May 17, 1955 R. M. CONKLIN ET AL 2,708,284

MAGNETICALLY DAMPED DOOR CLOSER

Filed Feb. 1, 1950 4 Sheets-Sheet 1

FIG. 7.

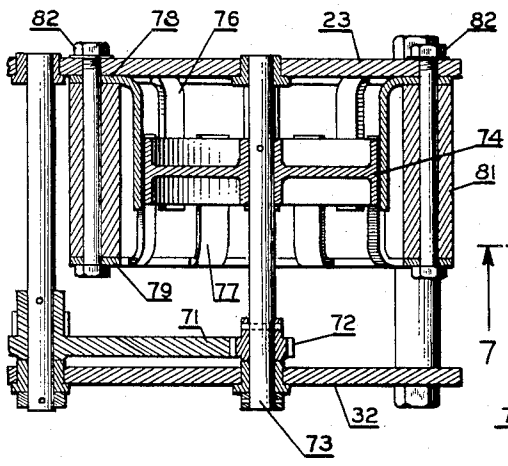


FIG. 6.

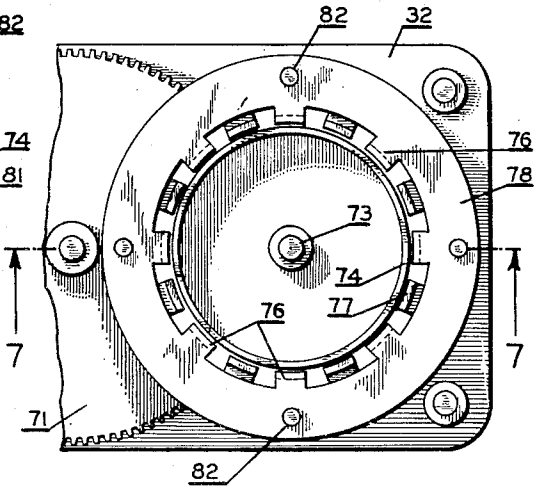


FIG. 1.

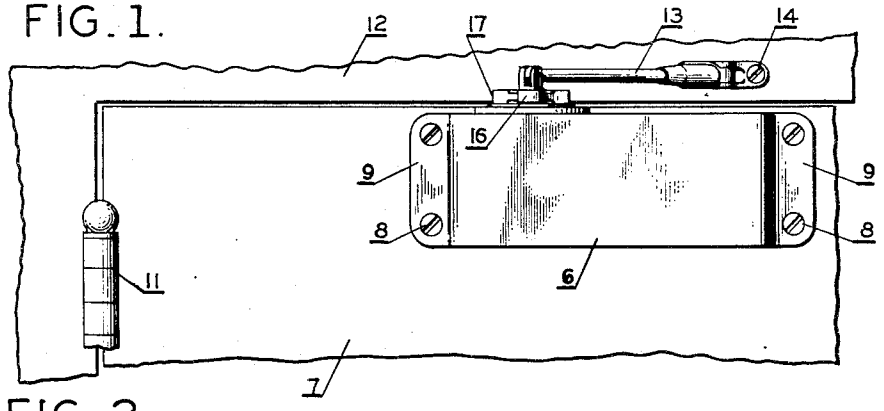
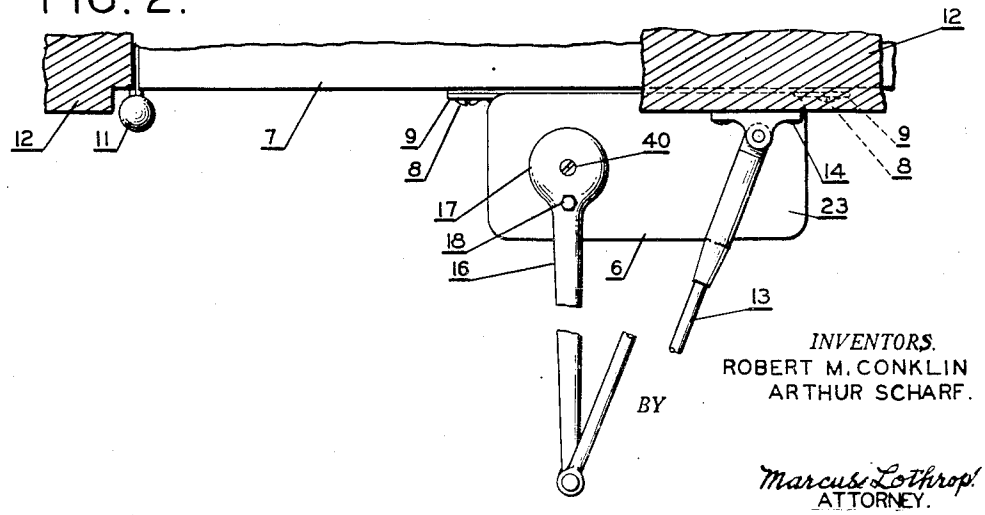


