Sept. 12, 1950 E. BILLETER 2,522,252

DOOR CLOSER

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FIG. 1

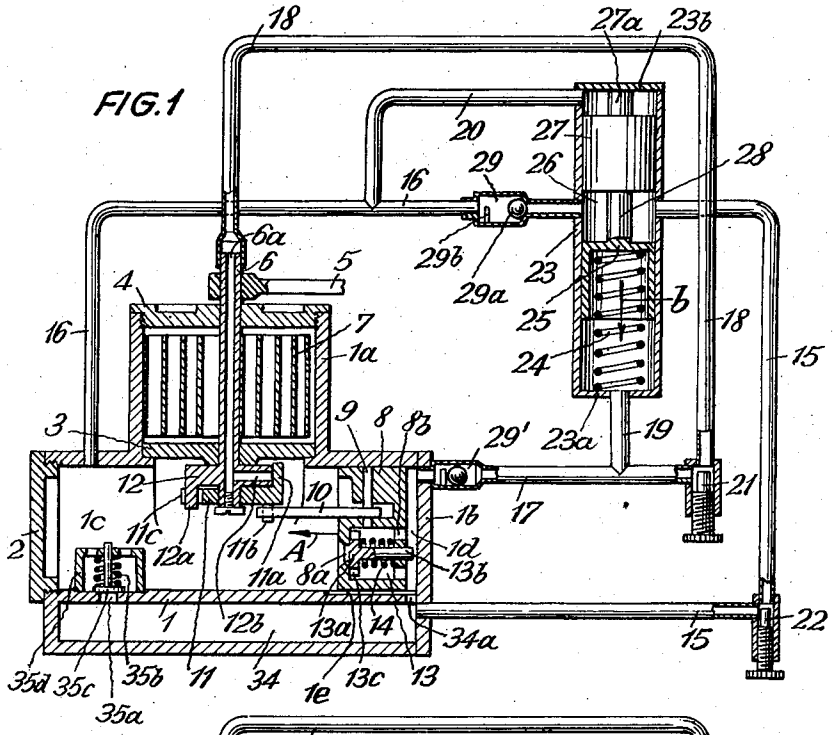
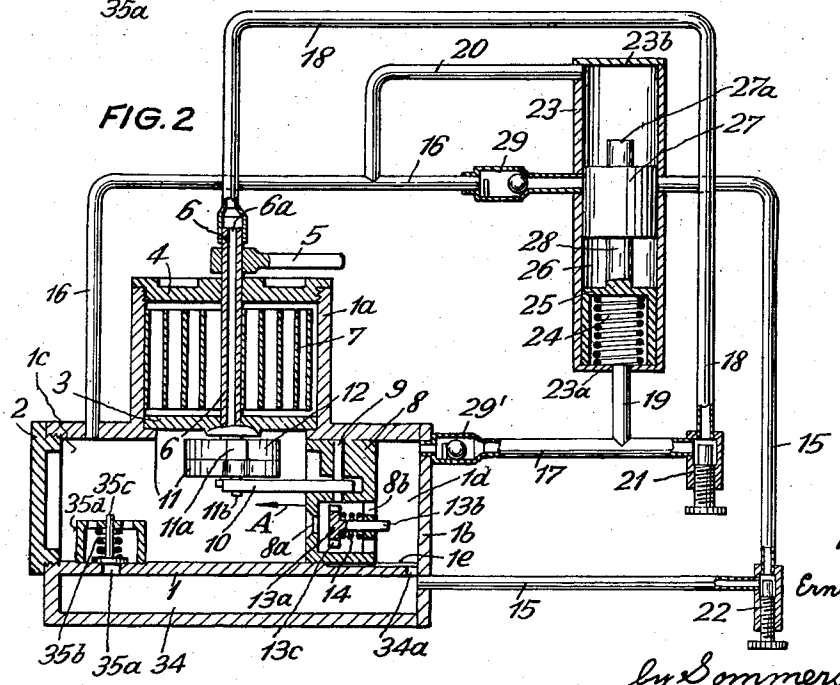


