July 30, 1968 H. KORTHAUS ET AL 3,394,499

SPRING-OPERATED DOOR CLOSING DEVICE

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FIG. 1

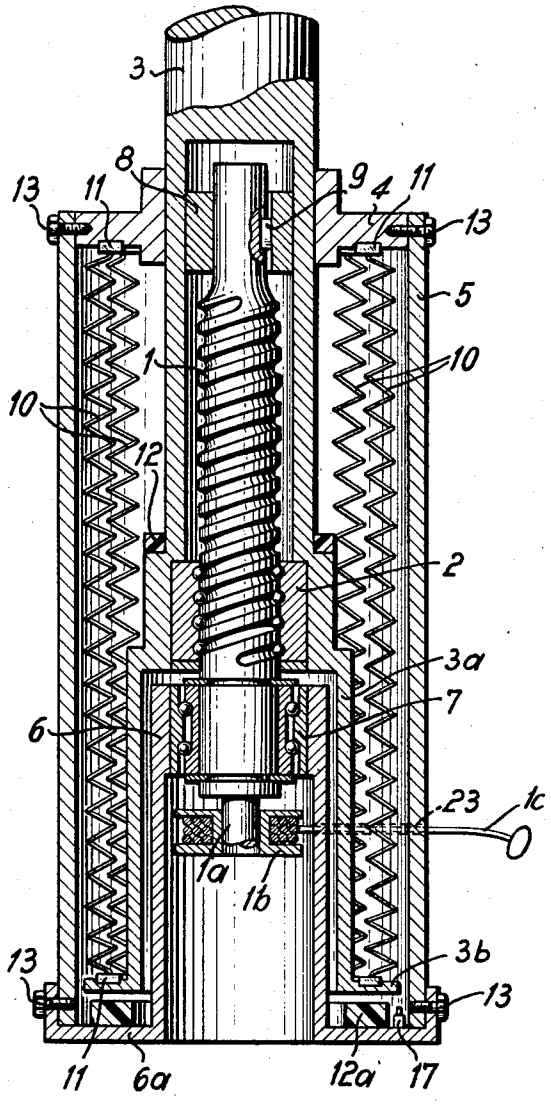

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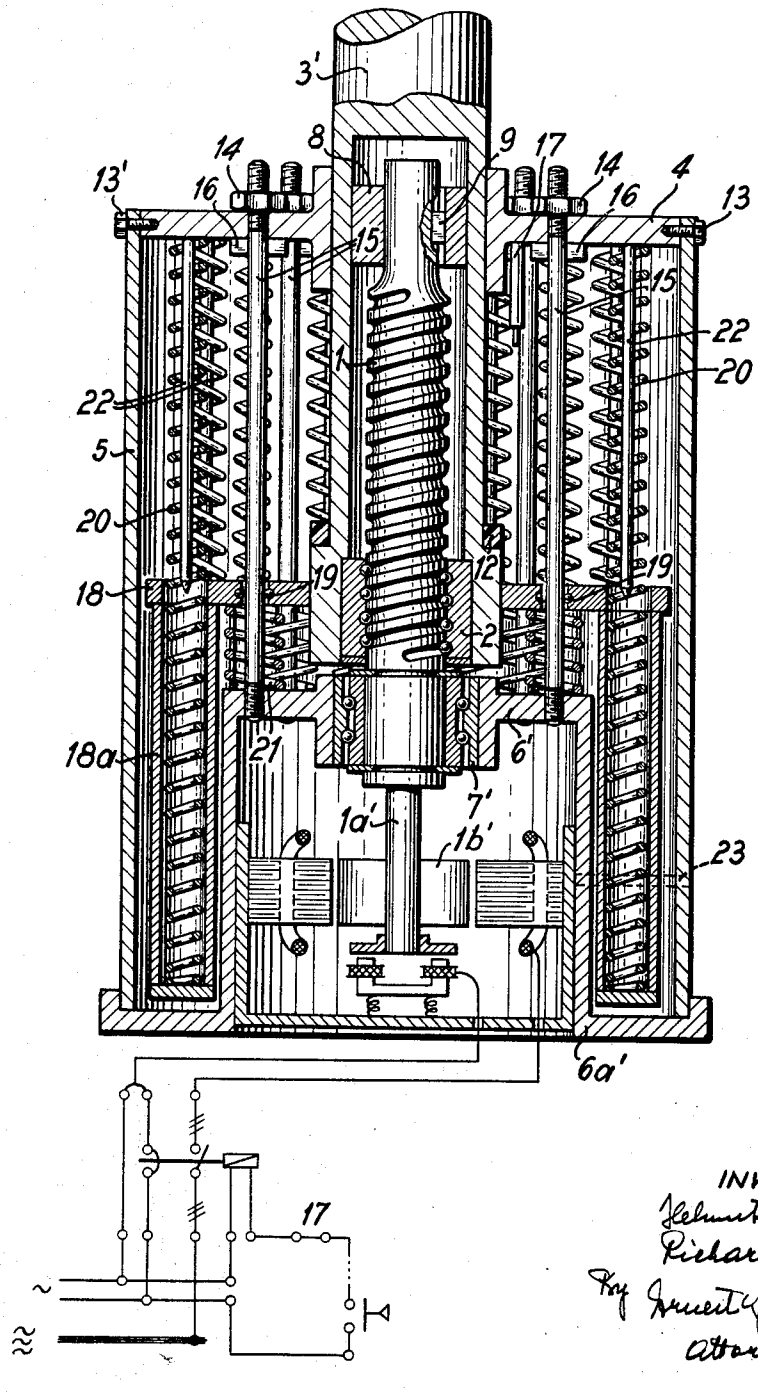
FIG. 2



