parts of the mechanism may also have the same effect, but the elastic deformation of the shaft is the greater factor. That deformation also is effective in pressing the door tightly closed even though pin **72** is provided with the flat **73** which functions the same as if, in the final locked position of Fig. 2, pin **72** (with no flat) were moved to a position "over center" with relation to slot wall **74**; that is, to a position where line D (Fig. 2) were angularly rotated about **60** in counter-clockwise direction. As will be

explained, the flat has that same handle locking action and at the same time provides a broad surface for the pressure action between pin **72** and the slot wall.

The functioning of the flat **73** as the parts approach final locked position is illustrated particularly in Figs. 7, 7*a*, 7*b* and 7*c*. In the positions of Figs. 7 and 5 the flat is inoperative or substantially so; the cylindric surface of pin **72** bearing against wall **74**. Beginning with about the position of Fig. 7 and through the progressive positions shown in Figs. 7*a* and 7*b* the flat **73** is moving more nearly into flat contact with wall **74**, until, in the position of Fig. 7*c*, with line D normal to the face of wall **74**, the flat fully engages that wall. From approximately the position of Figs. 7*b* to that of 7*c*, cam slot member **64** moves slightly in a retrograde direction, that is, clockwise about the axis of shaft **34** as flat **73** reaches its final position. Just before that position is reached the cam member **64** is in its furthest position counter-clockwise and shaft **34** and the other parts of the locking mechanism are under their greatest stress and elastic deformation. When cam member **64** has finally backed off to the position of Fig. 7*c*, that stress and deformation are slightly relieved, but the locking tongues are still held in heavy pressurable engagement with the keepers, and the door held tightly closed, by the elastic deformation which still exists. Slot wall **74** is pressed against flat **73** by the same elastic stresses, and holds pin **72** and handle in the position of Fig. 2, without any torque being exerted on the handle. In fact, positive torque in a clockwise direction must be exerted on the handle to move it from the fully locked position of Fig. 2. Thus, the handle is not only "dead" in that position but requires positive force to move it out of that position and to start the movement of the lock mechanism toward open position.

It will be noted that when the locking tongue **40** is in full pressural engagement with keeper **42**, as in Fig. 2, pivot pin **60** lies below the line R which represents a radius from shaft **34** extended to the then effective surface of cam interengagement—that is, point E where pin **72** engages slot wall **74**. On the other hand, in Fig. 5 pivot pin **60** lies above line R*a* which represents a radius from shaft **34** extended to the then effective surface of cam interengagement—that is point E*a* where pin **72** engages slot wall **74**.

The relative movements of the parts from locked to unlocked condition, and the stresses, strains and torques involved, are in general simply the reverse of those involved in movement from open to locked condition. That would be exactly true if pin **72** were fully round and fitted slot **70** tightly. Exactly the same high torque ratio which facilitates forcible closing of the door would be applied to opening the door against any condition tending to stick it closed—ice in the space between the door edge and the frame, for instance. And the same is true generally when pin **72** has the flat **73**. In approximately the position of Fig. 7*a* or 7*b* the pin comes into contact with the face of slot wall **76**, and from that position on the handle exerts a high torque on member **64** to force or break the door open if necessary.

To securely lock the mechanism in closed position against unauthorized opening, it is sufficient to lock handle **68** in the position of Fig. 2 in any suitable manner. For example the swinging keeper **78** can be padlocked; or a padlock can be inserted and locked in the opening **71** in the member **64** to prevent pin **72** from moving in the opening direction.

In the modification shown in Figs. 8 to 11, the shaft **34***a* may be the same and have the same relation to door **20***a* as in Figs. 1 to 7; and tongues **40***a* and keepers **42***a* may be the same in structure, location and function as in Figs. 1 to 7. The tongue and keeper shown in Figs. 8–11 are somewhat modified in form, but are functionally the same as in Figs. 1–7. The modification of Figs. 8–11 is in the camming mechanism which operates the lock shaft and tongues.

In Figs. 8–11 an operating lever-handle **68***a* is pivoted at **60***a* on an arm **62***a* which is secured to shaft **34***a*. A stop **62***b* on arm **62***a* limits the swing of handle **68***a* in the direction indicated with relation to **62***a*; so that, in the relative positions of Figs. 10 and 11, the arm **62***a* swings with handle **68***a*. Handle-lever **68***a* carries a cam formation **72***a* adapted to enter and to cooperate with the cam receiving member **70***a* which is mounted on the door.

The operation of this modification will be understood from Figs. 10, 11 and 9. In the open position of Fig. 10, the door can be pulled open or pushed toward closing position by pulling or pushing on handle **68***a*. In closing, upon tongue **40***a* reaching a position where by rotation it will enter keeper **42***a*, handle **68***a*, and with it the arm **62***a* and the tongues, is swung counter-clockwise through such a position as shown in Fig. 11 and into approximately the position indicated in broken lines for **68***a* and **62***a* in Fig. 9. In that last mentioned position the tongues **40***a* are well within their keepers and the cam member **72***a* is entering the box **70***a*. Then, from that position shown in broken lines in Fig. 9, handle **68***a* and its cam member **72***a* are now thrown around clockwise through approximately 180°, to the final position shown in full lines in Fig. 9. The shape of cam member **72***a* is such that, by engagement with the inner face of box **70***a*, it forces arm **62***a* through a total angle of about 30°, for 180° movement of the handle; and also such that the mechanical advantage of the handle over arm **62***a* and tongue **40***a* increases as the final locked position is reached. And in that final position a flat cam face **72***b* may bear flatly against a flat box face **70***b*, so that the parts are all held in their final locked positions with no rotative forces being exerted on the then "dead" handle. And in the final locked position the several parts and particularly the shaft may be under the same distortion stresses and with the same functional actions as in the form first described. A padlock inserted in hole **71***a* in a lug **71***b* projecting from journal member **36***a* will prevent handle **68***a* from being swung out from its position of Fig. 9 and thus prevent the lock mechanism from being thrown open.