FIG. 2



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FIG. 3

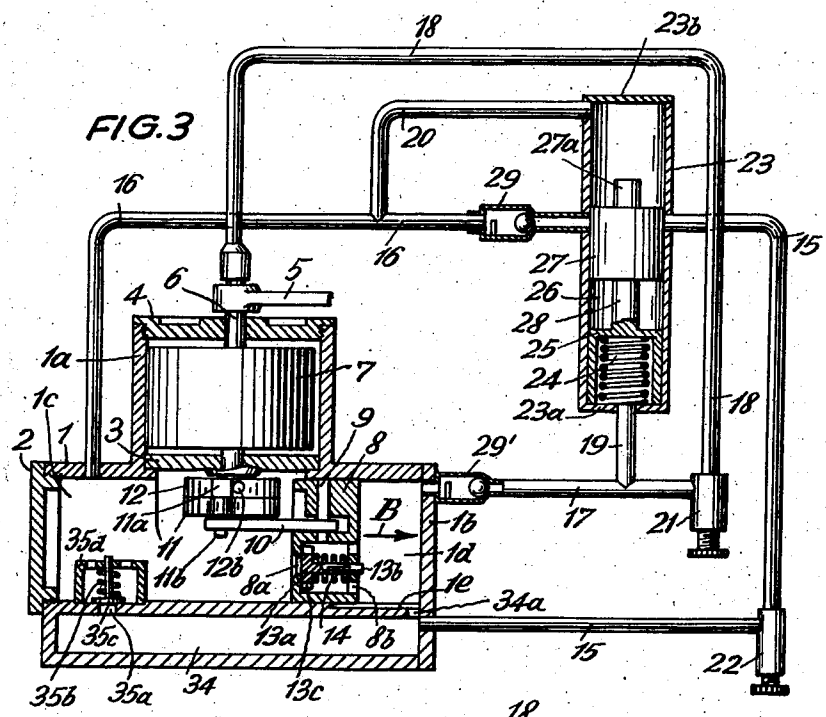
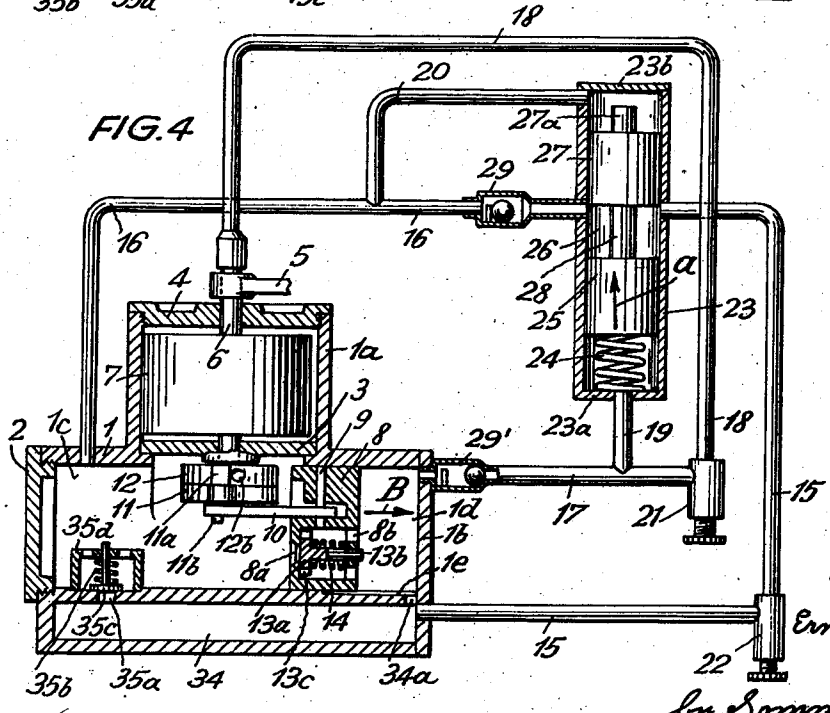


FIG. 4



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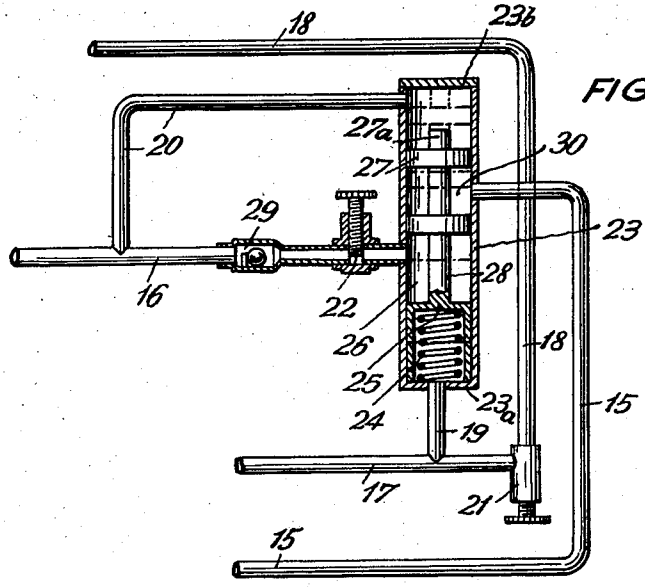


