May 13, 1958 G. SASSE 2,834,039

DOOR CLOSING DEVICE

Filed April 6, 1953 2 Sheets-Sheet 1

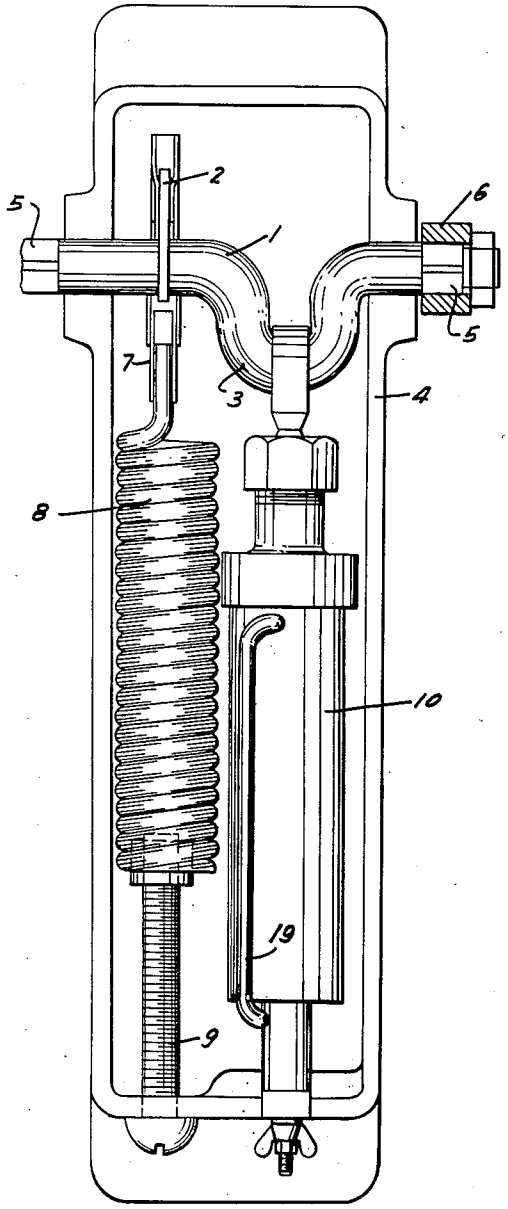


FIG. 1

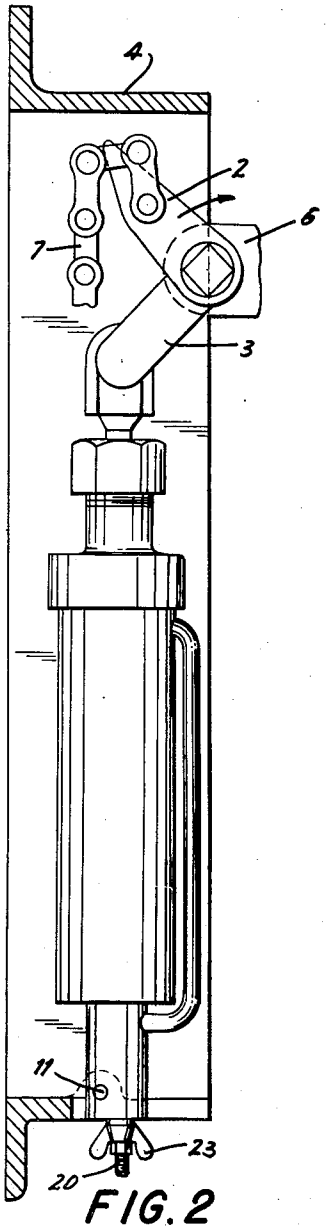


FIG. 2

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DOOR CLOSING DEVICE

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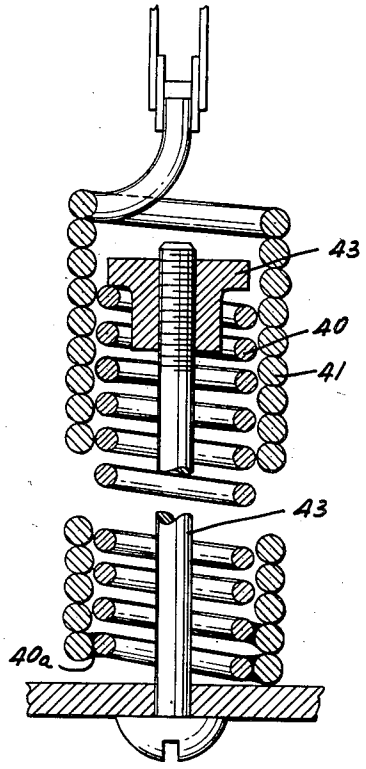


FIG. 5

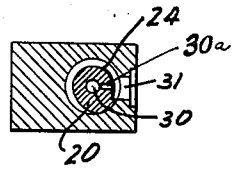


FIG. 4

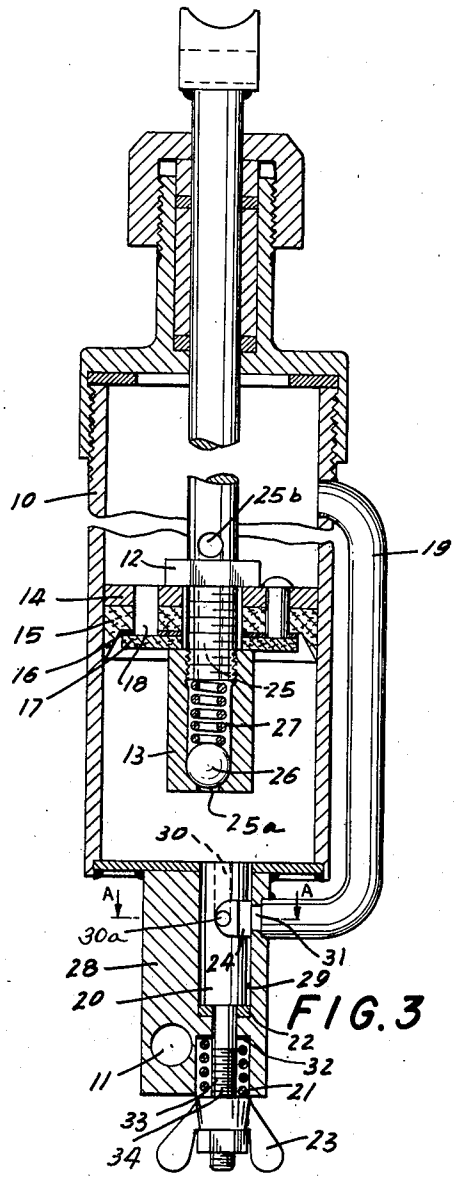


FIG. 3

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2,834,039

DOOR CLOSING DEVICE

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Claims priority, application Germany April 5, 1952

6 Claims. (Cl. 16—51)

The present invention relates to door closing devices. More particularly, the present invention relates to automatic door closing devices of a hydraulic type.

In the known structures of this type, there are several defects which have not yet been overcome. Thus, the known automatic door closing devices do not always fully close the door, do not always permit a door to be fully opened through approximately 180°, are not capable of being used without auxiliary devices for doors which open both in the right hand and left hand directions, and furthermore are likely to become damaged when the door is opened with an exceedingly large force. Moreover, with these known structures it is often a difficult matter to adjust the closing and braking forces. Furthermore, these known devices must be mounted out in the open where they are always visible and where they collect dust.

One of the objects of the present invention is to overcome the above drawbacks by providing a door closing device which exerts the greatest door closing force at the end of the door closing movement so as to guarantee that the door will always be fully closed.

Another object of the present invention is to provide a door closing device which permits the door to be easily opened through almost 180° and even through a full 180° or more.