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SPRING-OPERATED DOOR CLOSING DEVICE

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15 Claims. (Cl. 49—340)

The present invention relates to a spring-operated door closing device having on the one hand a housing fixed in space, for instance provided on the door frame, and on the other hand having a movable door actuating member which acts at the one end for instance on the door proper and at the other end on the housing, the door actuating member being urged in one direction by closure springs.

In order automatically to close doors which in practice swing open and hold them in a closed position, devices are know which effect the closing of the open door by compression, tension or torsion springs.

It is one object of the present invention to provide a door closing device, wherein in order for instance in automotive vehicles to protect the doors and to avoid the opening of the door by the vehicle, the spring-operated door closing device can be acuated by a simple means, for instance by hand. This measure not only serves to protect the door, but also simultaneously serves to reduce the danger of accidents, since it makes possible for the person who opens these doors to be located outside the danger zone or outside the opening radius of the door.

It is another object of the present invention to provide a spring-operated door closing device of the type described above in a particularly suitable and effective manner with the use of simple structural parts which, however, are extremely dependable in operation, and which, despite small dimensions, can exert considerably high pushing or pulling forces, so that such a spring-operated door closing device is particularly suitable for large and heavy doors. One particularly simple embodiment of such a door-closing device can however also serve in an extremely simple and economical construction for lighter doors. Furthermore, such a door-closing device is intended simultaneously to lock the door, so as to prevent unintentional opening. It then, for all practical purposes, fulfills the function of a door lock.

It is still another object of the present invention to provide a door-closing device, wherein the housing is developed essentially as a hollow body of rotational symmetry which has on its inside first of all on the longitudal central axis of the housing the door operating member together with its drive device, for instance in the form of an easily movable ball spindle drive for carrying out the one actuating movement, for instance the opening of the door, while concentrically around same there are arranged, uniformly distributed, a plurality of closing springs to carry out the other actuating movement, for instance the closing of the door.

In this connection one particularly preferred embodiment of the present invention consists in that the ball-spindle drive device is provided concentrically within the door-actuating member which is developed as a push-pull rod supported displaceably in a bearing cover of the housing, the actuating member being hollowed out at least on part of its axial length corresponding at least to the active spindle length, so as to form a cylindrical hollow space in which on the one hand the ball-spindle nut is secured against rotation and axial displacement and on the other hand axially behind same a sliding bearing for the free spindle end is provided, while the end of the spindle on the drive side is rotatable in the opposing

bearing cover, for instance of a thrust ball bearing, but is prevented from moving axially, and that furthermore one end of the closing spring acts on the part of the push-pull rod on the inside of the housing while their instantaneous other end acts inside on the opposite bearing cover.

In a structurally simple solution of the present invention, it is intended to use as closure spring tension springs which bring doors of smaller and lighter construction into their locked position. In addition to this, the bearing cover which supports the spindle rod is to be developed essentially as the cylinder-pot bearing cover which is developed corresponding to the pot-shape of the push-pull-rod flange and engages concentrically into same.

This has the advantage in this connection, that one creates a free space in which the free end of the spindle extends. A spindle drive device can possibly be installed in this space.