FIG. 5

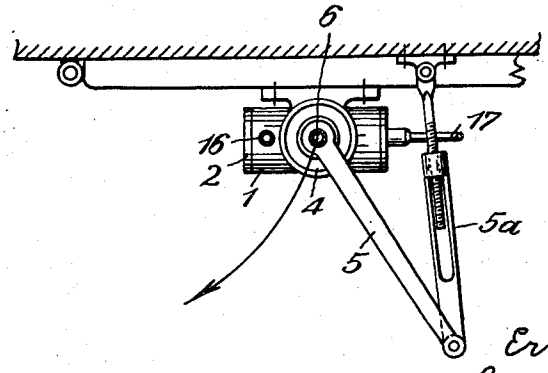


FIG. 14

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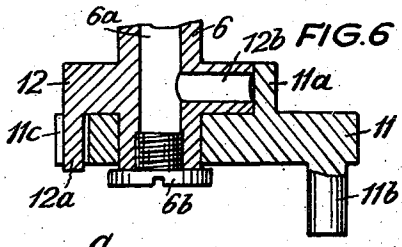


FIG.6

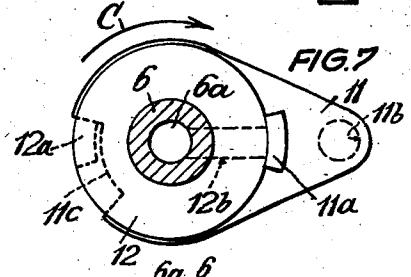


FIG.7

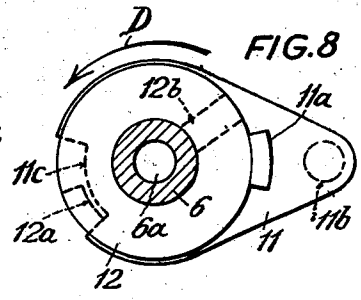


FIG.8

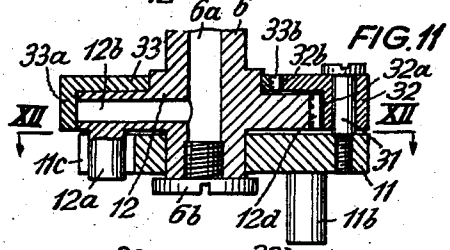


FIG.11

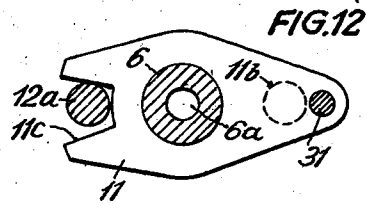


FIG.12

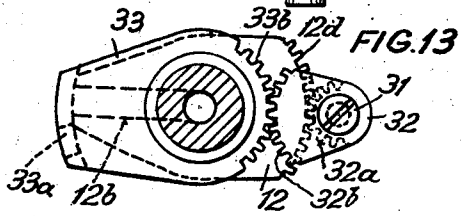


FIG.13

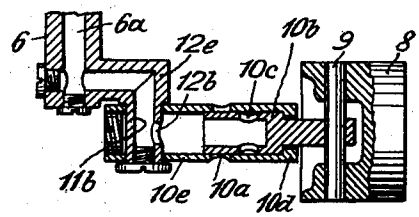


FIG.9

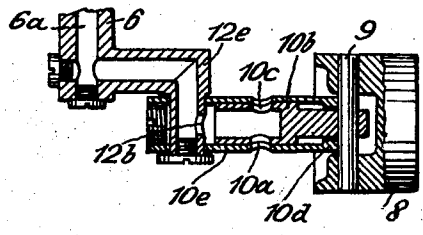


FIG.10

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Patented Sept. 12, 1950

2,522,252

UNITED STATES PATENT OFFICE

2,522,252

DOOR CLOSER

Ernst Billeter, Zurich, Switzerland

Application August 5, 1948, Serial No. 42,700
In Switzerland August 6, 1947

7 Claims. (Cl. 16—59)

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This invention relates to door closers, particularly to hydraulically operated closers of the type comprising a closing spring which is energized upon opening of the door, and in which the closing period of the door can be timed by means of a hydraulic braking piston system provided with regulating means for adjusting the rate of advance of the moving piston.

It is an object of the present invention to provide a door closer of this type with a retarding device operating to create a halting period between the opening movement and the closing movement of the door, so as to substantially stop any movement of the door before the beginning of the proper closing period, and to allow an unhindered passage of persons through the door.