FIG. 2.



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May 17, 1955 R. M. CONKLIN ET AL 2,708,284

MAGNETICALLY DAMPED DOOR CLOSER

Filed Feb. 1, 1950 4 Sheets-Sheet 2

FIG. 3.

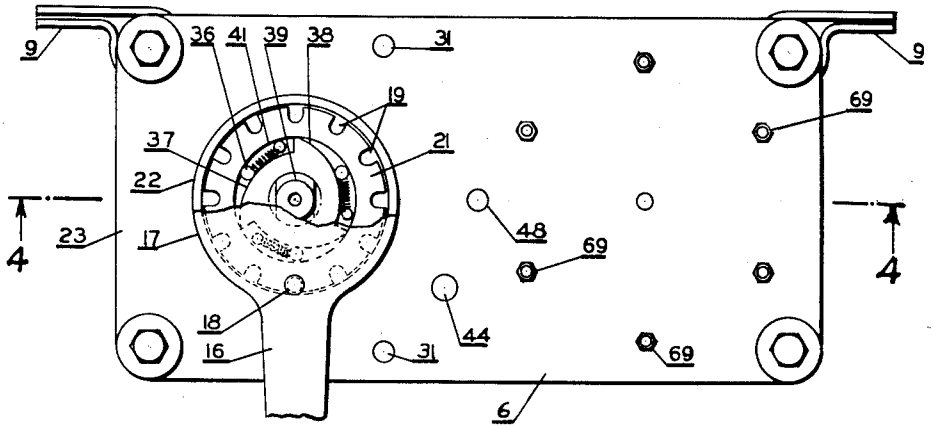


FIG. 4.

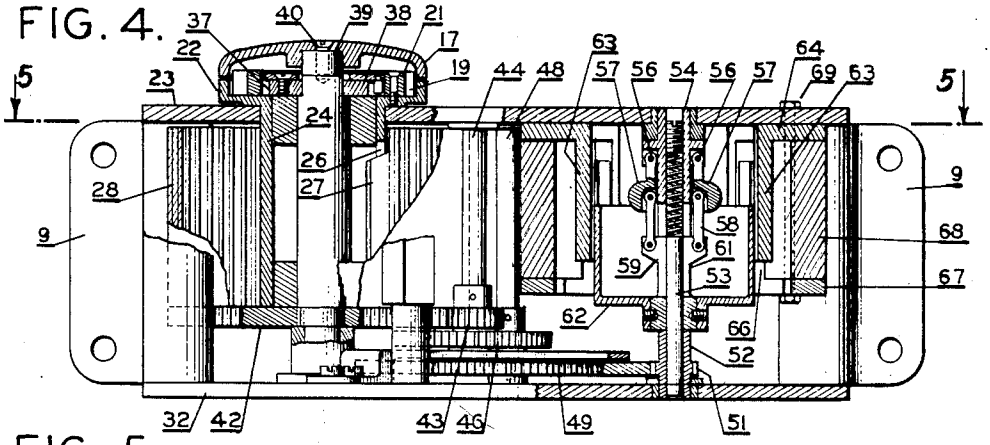
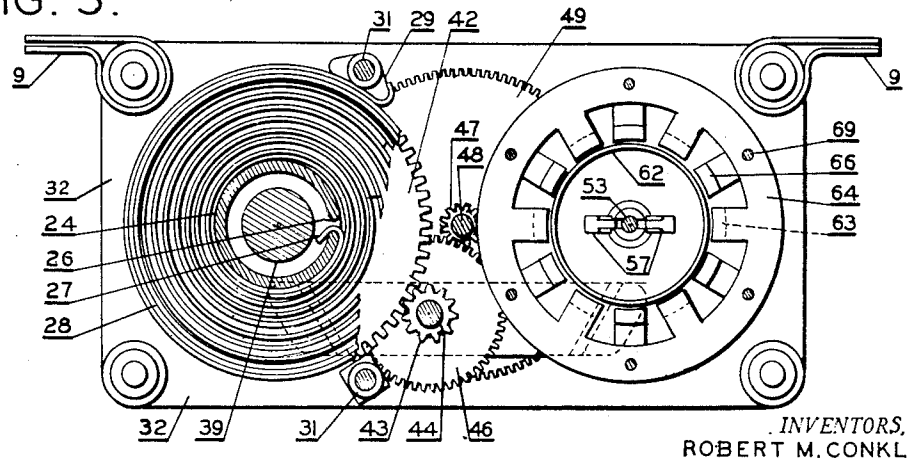