A further object of the present invention is to provide a door closing device which may be used for both right and left hand opening doors without requiring any additional adapters or the like to be used with the device.

An additional object of the present invention is to provide a simple means for quickly and easily adjusting both the closing and the braking force of the door closing device.

Still another object of the present invention is to provide a door closing device which will not become damaged when a door on which it is mounted is suddenly closed with an exceedingly large force.

A still further object of the present invention is to provide a door closing device which may be mounted in a door frame or in the floor beneath the door so as not to be visible.

Yet another object of the present invention is to provide a door closing apparatus capable of accomplishing all of the above objects while at the same time being made of a relatively small number of simple and ruggedly constructed parts which will give reliable service for a long period of time.

With the above objects in view, the present invention mainly consists of a door closing apparatus which includes a casing in which a shaft is mounted for rotation. This shaft has a crank portion which is connected to the piston of a hydraulic piston and cylinder arrangement for permitting the door to open easily and close slowly and

automatically, and a spring is connected to this shaft to a second crank portion for turning the shaft to automatically close the door. This second crank portion is so arranged that it has its greatest moment arm when the door is fully closed so that the greatest closing force is exerted at the end of the closing movement of the door, and in this way a full automatic closing of the door is assured.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

Fig. 1 is an elevational view of a door closing device constructed in accordance with the present invention and having the cover of its casing removed so that the interior of the casing is visible;

Fig. 2 is a view of the structure of Fig. 1 as seen from the right hand side thereof with the right hand part of the casing and the spring and its adjusting screw removed to illustrate the structure in the casing;

Fig. 3 is a sectional elevational view on an enlarged scale of a hydraulic cylinder and piston arrangement used in the door closing apparatus of the invention;

Fig. 4 is a sectional view taken along line A—A of Fig. 3 in the direction of the arrows; and

Fig. 5 is a sectional view of a modified spring arrangement incorporated in a door closing apparatus according to the present invention.

Referring now to the drawings, it will be seen that the door closing apparatus of the invention includes the casing 4 in which the shaft 1 is located, this shaft 1 having opposite end portions extending through and being rotatably supported by opposite side wall portions of the housing 4. The opposite end portions of the shaft 1 which extend beyond the housing 4 are non-circular, as shown at 5, so as to receive a non-circular opening of a lever or the like 6 which interconnects the door closing device with the door, for example. The opposite squared ends 5 of the shaft 1 allow the apparatus of the invention to be used with doors which open in the right hand or left hand direction without requiring the use of additional adapters or the like.

A crank portion 2 in the form of a lever fixed at one end to the shaft 1 and extending therefrom is connected to the end element of a chain 7 which is connected at its opposite end to an end of a spring 8. As is evident from Fig. 2, the free end of the crank portion 2 is pointed and extends into the link of chain 7 next to that link which is fastened to the crank portion 2, so that when this crank portion turns in a clockwise direction, as viewed in Fig. 2, the chain 7 will become wound against the lower edge of crank portion 2, as viewed in Fig. 2, and about the shaft 1. The apparatus is illustrated in Figs. 1 and 2 in the position where the door is fully closed.

The lower end of spring 8 is fixed to a nut or plug which is threaded to a bolt 9 which bolt passes through the bottom wall of the housing 4, as viewed in Fig. 1 and which has a slotted head at the exterior of the housing so that it is a simple matter to turn the screw 9 so as to adjust the force of spring 8.

A cylinder 10, adapted to contain a braking liquid, has an extension 28 fixed to its bottom wall, and as viewed in the drawings, and this extension is pivotally mounted at 11 on the bottom wall of the housing 4. As shown

in Figs. 1 and 2, this bottom wall is formed with a cutout through which this extension of cylinder **10** extends. The piston of this hydraulic braking arrangement is connected to a second crank portion **3** of the shaft **1** which forms a part of the shaft **1**, as shown in Figs. 1 and 2, and it is evident that the crank portions **2** and **3** extend at different angles from the turning axis of shaft **1**.