Furthermore annular bumpers are to be provided on the push-pull rod on the one hand and in the bearing cover which supports the spindle rod on the other hand, such bumpers to serve as stops for the two directions of displacement.

For a practical realization of a spring-operated door closing device of the type described above which is to be used for doors of heavy construction, it is suggested to provide on the part of the push-pull rod which is on the inside of the housing and on the inside part of its peripheral cylindrical surface an annular guide-supporting disc which has arranged concentrically around the push-pull rod on the same diameter ball guide openings for supports which prevent relative rotation between the housing and push-pull rod and are held on the one end in the bearing cover which conducts the push-pull rod and on the other end in the bearing cover which supports the spindle, the disc bearing also in a uniformly distributed concentric arrangement around the push-pull rod sleeve-like spring mounts for the closing springs, for instance compression springs, which are guided on the one hand within the sleeves on the outside and on the other hand, by centering pins engaging inside into the springs and held on the opposite bearing cover.

In this way there is now created a spring-operated door closing device which fully satisfies even high requirements with respect to the pulling or pushing forces to be provided. This embodiment operates extremely dependably and safely satisfies both in functional respects and in structural respects all demands made in practice.

Summarizing it has thus been possible to create a spring-operated door closing device which in its simplest embodiment, for instance when equipped with tension springs, is suitable for smaller doors of lighter weight, while an improved embodiment with compression springs can be used to great advantage in connection with doors of greater weight, since in this case by the same structural axial length, but larger diameter of the housing, a larger number of springs can be provided. In this case also the use of an easily movable ball spindle drive is of importance which is not to be under-estimated since here there occur frictional forces which need scarcely be taken into consideration, and therefore a high efficiency is obtained.

Furthermore, however, another possibility is to develop the closing springs in part as compression springs and in part as tension springs. Furthermore the spindle can be driven manually or else by an electric motor with automatically operating stand still brake.

The spring-operated door closing device operates always in all cases then in such a manner that upon a failure of current the force of the closure springs is able dependably to close the door.

With these and other objects in view which will become apparent from the following detailed description,

the present invention will be clearly understood in connection with the accompanying drawings, in which:

FIGURE 1 is a longitudinal section through a door closing device of simplified construction with tension springs, and

FIG. 2 is a longitudinal section through another embodiment of such a door closing device, in improved embodiment with compression springs, this door closing device being particularly suitable for heavy doors.

Referring now to the drawings, and in particular to FIG. 1, the door closing device comprises a shell of a housing **5**. At both ends the housing **5** is closed by a bearing cover **4** and **6**, **6***a*, respectively, the bearing cover **4** receiving a push-pull rod **3** and the bearing cover **6**, **6***a* supporting a spindle **1**, **1***a*, which is connected via a spindle nut **2** within the hollow push-pull rod **3** with the latter. Around this push-pull rod **3** there are provided on the inside of the housing **5** closing springs **10** and **20**, respectively.

The bearing cover **6**, **6***a* is now developed as a pot-shaped body of rotational symmetry into which a thrust ball bearing **7** is forced. The spindle **1** is supported in rotatable and non-translatable manner by this thrust ball bearing **7**.

The spindle **1**, in its turn, bears the spindle nut **2** with low frictional losses, for instance a ball rotating nut. This nut **2** is seated in non-translatable and non-rotatable manner in a lower part **3***a* of the push-pull rod **3**, which is developed as a hollow shaft over the length of the spindle **1**. The spindle **1**, in order to attain quiet operation, is supported via a sliding bearing **8** in the hollow part of the push-pull rod **3**, the sliding bearing **8** being secured by a keyway and a key **9** against rotation and translation on the spindle **1**.

To the lower part **3***a* of the push-pull rod **3** there is formed a pot-shaped flange of rotational symmetry with a radial collar **3***b*. The tension springs **10** are arranged symmetrically around the periphery and fastened by screws and corresponding insert pieces **11** which hold the ends of the tension springs in proper form. No guide for the tension springs **10** is required. After the tension springs **10** have been fastened between the upper bearing cover **4** and the radial collar **3***b*, the nut **2** together with the push-pull rod **3** and the parts **3***a*, **3***b* are moved downwardly by turning the spindle **1**, the upper bearing cover **4** being held fast by an assembling device.