The invention is illustrated by way of example in the accompanying drawings, in which

Fig. 1 is a diagrammatic representation of the improved door closer according to the invention, partly shown in section.

Figs. 2, 3 and 4 show each one particular position of operation of the door closer.

Fig. 5 is a fragmentary view of a modified arrangement represented in the position of operation according to Fig. 3.

Fig. 6 shows a detail of the door closer according to Fig. 1 drawn to a larger scale.

Fig. 7 is a plan view of the device according to Fig. 6, corresponding to the closed position of the door.

Fig. 8 is a similar plan view of the device corresponding to the open position of the door.

Figs. 9 and 10 show a further modification of a detail of the door closer, corresponding to the open and the closed position, respectively, of the door.

Fig. 11 is still a further modification of the same detail of the door closer.

Fig. 12 is a plan view of the device according to Fig. 11.

Fig. 13 is a transverse section along the line XIII—XIII of Fig. 12.

Fig. 14 is a general assembly view of the door closer.

Referring to Figs. 1 to 4, 1 indicates the usual hydraulic braking cylinder having an end cover 2 and a lateral extension 1*a*, the interior of which is separated from the braking cylinder space by a fixed partition 3. The free end of the extension 1*a* is closed by a screwed cover member 4. A hollow crank shaft 6 extends through and is rotatably mounted in the partition 3 and cover 4. The usual door closing spring 7 is mounted within the extension 1*a* and has one of its ends secured to the wall of the extension, and the other end to

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the crank shaft 6. One end of the shaft 6 projects into the space 1*c* of the braking cylinder 1 and carries a crank disc 12 having a crank pin 12*a* and a port 12*b* communicating with the bore 6*a* of the shaft 6 (Fig. 6). The end of the bore 6*a* is closed by a screw plug 6*b*. This end of the crank shaft 6 carries also a rotatably mounted control disc 11 provided with a peripheral recess 11*c* into which engages a driving pin 12*a*, so that an angular movement of the pin can produce a movement of the control disc 11 in the same direction. The disc 11 is provided with an obturator 11*a* which according to the relative position of the crank shaft 6 and the disc 11, opens or closes the port 12*b*. The disc 11 further carries a crank pin 11*b* engaging one end of a connecting rod 10 the other end of which is rotatably mounted on an axis provided by a pin 9 carried by the braking piston 8. As represented in Fig. 1, the piston 8 is in a dead center position, while the crank shaft 6 is in the so-called 0 degree or 360 degree position, as compared with the 180 degree position when the piston 8 is in its opposite dead center position. The piston 8 is provided with a valve controlled opening 8*a* adapted to communicate with a valve chamber 13, which contains a valve member 13*a* on a valve rod 13*b*. The valve member 13*a* is provided with peripheral recesses 13*c* which permit passage of fluid across the piston when the valve member is in an intermediate position in the valve chamber 13; however, the opening 8*a* is sealed by the valve member 13*a* when this latter abuts against the piston wall provided with the opening 8*a*. The valve chamber 13 communicates with the cylinder space 1*d* by openings 8*b*. A spring 14 acts on the valve member 13*a* to urge this member towards the valve opening 8*a*.

The interior wall of the braking cylinder 1 is provided with a longitudinally extending groove 1*e* adjacent one end of the cylinder. As shown in Fig. 1, the length of this groove 1*e* is such that when the braking piston 8 is in its extreme position near the end wall 1*b* of the cylinder, the groove still slightly projects beyond the piston into the cylinder space 1*c*. The space 1*d* of the braking cylinder communicates by a port 34*a* with a fluid return chamber 34, connected by the valve controlled opening 35*a* to the space 1*c* of the braking cylinder. A valve piston 35*c* is urged from the interior of the space 1*c* towards the port 35*a* by a spring 35*b* inserted in the valve casing 35*d*. The specific fluid pressure required for raising the valve member 35*c* from the port 35*a* is higher than the fluid pressure created by the action of the door closing spring 7 on the braking

piston 8. The valve member 35c accordingly can be opened only by a force which is additional to that created by the closing spring 7, as for example when the door is forcibly closed by hand.

A conduit 15 opens through the end wall 1b into the fluid return space 34. This conduit 15 leads to a fluid control chamber 26 connected by a conduit 16 to the space 1c of the braking cylinder. The conduit 15 comprises a regulating throttle valve 22, while a check valve 29 having a ball 29a and a ball stop 29b is inserted into the conduit 16.

A further conduit 17 opens into the space 1d of the braking cylinder and is connected by a conduit 19 to one end 23a of a control cylinder 23, and by a conduit 18 to the end of the crank shaft 6 projecting from the lateral chamber 1a to communicate with the bore 6a. The conduit 17 comprises a check valve 29', while a regulating valve 21 is inserted in the conduit 18.

