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(54) **Sliding door closing apparatus**

(57) Closing apparatus for a door member mounted for movement along a guide track, includes a spring (25) effective to cause closing moving of the door member, the spring (25) being provided in a rotor (16) coupled to the door by a belt (13) engaging the periphery of the rotor (16), to be rotated upon movement of the door member, and restraint means (35) to restrict the closing speed of the door member. The apparatus further includes a clutch group (37) comprising a friction clutch (39) and an electromagnetically controllable clutch (38) in series therewith respectively to provide a slip action if the door is manually pushed shut and a holding action in any opened position of the door. The clutch group (37) is connected to the rotor (16) by way of freewheel means (29) and a chain (52).

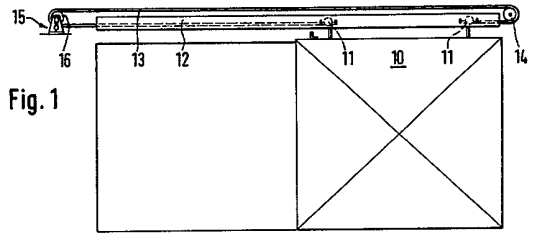

Fig. 1

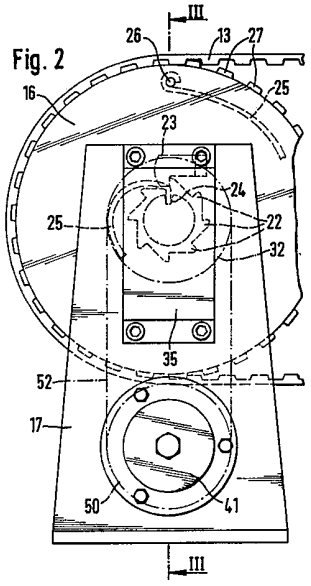

Fig. 2

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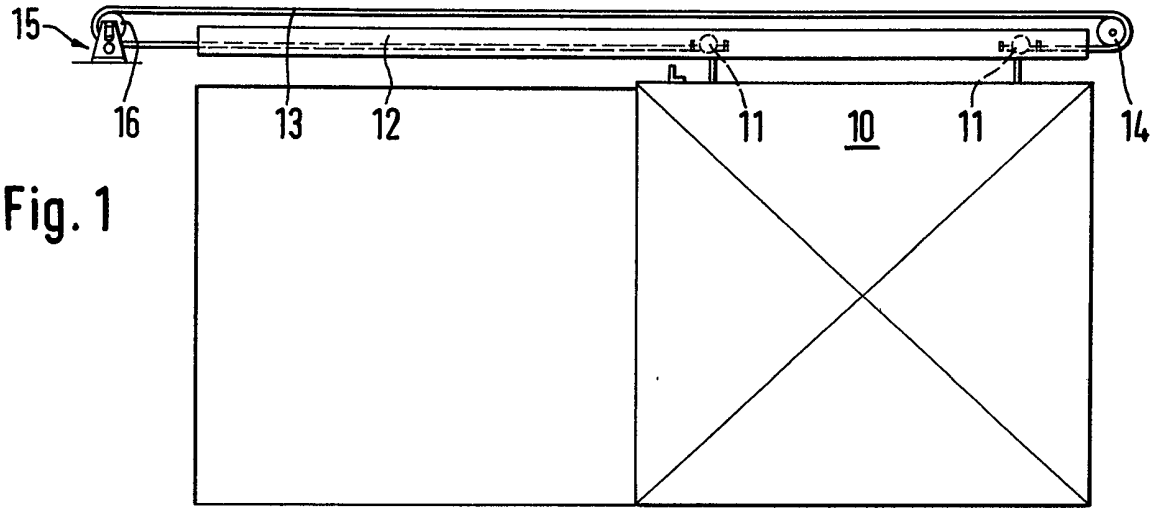