After reaching the end position of the push-pull rod **3**, the protective tube or housing **5** is then pushed over as housing shell and screwed by means of the screws **13** fast to the bearing cover **4** and the bearing cover **6***a*, respectively. Protection of the push-pull rod **3** against rotation is not required in this embodiment, since due to the attachment of the push-pull rod **3** which is suitably connected via a fork head with the lever transmission to be actuated with the door, this result is obtained. The supporting of the spring-operated door closing device is advisedly effected by pivot pins which may be arranged in addition on the bearing cover **4** and which have not been shown in the drawing in order not to disturb the clarity of the latter.

Referring now again to FIG. 1 of the drawings, the door closing device has a relatively small diameter. In a practical embodiment the spindle **1** has for instance a diameter of 30 mm. with a thread pitch of 5 mm. The outside diameter of the spindle nut **2** is 52 mm., so that a pitch circle diameter of 110 mm. can be obtained for the attachments **11** of the tension springs **10**. With the use of tension springs of a diameter of **15** mm., distributed over the entire circumference, it is therefore possible to provide ten tension springs which with a stretched spring length of 270 mm. gives a push-pull path of 100 mm., in which connection possibly transmittable push or pull forces of about 1000 kilograms maximum can be obtained without overloading the springs. It is obvious, and therefore not shown especially in the drawing, that by changing the pot-shaped body **3***a*, **3***b* by flipping it over upwards, the tension springs are now fastened to the lower outer part of the pot-shaped body **6***a* so that an outwardly acting pulling force is produced on the rod **3**, while in the embodiment shown in the drawing an outwardly acting push force of the same value is formed.

In order, when reaching the two possible end positions of the push-pull body **3***a*, **3***b*, to intercept blows, there are provided the elastic annular bumpers **12** and **12***a*, which may consist of elastic plastic or rubber.

Another embodiment of a door-closing device for large push-pull forces is shown in FIG. 2 of the drawings. First of all, the two parts, i.e., the upper bearing cover **4** and the lower bearing cover **6** are held in non-displaceable manner as supports against each other via a plurality of bolts **15** distributed over the periphery, for which purpose a stop **16** is provided on the bolts **15**. On these bolts **15** there slides a circular guide-supporting disc **18** which can form an integral unit with the hollow shaft **3**. The bore holes through which the bolts **15** pass are provided with slide balls **19** in order to maintain the frictional losses small. These bolts **15** act at the same time to protect the push-pull rod **3** against rotation.

On the periphery of the disc **18** there are placed uniformly distributed sleeve-like mounts, for instance pipes **18***a*, the lower end of which is closed. In these pipes **18***a* which are distributed uniformly on the periphery of the disc **18** there are placed compression springs **20** which are protected against buckling by these pipes **18***a* and centering pins **22** associated with them. The pins **22** are fastened in the upper bearing cover **4**. After insertion of the springs **20** and the placing on the upper cover **4** and fastening thereof by nuts **14**, the outer tube or housing **5** is placed thereover to provide external protection and screwed fast to the upper bearing cover by means of the screws **13'**. In order to take up blows in the end positions, buffer springs **21** are provided over the support bolts **15** between the disc **18** and the lower bearing cover **6**. In the other end position the elastic annular bumper **12** serves as protection.

The door closing device disclosed in FIG. 2 results in its construction in a larger diameter with the same structural length, and therefore permits the provision of a larger number of compression springs and the attaining of greater push-pull forces towards the outside. In this form also, it can easily be seen and therefore has not been shown, especially in the drawing, that by turning the pipe **18***a* upward and arranging the pins **22** in the lower part **6***a'* a reversal of the direction of the force towards the outside is obtained. The supporting of the spring-operated door closing device is advantageously also effected with pivot pins in the manner mentioned above.

From the description the manner of operation of the arrangement can be seen to be as follows:

Since the ball rotating nut **2** has an efficiency of more than 90%, it represents practically no resistance for the work of the springs. If one therefore for the time being disregards the spindle arrangement, then the tension or compression springs operate on the push pull rod **3'** in the manner resulting from the position of the door, i.e. they hold the door closed and effect a closing of the door when opened. The fastening of the push-pull rod **3'** can be affected in known manner to the door by means of a lever mechanism (not shown), in which connection sufficient closing pressure results even in the case of large doors as a result of the force which may be about 1 ton, and with a path of 100 mm.