FIG. 5.



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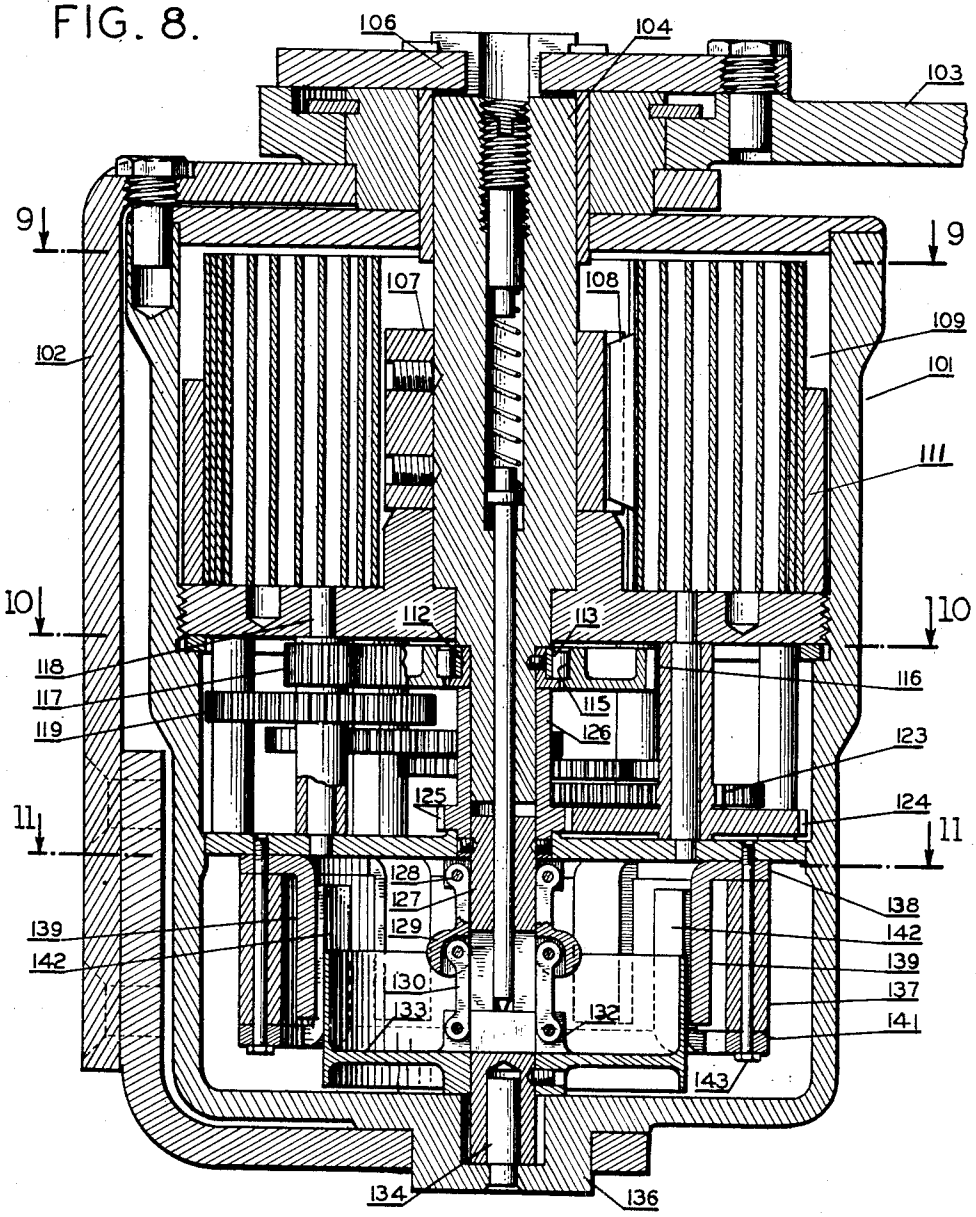
May 17, 1955 R. M. CONKLIN ET AL 2,708,284