Outside of the cover 4 an arm 5 connected to the door frame (Fig. 14) is secured to the crank shaft 6, the end of which is rotatably and tightly fitted into the end of the conduit 18.

The control cylinder 23 contains a control piston 27 connected by a rod 28 to a spring cup 25. The space 26 between the piston 27 and the spring cup 25 forms a control chamber. In the position shown in Fig. 1 fluid from the conduit 15 can freely pass through the chamber 26 into the conduit 16. A spring 24 is inserted between the spring cup 25 and the end wall 23a of the control cylinder; this spring tends to move the piston 27 towards the opposite end wall 23b. As represented in Fig. 1, the piston 27 is in its upper extreme position in which the abutment 27a makes contact with the end wall 23b. The conduit 20 is connected to this end of the cylinder 23 and leads to the conduit 16 communicating with the space 1c of the braking cylinder.

The specific fluid pressure required for opening the valve 13a against its spring 14 is higher than the fluid pressure necessary for moving the piston 27 from the extreme position shown in Fig. 1 to the position according to Fig. 2, or the force of the spring 14 is greater than that of the spring 24. The force of this spring 14 is so determined that the valve 13a is displaced to open the port 8a by the fluid pressure created by the door closing spring 7 acting on the piston 8 during the rotation of the crank shaft 6 in the closing direction from its 360° position to the 180° position, as soon as the control piston 27 arrives in the position represented in Fig. 3.

The two cylinder spaces 1c and 1d of the braking cylinder, the conduits 15, 16, 17, 18, 19 and 20, and the cylinder 23 are filled with an operating fluid, for example with oil. Fig. 1 represents the door closer at the beginning of the opening movement of the door, the piston 8 being pulled in the direction of the arrow A by the action of the arm 5 on the crank shaft 6 effecting an angular movement from 0° to 180°. When the crank shaft 6 turns further between 180° and 360° the piston 8 moves in the direction of the arrow B in Fig. 3. The beginning of the movement of the piston 8 can coincide with the beginning of the opening of the door from the closed position thereof; however, the arrangement could be such that the piston movement starts at an intermediate position of the door when this latter is to be further opened.

Fig. 2 shows the door closer in an intermediate position during opening of the door, the braking piston having been moved already through a certain distance in the direction of the arrow A. In this position the piston valve 13a has been opened and fluid can pass from the chamber 1c to the chamber 1d of the braking cylinder. The control piston 27 has been lowered by fluid pressure arriving through the conduit 20, until the spring cap 25 abuts against the end wall 23a of the cylinder 23. In this position the piston 27 prevents passage of fluid from the conduit 15 to the conduit 16.

Fig. 3 shows the door closer in a reversing position for closing the door, the braking piston 8 being urged in the direction of the arrow B by the action of the closing spring 7. This position distinguishes from that shown in Fig. 1 in that the port 12b to the bore of the crank shaft 6 is not closed by the obturator 11a. The control piston 27 is in the same position as in Fig. 2, and the ball check valve 29' in the conduit 17 is closed. Though the closing spring 7 transmits a force on the braking piston 8 in the direction of the arrow B, a movement of the piston in the direction B is impossible, since the fluid from the cylinder chamber 1d cannot pass through the conduit 15 which is shut off by the piston 27. The position represented in Fig. 3 accordingly is called the halting position.

Fig. 4 shows the position of the door closer during the return movement of the piston 8 for closing the door, following the halting position. The closure of the door is rendered possible by the piston 27 having been moved in the direction of the arrow a by the spring 24; the fluid ahead of the piston 27 is transferred through the conduits 20 and 16 into the cylinder chamber 1c. Displacement of the piston 27 has opened the passage between the conduits 15 and 16 and fluid from the cylinder chamber 1d can be transferred through the conduit 15, the control chamber 26 and the conduit 16 to the cylinder chamber 1c. The braking piston 8 accordingly can return in the direction of the arrow B and transmit movement to the arm 5 for closing the door.

In the modified arrangement according to Fig. 5 the control piston 27 movable in the cylinder 23 is represented in a position corresponding to that shown in Fig. 3. The throttle valve 22 in the transfer conduit connecting the two braking cylinder chambers is here provided in the conduit 16 after the control cylinder 23. For this reason, the fluid in the conduit 15, upon closing of the door, would act with a higher pressure on the piston 27, since the fluid in the conduit 15 is not throttled, and this pressure would increase the friction of the piston 27 along the cylinder wall. In order to prevent such friction, the conduit 15 opens into an annular relieving chamber 30 surrounding the piston, so that the fluid pressure acts on the entire area of the piston, thus reducing the wall friction to a minimum. The conduit 15 leading from the cylinder 23 to the braking cylinder is connected to the cylinder 23 at a point axially spaced from the relief chamber 30.