Fig. 1

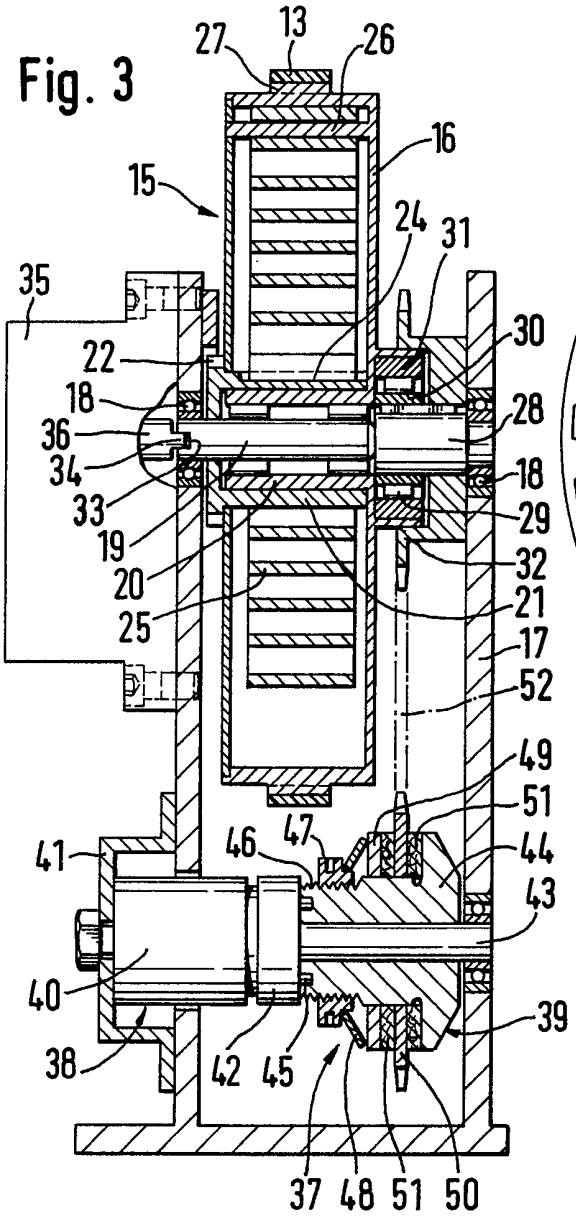

Fig. 3

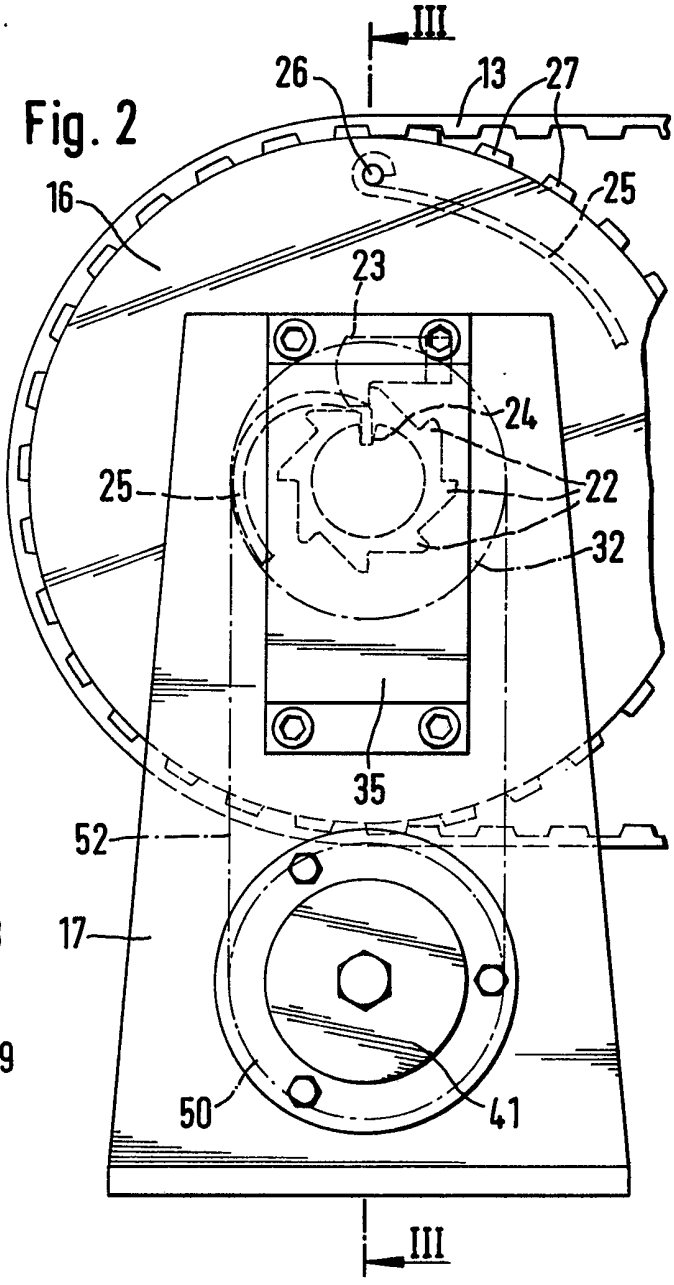

Fig. 2

SPECIFICATION

Closing device for a door member mounted for movement along a guide track

The invention relates to a closing device for a door member, such as a sliding door, which is movable along a guide track, which device can apply a force, from force storage means, to cause a closing movement of the door member. The device may comprise a rotor which is rotated upon movement of the door member and restraint means to restrict the closing speed of the door member. The rotor may act upon the door member by way of an intermediate member in the form of a bar, rod or other elongate element which may be flexible for example a chain or belt.

In a closing device of the above-indicated kind, as disclosed in German patent specification No 668 313, the intermediate member for transmitting the closing force of the force storage means to the door member, comprises a chain which is connected on the one hand to the door member and on the other hand to a weight or a winding drum. In order to restrict the speed of closure of the door member, the chain is passed over a chain wheel which, during the door closing movement, is connected by way of transmission means to a rotatable bladed wheel which forms the restraint means. By using a high transmission ratio in transmission means, when the door moves in the closing direction, the bladed wheel rotates at high speed and, the action of air resistance on the bladed wheel, restricts the speed of closing movement of the door member.

During opening movement of the door member, the bladed wheel is not rotated because the chain wheel is connected to the transmission means for the bladed wheel by way of a ratchet wheel and a pawl which acts as a freewheel.

The door member when moved into a fully open position may be held temporarily in that position by way of mechanical locking means, particularly a spring-loaded locking bolt member, which can be moved into a locking position by the door member, to secure the bladed wheel. Return movement of the locking bolt member may be delayed by a pendulum mechanism so that the door member remains in its open position for a given short period of time, and thereafter automatically returns to its closed position, with the speed of its closing movement being restricted. A disadvantage with this known closing device is that the door member can only be held at its position of maximum opening, and in addition the period of time for which the door member can be held in the open position is also limited. If the door member needs to be opened by only a small amount, it must be held manually in the open position because otherwise it immediately returns to the closed position automatically.

According to the invention there is provided a closing device for a door member mounted for movement along a guide track, which device can apply a force, from force storage means, effective to cause a closing movement of the door member comprising a rotor which is rotated upon movement of the door member, restraint means to restrict the closing speed of the door, and a clutch group, interposed between the rotor and non-rotatable support means, and comprising an electromagnetically controllable rotary clutch and a friction clutch disposed in series therewith.

Such a closing device can, on the one hand, permit the door member to be automatically held open in any desired open position and, on the other hand, makes it possible, if required, for the door member to be automatically returned from any open position, with a restrained closing movement.