MAGNETICALLY DAMPED DOOR CLOSER

Filed Feb. 1, 1950

4 Sheets-Sheet 3

FIG. 8.



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May 17, 1955 R. M. CONKLIN ET AL 2,708,284

MAGNETICALLY DAMPED DOOR CLOSER

Filed Feb. 1, 1950 4 Sheets-Sheet 4

FIG. 9.

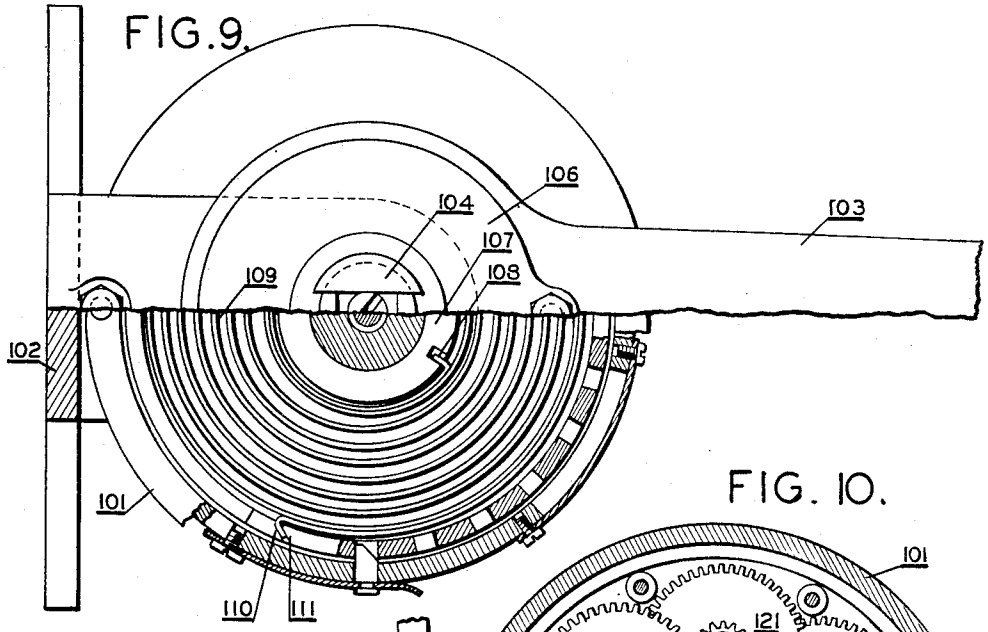


FIG. 10.