Figs. 6, 7 and 8 show the crank assembly for connecting the braking piston 8 to the crank shaft 6. The port 12b communicating with the bore 6a in the crank shaft is closed in Figs. 6 and 7 by the obturator 11a of the crank disc 11, so that no fluid can flow out of the port 12b. The driver 12a on the crank disc 12 engages the recess 11c in the disc 11. This recess 11c is longer in circumferential direction than the width of the driver 12a, so that the driver can move relatively to the disc 11. The relative position of the discs

11 and 12 shown in Figs. 6 and 7 is obtained upon opening of the door, accordingly when the braking piston 8 moves in the direction of the arrow A in Figs. 1 and 2 and the crank assembly moves in the direction of the arrow C in Fig. 7.

In Fig. 8 a position of the crank assembly is represented in which the crank shaft 6 and the disc 12 have been turned relatively to each other by the action of the closing spring 7 so that the port 12*b* has passed the obturator 11*a*; the driver 12*a* has arrived against the opposite end of the recess 11*c* and further rotation of the crank shaft 6 results in rotation of the disc 11 in the direction of the arrow D by the action of the driver 12*a*. Rotation of the crank shaft 6 in the direction of the arrow D takes place when the door closes. The position shown in Fig. 8 corresponds to that represented in Figs. 3 and 4. The lost motion return movement of the crank shaft 6 without driving the disc 11, which takes place between the opening and closing movement of the door should preferably be quite short. After this lost motion return movement, the door closer is in the halting position above referred to as represented in Fig. 3.

Figs. 9 and 10 show a modified crank assembly which is independent of the directions of rotation of the crank shaft 6 for opening or closing the door. The end of the shaft 6 carries a hollow crank pin 12*e*, the bore of which communicates with the bore 6*a* and opens by a lateral port 12*b* into a hollow sleeve 10*e* which is pivotally mounted on the pin 12*e*. This sleeve is closed at the end mounted on the pin 12*e*. A valve piston 10*b* connected to the pin 9 is slidably mounted within the sleeve 10*e* and is provided with openings 10*c* which can register with ports 10*a* in the sleeve 10*e*, in which position the abutments 10*d* bear against the pin 9 mounted in the braking piston 8 as represented in Fig. 10. Fig. 9 shows the sleeve 10*e* and the piston 10*b* in the relative position which corresponds to opening of the door, according to Figs. 1 and 2. It results from Figs. 9 and 10 that this modified crank assembly is effective in both directions of rotation of the crank shaft 6 so that after a certain lost motion return movement of the piston 10*b* the fluid can pass through the registering openings 10*a* and 10*c*.

Figs. 12, 13 and 14 show a further modification of the control crank assembly. At the end of the crank shaft 6 are mounted again the two crank discs 11 and 12. The disc 12 carries the driver 12*a*. The bore 6*a* of the crank shaft opens through the duct 12*b* at the periphery of the disc 12. Diametrically opposite the duct 12*b* the edge of the disc 12 is provided with gear teeth 12*d*. The disc 11 is rotatably mounted on the end of the shaft 6 and carries the crank pin 11*b* to be connected with the braking piston, while a recess 11*c* provided in the disc 11 receives the driver 12*a*. A pin 31 secured to the disc 11 carries a toothed sector 32 having a series of teeth 32*a* meshing with the gear teeth 12*d* of the disc 12, and a series of teeth 32*b* meshing with gear teeth 33*b* on the edge of a disc 33 which is rotatably mounted on the crank shaft 6 and carrying an obturator member 33*a* adapted to close the duct 12*b*. The driver 12*a* has a certain amount of lost motion in the recess 11*c* of the disc 11. In order to keep this lost motion return movement as small as possible the gear reduction 12*d*—32*a* and 32*b*—33*b* is provided. Since the disc 11 owing to its connection with the braking piston 8 cannot be moved in the direction of the arrow

B when the door closer is in the position according to Fig. 3, a rotation of the crank shaft 6 results first in a rotation of the disc 33 by the meshing gear teeth, this disc 33 requiring a very small effort to be moved. The gear ratio of the teeth 12*d*—32*a* is so chosen that the driver 12*a* must effect a small angular movement only in the recess 11*c* until it moves the disc 11, and that the disc 33 effects a considerably greater angular movement in order to remove the obturator 33*a* from the opening of the duct 12*b* or to close this opening by the obturator. In this manner the door, in the moment of the reversal from the opening to the closing movement, must only effect a small return movement until it reaches the proper halting position.