If the rotary torque which can be transmitted by the friction clutch is so adjusted that the torque is somewhat greater than the rotary torque which is produced by the force storage means in the direction of door closing, and the electromagnetically controllable rotary clutch is in the connecting mode, the opened door member remains in any desired open position. Only if a closing force, additional to the force produced by the force storage means, is applied by hand to the door member will the friction clutch slip and allow the door member to be moved into its closed position. If however, when the door member is in an open position, the electromagnetically controllable rotary clutch is released from its connection to the friction clutch, the rotary movement produced by the force storage means is sufficient to move the door member into the closed position under the control of the restraint means, at a retarded speed.

The closing device of the invention can be provided as a compact structural unit, so that it can be installed in a small space and preferably can even be installed subsequently, in regard to almost all sliding doors.

Advantageously the friction clutch for transmitting a limited rotary moment is connected between the rotor and an input member of the electromagnetically controllable rotary clutch and an output member of the electromagnetically controlled rotary clutch is secured to the non-rotatable support means.

The electromagnetically controllable rotary clutch is preferably rated for substained control by a holding current.

A particularly compact unit may be achieved, by providing the series disposed electromagnetically controllable rotary clutch and the friction clutch to be arranged coaxially. In this arrangement, the common axis of rotation of the electromagnetically controllable rotary clutch and the friction clutch is preferably displaced from but parallel to the axis of rotation of the rotor, while a chain transmission means between the rotor and the input member of the clutch group is preferably provided for the purposes of transmitting the rotary moment between the rotor and the clutch group.

So that, when the electromagnetically controllable rotary clutch is released, the door member can be automatically returned from any open position to the closed position thereof, the rotor preferably includes a drum enclosing a flat spiral spring which forms the force storage means, which drum mounts one end of the flat spiral spring while the other end is non-rotatably held, preferably in such a way that the

tension in the spring can be adjusted. In this arrangement, the inner end of the flat spiral spring is preferably carried on a core sleeve which is rotationally adjustably supported on a carrier, so that the flat spiral spring can be tensioned by means of a tool to form an energy-storing unit, even without moving the door member into the open position. This is particularly advantageous in relation to assembly or repair operations.

So that it is not also necessary to overcome the force-locking connection produced by the friction clutch, when opening the door member, in addition to the resistances to movement and the spring force which also increases as the door is opened wider, the device preferably includes freewheel means disposed between the rotor and an input member of the clutch group, which freewheel means is in a drive condition when the door member is closing and is in a freewheel condition when the door member is opening. In this arrangment, an output member of the freewheel means which is disposed on the input side on the rotor is carried on a shaft which passes through the rotor and which is non-rotatably connected to the input member of the clutch group.

The rotor and a drivable member of the restraint means are preferably disposed coaxially, since this can contribute to forming a compact unit. In this arrangement, the shaft is preferably non-rotatably connected to the drivable member of the restraint means.

The invention is diagrammatically illustrated by way of example in the accompanying drawing, in which:-

Figure 1 is a diagrammatic view of a sliding door in an open position, and provided with a closing device according to the invention;

Figure 2 shows a side view from the side of the closing device of Figure 1, on an enlarged scale; and

Figure 3 shows a view of the closing device in longitudinal section taken on line III-III of Figure 2.

Referring to the drawing and firstly to Figure 1, a door member 10, shown in its open position, is mounted on a guide rail 12 by way of rollers 11. Connected to the mountings of the rollers 11 is an intermediate member of elongate nature, as shown a toothed belt 13, in such a way that the toothed belt passes in a loop configuration over a rotatable guide roller 14 which is stationarily disposed at one end of the guide rail 12, while at the other end which is adjacent the door opening, the toothed belt passes around a rotor 16 of a closing device 15.