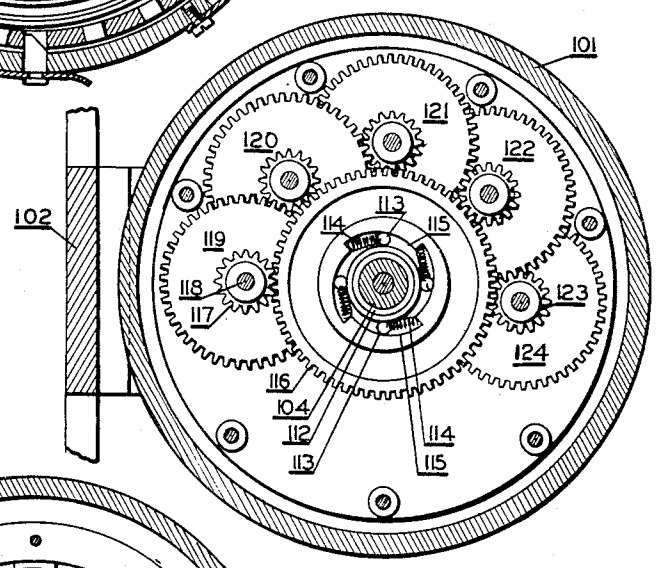
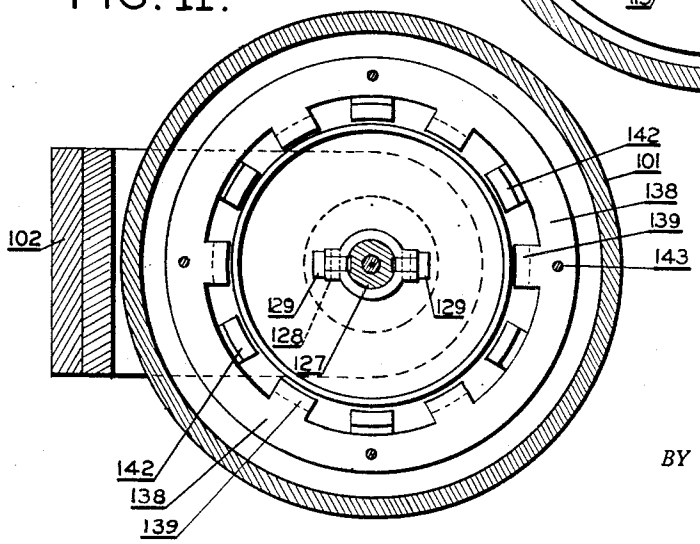


FIG. 11.



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MAGNETICALLY DAMPED DOOR CLOSER

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Application February 1, 1950, Serial No. 141,822

3 Claims. (Cl. 16—49)

Our invention relates to door closers having damping means, particularly a damping means equipped with a permanent magnet for controlling the speed of closing of the door.

Door closers generally provide a hydraulic dash pot to control the speed of closing of the door. The retention of the hydraulic fluid within the mechanism is difficult. The liquid employed tends to seep through the packings and gaskets. Such seepage is not only objectionable as to appearance, but also reduces the effectiveness of the damping mechanism. Frequent inspection, filling, and replacement of packings and gaskets are required to maintain the door closer in operative condition. Even at best, a hydraulic dash pot permits considerable variation in the speed of the door in its closing movement in response to changes in forces operating on the door.

It is therefore an object of this invention to provide a door closer having a damping means effective to provide substantially constant door closing speed despite variations in forces operating on the door.

It is another object of this invention to provide a non-hydraulic means for controlling the closing of a door.

It is yet another object of this invention to provide a magnetic damper especially useful for controlling the action of a door closer.

It is a further object of this invention to provide a door closer having means to augment the effectiveness of a magnetic damper.

Other objects together with the foregoing are attained in the embodiments of the invention described in the accompanying description and illustrated in the accompanying drawings, in which:

Figure 1 is a front elevation of a door closer constructed in accordance with our invention and mounted in position on a door and door frame.

Figure 2 is a plan of the structure shown in Figure 1, portions being broken away.

Figure 3 is a plan to enlarged scale of the closer shown in the preceding figures, parts being broken away to disclose the interior construction and to reduce the size of the figure.

Figure 4 is a cross section of the closer on a vertical transverse plane, the plane of section being indicated by the line 4—4 of Figure 3.

Figure 5 is a cross section of the closer, the plane of section being indicated by the line 5—5 of Figure 4.

Figure 6 is a plan of a modified form of magnetic damping mechanism useful in conjunction with the closer of the preceding figures.

Figure 7 is a cross section of the structure shown in Figure 6 the plane of section being indicated by the line 7—7 of Figure 6.

Figure 8 is a cross section on a transverse vertical plane through a modified form of door closer in accordance with our invention.