The described improved door closer operates in the following manner: This door closer is secured to the door and connected to the door frame in exactly the same manner like the usual known hydraulically operated door closers, as is represented in Fig. 14. When the door is closed, the device is in the position as shown in Fig. 1. When the door is opened the crank shaft 6 turns and produces a movement of the braking piston 8 in the direction of the arrow A. As shown in Figs. 6 and 7, the opening 12*b* of the bore 6*b* is then closed by the obturator 11*a*. The fluid in the chamber 1*c* of the braking cylinder is displaced through the conduits 16 and 20 into the cylinder 23 above the central piston 27, while the ball valve 29 in the conduit 16 is closed. Since the specific fluid pressure required for opening the valve 13 against the spring 14 is higher than that required for moving the piston 27 against the spring 24, the piston 27 is first moved to the position represented in Fig. 2. From this moment, while the piston 8 continues to move in the direction of the arrow A, the fluid pressure in the chamber 1*c* overcomes the pressure of the spring 14 and opens the valve member 13*a* so that fluid can pass through the opening 8*a* into the chamber 1*d*. Now the various members of the door closer are in the position according to Fig. 2. This position is maintained during the entire opening movement of the door.

When the door is closed by the action of the closing spring 7, the crank shaft 6 turns in the opposite direction. The obturator 12*a* moves in the recess 11*c* (Fig. 8) without moving the disc 11. By this lost motion movement the opening 12*b* moves away from the obturator 11*a*, and the force of the closing spring 7 now acts through the driver 12*a* on the disc 11 and accordingly on the piston 8, while the relative position of the discs 11 and 12 remains as shown in Fig. 8, the force of the closing spring acting on the piston 8 in the direction of the arrow B in Fig. 3. A fluid pressure builds up in the chamber 1*d*, which fluid pressure causes closure of the ball valve 29' in the conduit 17, and of the piston valve 13*a*. The door closer is then in the position according to Fig. 3. Now the fluid above the control piston 27, owing to the spring 24 becoming effective, is displaced through the conduits 20 and 16, and while the ball valve 29 in the conduit 15 remains closed, the fluid enters into the cylinder chamber 1*c*. However, since the volume of this chamber cannot increase, the fluid therein is discharged through the opening 12*b* and the bore 6*b* of the shaft 6 and passes through the conduits 18 and 19 into the bottom of the control cylinder 23 in which the volume below the spring cap 25 is increasing owing to the rising piston 27. A passage through the valve 29' does not take place, as the counter pressure ex-

erted by the piston 8 is higher than the pressure in the conduit 18.

During this upward movement of the piston 27 the closing action of the door closer is suspended, and the device is in the already mentioned halting position. In order to adapt the halting period to the requirements in each particular case, the regulating valve 21 is provided in the conduit 18; a decrease of the section of flow in the conduit produces a longer halting period, while an increase of the section of flow produces a reduction of the halting period. This position of the members of the door closer is conserved until the piston 27 arrives in the position represented in Fig. 4. In this position the fluid can pass from the conduit 15 through the control chamber 26 into the conduit 16 while opening the ball valve 29, to pass into the chamber 1c of the braking cylinder; since fluid can now escape from the chamber 1d through the conduit 15, the piston 8 can move in the direction of the arrow B in Fig. 4 and the volume of the chamber 1d decreases at the same rate as the volume of the chamber 1c increases. With the beginning of the movement of the piston 8 in the direction of the arrow B, the proper closing movement of the door is initiated. In order to adapt the duration of the closing period to particular conditions the regulating valve 22 is inserted in the conduit 15, by means of which the section of flow in this conduit can be varied to vary the speed of the piston 8 and accordingly the time required for closing the door.

In the above description of operation of the device it had been supposed that the door is opened from its closed position and then is closed again. The operation is the same when the door is already open in an intermediate position and starting to close, and this closing movement is interrupted and the door further opened until the members are again in the position according to Fig. 3.

It has alrady been described, that the internal wall of the braking cylinder 1 is provided with a groove 1e which connects the chamber 1d with the chamber 1c in the position of the piston shown in Fig. 1, a moment before the piston arrives at the end of its stroke in the direction of the arrow B. This provides that a portion of the fluid from the chamber 1d can flow directly through this groove into the chamber 1c without passing through the conduits 15 and 16. The increased rate of flow from the chamber 1d to the chamber 1c shortly before the door arrives in the closed position causes an acceleration of the closing speed and ensures a safe closure of the door by engagement of the door latch.