Referring to Figures 2 and 3, the closing device 15 has a mounting bracket 17 in which two shafts are disposed parallel to each other and one above the other. An upper one 19 of the shafts is rotatably supported by means of roller bearings 18 in the mounting bracket 17, and the rotor 16 is rotatably mounted on the shaft 19, by means of a hub 20. The hub 20 of the rotor 16 is enclosed by a core sleeve 21 having a collar which is provided with ratchet teeth 22 into which a pawl 23 engages, under the loading of a force applied thereto. The pawl 23 is mounted pivotally on the mounting bracket 17. The sleeve 21 also has a slot 24 into which engages the inner end of a flat spiral spring 25 which is arranged in the drum-like rotor 16 and which serves as a force storage means. The outer end of the flat spiral spring 25 is secured to a pin 26 which passes across the interior of the rotor in the region of the periphery thereof. In the embodiment illustrated, the outside surface of the rotor 16 has teeth 27 for co-operation with the toothed belt 13, so that the storage force of the flat spiral spring 25 can be transmitted to the toothed belt 13.

The shaft 19 has a shaft portion 28 to which an output member 30 of freewheel means 29 and a chainwheel 32 are non-rotatably connected, for example by way of a slot and key or spline connection. The freewheel means 29, in addition to the output member 30, has an input member 31 non-rotatably connected to the rotor 16, for example by being pressed into the hollow space formed by a collar portion. In this arrangement, the freewheel means 29 is formed in known manner by interposing rollers between the input member 31 and the output member 30, in such a way that, during closing movement of the door member 10, that is to say, movement which relieves the stress in the spiral spring 25, the output member 30 is driven by way of the rollers by the input member 31, while during movement which stresses the flat spiral spring 25, that is to say, opening movement of the door member 10, the output member 30 is freed from the input member 31. In its lefthand end face (as viewed in Figure 3) the shaft 19 has a slot 33 into which engages drive means 34 of a drivable member 36 of restraint means 35. The restraint means 35 opposes the storage force of the flat spiral spring 25 so that closing movement of the door member is restrained over its entire closing movement. The restraint means 35 is secured to the mounting bracket 17, for example by screw means, in such a way that its drivable member 36 and the shaft 19 are disposed coaxially.

A lower one 43 of the two shafts is disposed in the mounting bracket 17 below the shaft 19 which caries the rotor 16, the free-wheel locking mechanism 29 and the chainwheel 32. A clutch group 37 is disposed on the shaft 43 and comprises an electromagnetically controllable rotary clutch 38 and a friction clutch 39 which is arranged coaxially therewith. In the embodiment illustrated, as can be seen in particular from Figure 3, the electromagnetically controllable rotary clutch 38 is secured by means of its output member 40 to a cup-shaped mounting member 41 which is secured to the mounting bracket 17 and which forms a non-rotatable support. An input member 42 of the rotary clutch 38 is rotationally connected, for example by entrainment pins 45, to a clutch body 44 of the friction clutch 39, which is rotatably supported on the shaft 43 mounted in the mounting backet 17. The clutch body 44 which has a support collar portion also has a shank portion which faces towards the rotary clutch 38 and which is provided with an external screw-thread 46 carrying an adjusting nut 47. The nut 47 bears against a support ring 49 by way of a spring disc 48, while a chainwheel 50 which forms an input member for the clutch group 37 is arranged rotatably on the clutch

body 44 between a support ring 49 and a support collar portion of the clutch body 44. Friction rings 51 for increasing the coefficient of friction may be arranged between the chainwheel 50 and the support collar portion of the clutch body 44 on the one hand, and the ring 49 on the other hand. The chainwheel 32 which can be connected to the rotor 16 by way of the freewheel locking means 29, and the chainwheel 50 which forms the input member of the clutch group 37, in conjunction with a chain 52, represents a chain transmission means. The pressure force acting on the chainwheel 50 can be adjusted by way of the nut 47, the spring disc 48 and the ring 49, in such a way that the torque to be transmitted by the friction clutch 39 can be adjusted as required.