Figure 9 in the upper half is a plan of the door closer shown in Figure 8 and in the lower half is a cross section

of the plane of which is indicated by the line 9—9 of Figure 8.

Figure 10 is a cross section the plane of which is indicated by the line 10—10 of Figure 8.

Figure 11 is a cross section the plane of which is indicated by the line 11—11 of Figure 8.

In the form of closer especially shown in Figures 1 to 7 inclusive, there is provided a closer casing 6 secured to a door 7 by suitable fastenings 8 on brackets 9 extending from the casing. The door 7 is mounted by hinges 11 on a door frame or casing 12 to which one of the actuating arms 13 of the closer is secured by fastenings 14. An actuating arm 16 is pivotally connected to the arm 13 and at its inner end is enlarged to provide a hub 17 having a removable screw 18 therein designed to engage in any one of a plurality of peripheral serrations 19 in a disc 21 lying within and fastened to a lower drum 22 journalled in the upper plate 23 of the casing 6.

The drum 22 continues as a spool 24 having a slot 26 in one side thereof to receive the inturned end 27 of a spiral spring 28 disposed within the casing 6 and having its outer end hooked around a retainer 29 mounted on one of the several posts 31 extending through the casing between the top plate 23 and a bottom plate 32. The effect of the mechanism as so far described is to provide an adjustable mounting for the actuating lever 16 so that when the door 7 is opened the drum 22 is rotated and the sleeve 26 likewise rotates to wind the spring 28. When the door is released, the energy so stored in the spring is effective to propel the door toward closed position.

It is desirable to damp the movement of the door toward closed position under the influence of the spring but it is equally desirable to have no restraint upon the door during opening movement and as the spring 28 is being wound. For that reason we provide a one-way or overrunning clutch cooperating with the drum 22. The inner face of the ring 21 is sufficiently hard to coact with a plurality of clutch rollers 36 disposed within such face and likewise co-acting with cam surfaces 37 formed in a disc 38 keyed to a central shaft 39 concentric with the spool 26 and having a loose fastening 40 to hold the hub 17 in position.

The action of the arm 16 in rotating the drum 22 in the opening direction permits the ring 21 to ride freely over the rollers 36. But when the door moves in the closing direction and the drum operates in the reverse direction, the rollers 36 are jammed against the camming surfaces 37 especially under the influence of restoring springs 41 and consequently the shaft 39 is revolved in unison with the spool 24. Thus, as the door opens the spring only is wound and the shaft 39 is not wound whereas during closing movement of the door the spring unwinds and the shaft is turned in unison therewith.

At the bottom of the shaft 39 there is provided a main driving gear 42 meshing with a spur gear 43 on an intermediate shaft 44. This shaft is suitably journalled within the casing 6 and carries also a gear 46 meshing with an intermediate spur 47. The shaft 48 carrying the intermediate spur likewise carries an intermediate gear 49 in turn engaging a pinion 51 on a sleeve 52 journalled in the lower plate 32 of the casing. Secured to the sleeve for rotation therewith is a spindle 53 extending across the case and carried in and secured to a sleeve 54 journalled in the top plate 23. Mounted on the sleeve 54 by opposite pivots 56 are fly-ball weights 57 of a speed responsive mechanism. Links 58 connect such fly-ball members to a collar 59 preferably formed integrally with a sleeve 61 slidable axially along the spindle 53.

As the gears transmit the rotation of the shaft 39 to the spindle 53, the spindle is driven at a relatively rapid rate and through the fly-ball governor lifts the sleeve 61. This motion is utilized to vary the effect of a damping

mechanism in accordance with speed. Secured to and revolving with the sleeve 61 is a magnetically effective cup 62 also movable axially with the sleeve. In its normal, lower location the cup is disposed in a position somewhat displaced from the center of a plurality of magnetic field members. These include poles 63 of one sense depending from an upper disc 64, alternated with poles 66 of the opposite magnetic sense upstanding from a lower disc 67. The discs 64 and 67 are joined together on opposite sides of a ring permanent magnet 68 and the entire assembly is held in the casing by fasteners 69 passing through the top plate 23. Thus as the cup 62 rotates in the magnetic field provided by the several pole pieces 63 and 64, its rotation is braked or damped.