The purpose of the fluid return chamber 34 and valve 35c is to be able to cut out the halting period of the opened door and to reverse the movement of this latter immediately from opening to closing movement by imparting an additional pressure by hand on the door, so as to create an increased fluid pressure in the chamber 1d by which the valve 35c is opened and allows transfer of fluid from the chamber 1d to the chamber 1c of the braking cylinder.

The described door closer can be used for operating pivotally mounted doors as well as for sliding doors.

I claim:

1. A door closer comprising a casing, a piston reciprocatingly mounted in the casing, an arm operatively connected to said piston and adapted to be connected to the door, spring means to urge said arm in a direction to close the door, a control cylinder, and a fluid controlled spring pressed check member movable in said cylinder and operative to temporarily prevent substantial movement of said piston in a direction corresponding to closing of the door upon reversal of the movement of said arm after an opening movement and before the subsequent closing movement of the door.

2. A door closer comprising a casing, a fluid filled braking cylinder in said casing, a braking piston reciprocatingly mounted in the cylinder, an arm operatively connected to said piston and adapted to be connected to the door, a closing spring to urge said arm in a direction to close the door, a transfer conduit for interconnecting the two cylinder chambers on either side of said braking piston, a control cylinder in said transfer conduit, a check member movable in said control cylinder, a fluid conduit for connecting one of said braking cylinder chambers to one end of said control cylinder to move said check member to a position for interrupting the flow of fluid in the transfer conduit during opening of the door, a second fluid conduit for connecting said braking cylinder chamber with said control cylinder, spring means acting on said control piston to move the piston at the end of the opening period of the door to liberate the fluid passage through said transfer conduit, an obturator normally closing the communication between said second fluid conduit and said braking cylinder chamber, and means operatively connected to said closing spring for establishing communication between said second fluid conduit and said chamber when said spring starts to become effective for closing the door.

3. A door closer comprising a casing, a fluid filled braking cylinder in said casing, a braking piston reciprocatingly mounted in the cylinder, a door closing spring mounted in said casing, a hollow crank shaft connected to said closing spring, two relatively movable crank members connecting said crank shaft to the braking piston, an arm secured to said crank shaft and adapted to be connected to the door, said closing spring urging said crank shaft and said arm to move in a direction for closing the door, a transfer conduit for interconnecting the two braking cylinder chambers on either side of the braking piston, a control piston subjected to fluid pressure from one of said braking cylinder chambers upon movement of the braking piston due to opening of the door for moving the control piston to interrupt passage of fluid through said transfer conduit, a spring acting on the control piston to move the piston in opposite direction for reestablishing passage of fluid in the transfer conduit, fluid conduits for establishing a flow of fluid from one side of said control piston to said braking cylinder chamber and to the other side of the control piston, and a flow regulating valve in said fluid conduits to vary the rate of flow and timing the period required for said control piston to move from its position of interruption of flow in said transfer conduit to the position where it reestablishes the flow in this conduit.

4. A door closer as claimed in claim 3, wherein said hollow crank shaft is mechanically connected to said braking piston by means of a crank assembly including a crank disc rigid with the crank shaft and a second crank disc connected to the braking piston through a pin and slot connection to effect a limited relative movement of rotation with respect to the first crank disc and said second crank disc serving as a valve to

establish or to interrupt communication between said hollow crank shaft and one of the braking cylinder chambers.

5. A door closer as claimed in claim 3, wherein said hollow crank shaft is connected to said braking piston by a crank assembly including a hollow crank pin rigid with said crank shaft, a sleeve pivotally mounted on said crank pin, and a piston valve slidable within said sleeve and hingedly connected to the braking piston, said sleeve and said piston valve being provided with openings registering with each other upon reversal of the door movement to provide communication between the hollow crank shaft and one of the braking cylinder chambers.

6. A door closer as claimed in claim 3, wherein said hollow crank shaft is connected to the braking piston by means of a crank assembly including a crank disc rotatably mounted on the crank shaft, a crank pin on said disc connected with the braking piston, a driver rigid with the crank shaft and engaging said crank disc so as to allow for a limited lost motion between the crank shaft and said crank disc, said crank shaft being provided with a fluid entrance, and an obturator carried by said crank disc and coacting with said fluid entrance to close said entrance during movement of the braking piston corresponding to opening of the door, and to open said entrance upon reversal of the door movement to establish communication between the hollow crank shaft and one of said braking cylinder chambers.

7. A door closer as claimed in claim 2, wherein the inner side of the braking cylinder is provided with a longitudinal groove connecting the two braking cylinder chambers when the braking piston approaches the end of its door closing stroke.

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