The piston rod, which is connected to the crank portion **3**, extends through a suitable sealing gland, such as a graphite packing, into the cylinder **10**, and, as is shown in Fig. 3, this piston rod threadedly carries a nut **12** and a six-sided tubular member **13**. The parts **14**, **15**, **16** and **17** are clamped between the members **12** and **13**, part **14** being a metallic piston, part **15** being an oil-resistant leather member, part **16** being a metallic plate, and part **17** being a disc made of soft, easily bendable leather. The parts **14—16** are held together by a rivet and are each formed with an opening, these openings being aligned with each other to form the passage **18**.

When a door to which the apparatus of the invention is connected is opened, the shaft **1** turns in a clockwise direction, as viewed in Fig. 2, to tension the spring **8**, and the piston **14** moves upwardly in the cylinder **10**, as viewed in Fig. 3, so that oil from the top side of the piston flows through the passage **18** to the bottom end of the cylinder, the leather member **17** bending easily under the influence of the oil moving downwardly through passage **18** so that there is almost no resistance produced by the movement of piston **14** during the opening of the door. However, when the spring **8** pulls the door shut, the piston **14** moves downwardly toward the bottom of the cylinder **10** and the oil beneath piston **14** acts against the leather disc **17** to urge the same toward the piston **14** so as to automatically close the opening **18**, and there is therefore a braking force produced by the apparatus which prevents the spring **8** from quickly closing the door and slamming the same. During closing of the door, the oil in the lower portion of cylinder **10** can only move through the by-pass **19** back to the top portion of the cylinder. There is sufficient resistance to movement of the oil through the by-pass **19** to provide a braking force which prevents a quick closing of the door when it is released by the person opening the same.

It will be seen from Fig. 2 that the moment arm of spring **8** gradually decreases as the door is opened because the chain **7** gradually approaches the turning axis of shaft **1**, and when the door is fully opened the chain **7** contacts the shaft **1** so that the turning moment at this time has a moment arm equal to the radius of the shaft **1**. On the other hand, during the automatic closing of the door under the action of spring **8**, this moment arm continually increases and is greatest when the door is fully closed so that the spring **8** exerts the greatest closing force on the door at the end of its closing movement, and in this way a complete closing of the door is assured with the apparatus of the invention.

As was mentioned above, the apparatus of the invention may be adjusted by turning the screw **9**. It is further possible to adjust the apparatus through regulation of the braking force by adjusting the resistance which the oil must overcome upon moving through the by-pass **19**. The regulation of this resistance is provided by the elongated member **20** which is mounted in a recess **29** of the extension **28** at the bottom of cylinder **10**, this member **20** being formed with an axial bore **30** and a lateral bore **30***a* communicating with this axial bore and located opposite the open bottom end **31** of by-pass **19**, as viewed in Fig. 3, so that the oil from the cylinder **10** flows through these bores **30**, **30***a* of member **20** to the end **31** of the by-pass **19**. The extension at the bottom of cylinder **10** is provided with a recess **32** in which the spring **21** is located and is provided with a bore **33** through which an extension **34** of member **20**, of reduced diameter, extends, this extension being threaded to receive the wing nut **23** which regulates the force of

spring **21** which acts on the wing nut to urge the member **20** in a downward direction, as viewed in Fig. 3, a suitable sealing ring **22** being located about the extension of member **20**, as viewed in Fig. 3. Upon loosening of the wing nut **23**, the member **20** may be turned about its axis and upon tightening of the wing nut **23**, the force of spring **21** will maintain the member **20** in its adjusted position.