Since the value of the push-pull forces acting toward the outside is dependent in known manner on the spring path and it is not possible in all cases due to considerations of space to have the direction of the acting push-pull forces act on the door in such a manner that a smaller lever path corresponds to the greater spring force, so that equalization of the different push-pull forces can be obtained, it is provided, in accordance with a further feature of the present invention, to replace in both embodi-

ments of FIGS. 1 and 2 a part of the tension and compression springs by compression and tension springs, respectively, and to adapt them in such a manner to each other that the resultant overall spring characteristic exhibits less dependence over the path.

In accordance with another feature of the present invention, by the provision of a very easily movable spindle and spindle nut with low pitch, i.e. high transmission ratio, special new possibilities of actuation result. It is readily possible, and therefore not especially shown, to fasten a cable drum **1***b* to the part **1***a* of the spindle end. A cable **1***c* fastened to and wound up on this drum and conducted to the outside through a pipe **23**, indicated in dotted lines, between the springs, can be pulled by hand without the exertion of any particular force and thus places the spindle **1** in rotation, cocks the springs and simultaneously moves the push-pull rod **3'** in opposition to the spring tension.

By simply attaching the handle at the lower end of the cable where it is pulled, into an eye, the door can be held in open position. However it is furthermore readily possible to connect the lower part **1***a'* of the spindle with a motor **1***b'* which, while in remote control, makes possible actuation of the closing and opening device. Via end contacts **17** (FIG. 2) the remote-controlled drive unit, for instance the motor **1***b'*, can be automatically stopped when the operating movement of the push-pull rod **3'** is to be terminated in the one direction of motion. Since there are also known motors which, when stopped, have an additional brake to protect against rotation, the result is obtained when using such a motor that the door can be held immovably fast in all positions, and in particularly it is then as closing door simultaneously locked. If, as stand-still brake in connection with such motors, one uses a brake which opens upon failure of the power supply, then in such case the spindle which has been previously held fast will be released and the spring-operated door closing device can move in to the position desired upon failure of the power.

In this way it is possible to provide the spring-operated door closing device with an additional safety feature which in case of danger either opens or closes closing doors.

Instead of using a very easily movable spindle nut with ball rotation, any other type of easily movable spindle nut of low thread pitch can also be used. Furthermore it is possible with the small paths necessary to make the spindle nut longer and, instead of equipping it with a ball rotation, provide it only with a few balls which do not fill up all the threads but permit an easy movement of the nut within the desired limits.

Furthermore the embodiments shown and described are merely examples of the present invention which however is by no means to be limited to them; rather many other embodiments and applications are possible within the scope of the present invention. Thus, this spring-push or pull device could also be used with advantage in other devices differing from door closure devices when it is desired to effect one of two movements by the force of springs.

While we have disclosed several embodiments of the present invention, it is to be understood that these embodiments are given by example only and not in a limiting sense, the scope of the present invention being determined by the objects and the claims.

We claim:

1. A spring-operated door closing device, comprising

a housing adapted to be secured between a door and a door frame,

a ball-spindle drive operatively connected with a door and with said housing, respectively,

said housing comprising a hollow body of rotational symmetry,

said ball-spindle drive comprising driving means disposed in the longitudinal central axis of said housing and including a spindle rotatably and axially immovably mounted for performing one of the operational movements, and a door-operating member non-rotatably and axially movably disposed, and

a plurality of closing springs disposed equally divided concentrically in said housing and secured at one end to said door-operating member for performing directly the other of the operational movements.

2. The spring-operated door closing device, as set forth in claim **1**, wherein:

said door operating member comprises a push-pull rod,

a first bearing cover closing one end of said housing and guiding axially said push-pull rod,

said ball spindle drive is concentrically disposed within said push-pull rod,

said push-pull rod has a cylindrical recess of a length at least equal to the effective avial length of said spindle,

a nut engaging and cooperating with said spindle and secured in said recess against rotation and axial displacement and a sliding bearing supporting the free end of said spindle and likewise disposed in said recess of said push-pull rod,

a second bearing cover closing the opposite end of said housing,

the end of said spindle on the driving side being rotatable but axially not displaceable by means of a pressure ball-bearing, and

said closing springs engage at one end thereof the inner housing part of said push-pull rod and at the other end said first bearing cover.