As the drum 62 revolves in the magnetic field it offers a resistance to turning. From the magnetic aspect this resistance is in general somewhat more than in direct proportion with the speed of rotation so that the faster the drum 62 is rotated, the greater is the retardation or braking or governing. The effect is augmented or increased by the centrifugal governor since, with an increase in speed the drum is lifted farther into the magnetic field. Because of the increased field density, the overall magnetic braking or damping effect is considerably greater. The net result is that the closing movement of the door is retarded substantially. If, due to external forces, the speed of closing of the door increases, the damping effect increases not only due to the inherent speed relationship of the magnetic field damping but also because of the effect of the centrifugal governor in increasing the effective magnetic field.

With this mechanism therefore, there is provided a structure which is non-hydraulic and hence is not subject to leakage and the other difficulties of hydraulic systems but also one in which a permanent force such as a magnetic force is utilized in proportion to the speed in augmented fashion to provide a substantially constant net closing or return speed of the door despite variable external influences. The damping mechanism being declutched when the door is opened, offers no resistance to the opening movement whatsoever.

If it is desired that the magnetic damping have only its natural proportion to the speed without augmentation, a simplified version of the structure is effected as shown in Figures 6 and 7. In this arrangement a drive gear 71 driven by the mechanism substantially as in the preceding version spins a pinion 72 on a through shaft 73 held between the upper plate 23 and the lower plate 32 of the casing. The shaft 73 carries a magnetically responsive drum 74 for spinning movement without axial translation in a magnetic field set up by alternating pole pieces 76 and 77. The upper pole pieces 76 depend from a disc 78 while the lower pole pieces 77 are upstanding from a lower disc 79. The discs 78 and 79 are confined on opposite sides of a permanent ring magnet 81 by through fasteners 82. In the operation of this structure, the braking or damping effect due to the spinning rotor operating in the magnetic field, has only its natural proportion to the speed of rotation of the rotor and, correspondingly, to the speed of closing of the door, without any augmentation with speed.

A different form of arrangement including the same general characteristics is provided in the embodiment shown in Figures 8 to 11, inclusive, and which corresponds in general configuration and mounting to the hydraulic structure shown in our co-pending application entitled "Door Closer With Constant Flow Orifice" filed February 1, 1950, with Serial No. 141,821, now Patent No. 2,629,127, dated February 24, 1953.

In this form of the structure there is provided a casing 101 mounted on a bracket 102 secured to the door and provided with an actuating lever 103 secured to the door frame in the usual fashion and effective upon opening of the door to rotate a central shaft 104 through a suitable connecting means 106. The shaft 104 is provided with

a collar 107 set on the shaft and engaging the inturned end 108 of a spiral spring 109 itself secured by a bent end 110 to an anchor 111 on the casing 101. The effect of this arrangement is to wind the spring when the door is opened and when the door is released to permit the stored energy in the spring to return the door to its closed position.

The lower end of the shaft 104 extends to a sleeve 112 adapted to cooperate with jamming rollers 113 urged by springs 114 against cam surfaces 115 in a gear 116 surrounding the shaft. The uni-directional clutch so provided imparts no rotational force to the gear 116 during the door opening movement but drives the gear with the central shaft during door closing. The gear 116 meshes with a pinion 117 on a spindle 118 appropriately journalled and carrying with it a gear 119. The gear 119 operates through a gear train comprised of gear units 120, 121 and 122 to drive a pinion 123. Turning with the pinion 123 is a gear 124 meshing with a gear wheel 125 at the lower end of a sleeve 126 surrounding the shaft 104 and fastened to a rotatable plug 127 coaxial with the shaft 104. The plug is fastened by pivotal connections 128 to a plurality of fly-ball weights 129 forming constituents of a governor. Links 130 pivoted to the fly-ball weights are also pivoted to a collar 132 included in a drum 133 piloted on a spindle 134 upstanding from a hub 136 depending from the case 101.