In order to regulate the oil resistance, the member **20** is formed in its outer surface with a groove **24** which passes transversely about the member **20** through approximately three quarters of the circumference thereof and which is of a constantly increasing depth in a clockwise direction as viewed in Fig. 4 where this groove **24** is most clearly illustrated and where the member **20** is shown as having been turned 90° in counter-clockwise direction from the position shown in Fig. 3. Thus, by adjustment of member **20** it is possible to locate opposite the bottom open end of the by-pass **19** varying depths of the groove **24** and in this way regulate the oil resistance.

In order to prevent damage to the apparatus when a door to which it is connected is very suddenly closed with an extremely large force, the port **25***a* in the bottom end of tubular member **13** is narrowed and provides a seat for a ball member **26** which is located in the tubular member **13** and urged toward the bottom thereof by the spring **27** also located in the tubular member **13** and bearing against the ball member **26** and the free end of the piston rod. The piston rod is formed with an axial bore **25** communicating with the interior of tubular member **13** and laterally opening into the space above the piston **14** through the outlet **25***b* as viewed in Fig. 3. Thus, the parts **13**, **26**, and **27** form a non-return valve which allows fluid to flow upwardly through port **25***a* and bore **25** and pass out through outlet **25***b* into the portion of the cylinder above the piston when the piston **14** is moved downwardly with a force sufficient to cause the oil pressure to exceed the force of spring **27**. This spring is calibrated to prevent opening of the valve during normal opening and closing of the door. Only when an exceedingly large force is applied to the door is the force of spring **27** overcome so that valve member **26** rises from its valve seat to allow oil to flow through bore **25**, and in this way injury to the apparatus is avoided.

In some installations, it may be desirable to replace the spring **8** with a much shorter spring arrangement, and this may be accomplished as shown in Fig. 5, by placing a compression spring **40** within a tensioned spring **41** and connecting these springs to each other at one end **40***a* of the compression spring while joining the nut **42** of adjusting screw **43** to the opposite end of the compression spring **40**. Such an arrangement would provide the same force as spring **8** in a much shorter length and space.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of door closing devices differing from the types described above.

While the invention has been illustrated and described as embodied in an adjustable door closing device, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying the current knowledge readily adapt it for various applications without omitting features that, from the standpoint of the prior art, fairly constitute essential characteristics of the generic or 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. Automatic door closing apparatus comprising, in

combination, a housing; a shaft mounted for rotation about its axis in said housing; a first crank portion connected to said shaft, being located in said housing, and extending radially from the turning axis of said shaft; spring means located in said housing and being operatively connected to said first crank portion for urging the latter to turn said shaft in a direction which closes a door to which the apparatus is connected, said spring means including an elongated tension coil spring having one end portion which is nearer to said first crank portion than the opposite end portion is, said opposite end portion being connected to said housing, said spring means further including a flexible member connected at one end thereof to said one end of said tension coil spring and at an opposite end to the free end of said first crank portion, said first crank portion being turnable to and from an end position where the shortest distance between said flexible member and the turning axis of said shaft is at a maximum so that the effective moment arm of said first crank portion at said end position is at a maximum and where the door to which the apparatus is connected is closed; a second crank portion connected to said shaft, being located in said housing, and extending radially from the turning axis of said shaft; and hydraulic braking means operatively connected to said second crank portion for braking the turning of said shaft under the influence of said spring means during the closing of a door to which the apparatus is connected.

2. Automatic door closing apparatus comprising, in combination, a housing; a shaft mounted for rotation about its axis in said housing; a first crank portion connected to said shaft, being located in said housing, and extending radially from the turning axis of said shaft; spring means located in said housing and being operatively connected to said first crank portion for urging the latter to turn said shaft in a direction which closes a door to which the apparatus is connected, said spring means being in the form of an elongated coil spring and including a flexible member connected at one end thereof to said coil spring and at an opposite end to the free end of said first crank portion, said first crank portion being turnable to and from an end position where the shortest distance between said flexible member and the turning axis of said shaft is at a maximum so that the effective moment arm of said first crank portion at said end position is at a maximum and where the door to which the apparatus is connected is closed, the angle formed between said flexible member and said first crank portion at said end position being an acute angle; a second crank portion connected to said shaft, being located in said housing, and extending radially from the turning axis of said shaft; and hydraulic braking means operatively connected to said second crank portion for braking the turning of said shaft under the influence of said spring means during the closing of a door to which the apparatus is connected.