A brief comparison of the two forms will bring out their similarities both as to function and structure. In Fig. 2, the lever-handle is pivoted on a pivot (**60**) which is stationary with reference to the door, and carries a camming member (**72**) which operates on a camming member (**64**) that is carried by the tongue operating shaft (**34**). In Fig. 9, the relative carriages of handle pivot (**60***a*) and of camming member (**70***a*) are simply reversed; the handle pivot **60***a* now being carried by shaft **34***a* and the camming member **70***a* being stationary with reference to the door. In the final action of forcing the door closed by movement of the handle between the two positions of Fig. 9, the functionings of the two forms are very similar to each other. However, the form of Figs. 8–11 has one functional detail that the first form does not have. In the last figures the tongues are first moved into their keepers and into positions close to their final locked positions by swinging the handle counter-clockwise to the broken line position of Fig. 9. Then from that position the handle may be swung through approximately 180° clockwise to give the tongues their final locking movement. In the form of Fig. 2 etc. the maximum movement of handle **68**, both to enter the tongue in the keeper and then to force the tongue to final position, is 180°.

It will be noted by reference to Fig. 9, that when the locking tongue **40***a* is in full pressural engagement with keeper **42***a* (at which time the cam member **72***a* is in the full line position) pivot pin **60***a* lies above the line R*b* which represents a radius from shaft **34***a* extended to the then effective surface of cam interengagement—that is point E*b* where cam **72***a* engages cam face **72***b*; whereas, when cam **72***a* is in the dot-dash position of Fig. 9, said pivot pin **60***a* lies below the extended radius R*b*.

Both forms of the locking mechanism have a further advantageous feature. It is not necessary to rivet or

weld the journals **36** or **36***a* to the door to prevent unauthorized tampering. If all the bolts that hold the parts to the door should be removed, it is still impossible to remove tongue **40** from keepers **42**, if the parts are locked in their relative closed positions by padlocks in the openings **71** and **71***a*. To remove the tongues from the keepers it is necessary to rotate the whole assembly clockwise about a vertical axis located, in Fig. 2 for instance, somewhere to the right of the left hand ends **36***b* of the mounting lugs **36***c* of journals **36**. The extension of those lugs in contact with the door to the left of that axis makes that rotation impossible. In Fig. 9 the same mounting lugs may be similarly extended; or, in that form of the mechanism, the locked handle **68***a* extending to the left performs the same function.

The lock mechanism disclosed herein, as distinguished from the lock operating mechanism disclosed and claimed herein, is the subject matter of my application, Serial Number 602,369, filed August 6, 1956.

I claim:

1. In a locking mechanism for a door or the like which is movable with relation to a doorway frame, a shaft rotatably mounted on the door in a position with its axis substantially parallel to the plane of the door, a locking tongue rigidly carried by the shaft and projecting laterally from the shaft, said tongue being pressurally engageable with and disengageable from a keeper on the frame by virtue of shaft rotation in opposite directions, and cam mechanism comprising two relatively movable interengaging camming members, one mounted on the shaft and the other on the door and adapted by camming action to rotate the shaft and the locking tongue, one of the members being pivotally mounted, the effective surface of cam intenengagement being radially spaced more distantly from the shaft than is the point of pivotal mounting of said one member, said point of pivotal mounting lying at one side of a radius extended from the shaft to the then effective surface of cam interengagement when the locking tongue is in a position of full pressural engagement with the keeper and lying at the other side of a radius extended from the shaft to the then effective surface of cam interengagement when the tongue is in positions of lesser pressural engagement.

2. Locking mechanism as in claim 1; wherein said effective surface stands substantially at right angles to a radius through the pivot point when the members are in the position they occupy when the locking tongue is in full pressural engagement with the keeper.



3. Locking mechanism as in claim 1; wherein the pivotally mounted member is mounted on a pivot which is fixed with relation to the door and the other camming member is rigidly mounted on the shaft.

4. Locking mechanism as in claim 1; and in which the shaft-mounted camming member comprises an element rigidly mounted on the shaft and having a slot formation which has its length lying in a direction tangential of the shaft, and the other camming member comprises a manually operable handle having one end pivoted on a pivot axis parallel to and spaced from the shaft axis, and a cam pin mounted on said handle at a point spaced from the pivot and entered in said cam slot, said cam pin having a flat face on one side in a plane tangential to the pivot axis, and the parts being so positioned that said flat face flatly engages a wall of the cam slot when the locking tongue is in full pressural engagement with the keeper.

5. Locking mechanism as in claim 1; and in which the shaft-mounted camming member comprises an element rigidly mounted on the shaft and having a slot formation which has its length lying in a direction tangential of the shaft, and the other camming member comprises a manually operable handle having one end pivoted on a pivot axis parallel to and spaced from the shaft axis, and a cam pin mounted on said handle at a point spaced from the pivot and entered in said cam slot, said cam pin being engageable exclusively with slot walls which extend lengthwise of the slot formation.

6. Locking mechanism as in claim 1; wherein the shaft mounted camming member is pivotally mounted on a pivot which is fixed with relation to the shaft.

7. Locking mechanism as in claim 6; wherein the two camming members interengage on a surface which stands substantially at right angles to a radius through the pivot when the locking tongue is in full pressural engagement with the keeper.

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UNITED STATES PATENTS

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