The drum 133 is of magnetically responsive material and operates within a magnetic field set up by a permanent ring magnet 137 disposed between an upper pole disc 138 having a plurality of spaced depending poles 139 therefrom and a lower pole disc 141 having a number of upstanding pole fingers 142 disposed thereon in position to alternate with the poles 139. Suitable fastenings 143 extend through the pole discs and the ring magnet to secure the assembly together.

In the operation of this structure, during the door opening movement energy is stored in the spring 109 without actuating the gear train or the magnetic damper. During door closing, the energy of the spring is effective to turn the shaft 104 thus impelling the door toward its closed position and likewise actuating the gear train and through the multiplication in speed so provided operating the drum 133 within its magnetic field. The drum acts therefore as a magnetic brake or damper to the closing movement of the door. The governor of fly-ball weights when spun out in response to centrifugal force lift the drum 133 into a denser magnetic field near the center of the pole pieces so that the amount of damping or braking effect is considerably increased. In this fashion, therefore, there is provided a non-hydraulic, electromagnetic damper suitable for slowing the closing rate of the door to substantially a constant value despite variations in external forces acting upon the door.

We claim:

1. A door closer adapted to be actuated by the swinging of a door relative to its support comprising: a casing, a main shaft rotatably mounted in said casing, an actuating arm secured to one end of said shaft, means mounting said casing and said arm for swinging said arm to rotate said main shaft in one direction when said door is opening relative to its support, a spring in said casing and operatively connected with said shaft for winding said spring when said door is opening, a gear train operatively connected at one end with said main shaft and at its other end with a rotor of magnetic material for driving said rotor at a relatively high rotational speed upon rotation of said main shaft in the opposite direction when said door is closing relative to its support, clutch means for automatically disconnecting said gear train from said shaft when the latter rotates in said one direction, and a magnet in said casing positioned with its magnetic field cutting said rotor whereby said spring is wound when said door is opening and while said rotor is stationary and said rotor is rotated at a relatively high

speed against the magnetic resistance of the field of said magnet when said door is closing.

2. A door closer adapted to be actuated by the swinging of a door relative to its support comprising: a casing, a main shaft rotatably mounted in said casing, an actuating arm secured to one end of said shaft, means mounting said casing and said arm for swinging said arm to rotate said main shaft in one direction when said door is opening relative to its support, a spring in said casing and operatively connected with said shaft for winding said spring when said door is opening, a gear train operatively connected at one end with said main shaft and at its other end with a rotor of magnetic material for driving said rotor at a relatively high rotational speed upon rotation of said main shaft in the opposite direction when said door is closing relative to its support, clutch means for automatically disconnecting said gear train from said shaft when the latter rotates in said one direction, and a magnet in said casing positioned with its magnetic field cutting said rotor whereby said spring is wound when said door is opening and while said rotor is stationary and said rotor is rotated at a relatively high speed against the magnetic resistance of the field of said magnet when said door is closing, a mechanical governor responsive to the speed of said rotor for moving the latter toward said field upon an increase in rotor speed, and for moving said rotor away from said field upon a decrease of said speed.

3. A door closer adapted to be actuated by the swinging of a door relative to its support comprising: a casing, a main shaft rotatably mounted in said casing, an actuating arm secured to one end of said shaft, means mounting said casing and said arm for swinging said arm to rotate said main shaft in one direction when said door is opening relative to its support, a spring in said casing and operatively connected with said shaft for winding said spring when said door is opening, a gear train operatively connected at one end with said main shaft and at its other end with a rotor of magnetic material for driving said rotor at a relatively high rotational speed upon rotation of said main shaft in the opposite direction when said door is closing relative to its support, clutch means for automatically disconnecting said gear train from said shaft when the latter rotates in said one direction, and a magnet in said casing positioned with its magnetic field cutting said rotor whereby said spring is wound when said door is opening and while said rotor is stationary and said rotor is rotated at a relatively high speed against the magnetic resistance of the field of said magnet when said door is closing, said magnet comprising a plurality of annularly arranged pole pieces symmetrical about a central axis and said rotor being mounted for rotation about said axis, a mechanical governor mounted for rotation about said axis and adapted to move said rotor axially toward said field upon an increase in rotor speed, and for moving said rotor away from said field upon a decrease of said speed.

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