3. Automatic door closing apparatus comprising, in combination, a housing; a shaft mounted for rotation about its axis in said housing; a first crank portion connected to said shaft, being located in said housing, and extending radially from the turning axis of said shaft; spring means located in said housing and being operatively connected to said first crank portion for urging the latter to turn said shaft in a direction which closes a door to which the apparatus is connected, said spring means including at least one elongated tension coil spring having one end portion which is nearer to said first crank portion than the opposite end portion is, said opposite end portion being connected to said housing, said spring means further including elongated deformable connecting means connected at one end thereof to said one end of said tension coil spring and forming a continuation thereof, said connecting means being connected at an opposite end to the free end of said first crank portion, said first crank portion being turnable to and from an end position where the shortest distance between said connecting means and the turning axis of said shaft is at a maximum so that the effective moment arm of said first crank portion at said end position is at a maximum and where the door to which the apparatus is connected is closed, the distance between said connecting means and the turning axis of said shaft being decreased as the door is opened and increased as the door is closed, said connecting means engaging said shaft at a predetermined position of the door so that the minimum effective moment arm of said first crank portion is never less than the radius of said shaft; a second crank portion connected to said shaft, being located in said housing, and extending radially from the turning axis of said shaft; and hydraulic braking means operatively connected to said second crank portion for braking the turning of said shaft under the influence of said spring means during the closing of a door to which the apparatus is connected.

4. Automatic door closing apparatus comprising, in combination, a housing; a shaft mounted for rotation about its axis in said housing; a first crank portion connected to said shaft, being located in said housing, and extending radially from the turning axis of said shaft; spring means located in said housing and being operatively connected to said first crank portion for urging the latter to turn said shaft in a direction which closes a door to which the apparatus is connected, said spring means being in the form of an elongated coil spring and including a flexible member connected at one end thereof to said coil spring and at an opposite end to the free end of said first crank portion, said first crank portion being turnable to and from an end position where the shortest distance between said flexible member and the turning axis of said shaft is at a maximum so that the effective moment arm of said first crank portion at said end position is at a maximum and where the door to which the apparatus is connected is closed, the distance between said flexible member and the turning axis of said shaft being decreased as the door is opened and increased as the door is closed, said flexible member engaging said shaft at a predetermined position of the door so that the effective moment arm of said first crank portion at said predetermined position is equal to the radius of said shaft; a second crank portion connected to said shaft, being located in said housing, and extending radially from the turning axis of said shaft; and hydraulic braking means operatively connected to said second crank portion for braking the turning of said shaft under the influence of said spring means during the closing of a door to which the apparatus is connected.

5. Automatic door closing apparatus comprising, in combination, a housing; a shaft mounted for rotation about its axis in said housing; a first crank portion connected to said shaft, being located in said housing, and extending radially from the turning axis of said shaft, said first crank portion being turnable to and from an end position where the moment arm of said first crank portion about said shaft axis is at a maximum and where a door to which the apparatus is connected is closed; spring means located in said housing and being operatively connected to said first crank portion for urging the latter to turn said shaft in a direction which closes a door to which the apparatus is connected, said spring means including an outer tension spring and an inner compression spring located within said tension spring and being connected at one end thereto; a second crank portion connected to said shaft, being located in said housing, and extending radially from the turning axis of said shaft; and hydraulic braking means operatively connected to said second crank portion for braking the turning of said shaft under the influence of said spring means during the closing of a door to which the apparatus is connected.

6. Automatic door closing apparatus as defined in claim 5 and wherein an adjusting means is operatively connected to an opposite end of said compression spring.

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