3. The spring-operated door closing device, as set forth in claim **2**, which includes:

an annular, guide supporting disc disposed about the outer face of said push-pull rod and having a plurality of ball guiding bores equally displaced at the same diameter concentrically about said push-pull rod,

a support extending through each of said ball guiding bores extending through said first bearing cover and through said second bearing cover and preventing rotation between said housing and said push-pull rod,

said disc having a plurality of sleeve-shaped spring receptacles for said closing springs disposed likewise equally divided concentrically about said push-pull rod,

a plurality of centering pins secured to said first bearing cover and extending into said housing, and

said closing springs are guided on their outside by said sleeve-shaped spring receptacles and on their inside by said centering pins entering said closing springs.

4. The spring-operated door closing device, as set forth in claim **2**, which includes:

an annular, guide supporting disc disposed about the outer face of said push-pull rod and having a plurality of ball guiding bores equally displaced at the same diameter concentrically about said push-pull rod,

a support extending through each of said ball guiding bores extending through said first bearing cover and through said second bearing cover and preventing rotation between said housing and said push-pull rod,

said disc having a plurality of sleeve-shaped spring receptacles for said closing springs disposed likewise equally divided concentrically about said push-pull rod,

a plurality of centering pins secured to said first bearing cover and extending into said housing,

said closing springs are guided on their outside by said sleeve-shaped spring receptacles and on their inside by said centering pins entering said closing springs, and

said guiding carrying disc and said sleeve-shaped spring receptacles are integral with said push-pull rod.

5. The spring-operated door closing device, as set forth in claim **2**, which includes:

an annular, guide supporting disc disposed about the

outer face of said push-pull rod and having a plurality of ball guiding bores equally displaced at the same diameter concentrically about said push-pull rod,

a support extending through each of said ball guiding bores extending through said first bearing cover and through said second bearing cover and preventing rotation between said housing and said push-pull rod,

said disc having a plurality of sleeve-shaped spring receptacles for said closing springs disposed likewise equally divided concentrically about said push-pull rod,

a plurality of centering pins secured to said first bearing cover and extending into said housing,

said closing springs are guided on their outside by said sleeve-shaped spring receptacles and on their inside by said centering pins entering said closing springs, and

a plurality of buffer springs disposed between said guiding carrying disc wound about said supports.

6. The spring-operated door closing device, as set forth in claim **2**, wherein:

said inner housing part of said push-pull rod is formed as cylindrical pot-shaped flange and has a collar portion at the open end of said pot-shaped flange, and

said collar portion constitutes said inner part housing part of said push-pull rod to which said closing springs are engaged.

7. The spring-operated door closing device, as set forth in claim **6**, wherein:

said second bearing cover comprises a pot-shaped member formed complementary to and concentrically disposed in said pot-shaped flange of said push-pull rod.

said sliding bearing supporting said free end of said spindle is disposed in the bottom of said pot-shaped member, and

the open end of said pot-shaped member forms a radially outwardly extending collar surrounding said housing.

8. The spring-operated door closing device, as set forth in claim **7**, which includes:

a first, elastic, annular buffer on the outer face of said push-pull rod for an abutment during movement of the latter in one direction, and

a second, elastic, annular buffer inside of said radially outwardly extending collar of said pot-shapted member to form an abutment during movement of said push-pull rod in the other direction.

9. The spring-operated door closing device, as set forth in claim **1**, wherein:

said closing springs comprise selectively pressure springs and tension springs.

10. The spring-operated door closing device, as set forth in claim **9**, wherein:

at least a part of said pressure springs is replaced by said tension springs, in order to compensate for the path-responsive push- and pull-forces, respectively.

11. A spring-operated door closing device, as set forth in claim **2**, which includes:

a drive drum on the free end of said spindle for the manual operation of said spindle.

12. A spring-operated door closing device, as set forth in claim **2**, wherein:

said ball spindle drive comprises a remote controlled electric motor operatively connected with said spindle.

13. The spring-operated door closing device, as set forth in claim **12**, which includes:

abutment contacts inside of said housing to be operated to shut off said motor upon engagement by said push-pull rod.

14. The spring-operated door closing device, as set forth in claim **12**, which includes:

a locking brake coordinated to said motor operating automatically the latter to lock said motor in any one of a plurality of standing positions against the push and pulling forces, respectively.

15. The spring-operated door closing device, as set forth in claim **14**, wherein:

said brake comprises an electro-locking brake opening upon current cut-off,

a nut engaging and cooperating with said spindle and secured in a recess of said push-pull rod against rotation and axial displacement, whereby an automatic return of said nut is performable by the force of said closing springs.

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