In operation, if the door member 10 is moved by hand from its closed position into an open position, the rotor 16, during such movement, is rotated in the anti-clockwise direction (as viewed in Figure 2) by the toothed belt 13. When this occurs, the inner end of the flat spiral spring 25 maintains its stationary position on the sleeve 21 which is secured to the mounting bracket 17, and the flat spiral spring 25 is stressed by way of the pin 26 which rotates with the rotor 16 in the anti-clockwise direction. The input member 31 and the output member 30 of the freewheel means 29 are free to rotate with respect to each other so the chainwheel 32 is not rotated but remains stationary.

If the movementof the door member 10 in the opening direction is interrupted in any open position of the door member, the freewheel means 29 immediately comes into engagement its input member 31 is non-rotatably connected to its output member 30 by way of the rollers, so that, assuming the friction clutch 39 is suitably adjusted, the door member 10 remains in the open position in which it has been set, assuming also that the electromagnetically controllable rotary clutch 38 remains energised so that its input member 42 is connected to the output member 40 by the holding current. However, the door member 10 can be opened further if a force acting in the direction of door opeing is again applied thereto. If however, after the rotary clutch 38 has been de-energised, a force is applied to the door member to return it to its closed position, such force being sufficiently high, added to and assisting the force of the flat spiral spring 25, to overcome the friction grip set at the friction clutch 39, then the shaft 19 and thus, by way of its shaft portion 28, by means of the locked freewheel means 29, and the chainwheel 50 which forms an input member of the friction clutch 39, being disposed between the friction rings 51, is also rotated by way of the chain 52, overcoming the friction grip, with the clutch member 44 remaining stationary.

If however when the door member 10 is in the open position, the holding current of the electromagnetically controllable rotary clutch 38 is cut-off, the output member 40 and the input member 42 are disconnected from each other so that the door member 10 is pulled in the direction of door closing by way of the toothed belt 13 by the stored force in the flat spiral spring 25 acting on the rotor 16. When this occurs, the shaft 19 and the restraint means 35 rotationally connected thereto are also simultaneously rotated in the clockwise direction by way of the engaged freewheel means 29, so that the closing movement is continuously braked and the speed of door closing movement does not exceed a given value. In this case, the chain 52 and the chainwheel 50, the friction clutch 39 and the input member 42 of the rotary clutch 38, which is non-rotatably connected to the friction clutch 39, are also rotated, loosely on the shaft 43, by way of the chainwheel 32 which rotates with the shaft 19, until the door member 10 has reached its closed position.

The spring force of the flat spiral spring 25 may be increased if required by the sleeve 21 being rotated in the clockwise direction by means of a special spanner. This may be necessary in particular after the closing device has been fitted or repaired, the pawl 23 holding the sleeve 21 in the position to which it is moved.

As already mentioned, the embodiment illustrated and described above is only given by way of example, without the invention in any way being limited thereto, many other embodiments being possible within the scope of the appended claims. Thus it is possible for example for the positions of the electromagnetically controllable rotary clutch 38 and the friction clutch 39 to be interchanged, and for the friction clutch 39 to be then non-rotatably mounted at one end, with its movable member connected to one end of the electro-magnetically controllable rotary clutch 38, the other end of which is then rotationally coupled to the rotor 16. Instead of the toothed belt 13, it is possible for example to use a chain, and it is also possible for the closing device to be mounted on the door member and for the outer periphery of the rotor 16 to be toothed and engaged in a toothed rack disposed in the region of the guide rail. It is also possible for the clutch group 37 to be arranged coaxially with the rotor 16 so that it would be possible to omit the chain 52.

CLAIMS

1. A closing device for a door member mounted for movement along a guide track, which device can apply a force, from force storage means, effective to cause a closing movement of the door member, comprising a rotor which is rotated upon movement of the door member, restraint means to restrict the closing speed of the door, and a clutch group, interposed between the rotor and non-rotatable support means, and comprising an electromagnetically controllable rotary clutch and a friction clutch disposed in series therewith.

2. A closing device according to claim 1, in which the friction clutch for transmitting a limited rotary moment is connected between the rotor and an input member of the electromagnetically controllable rotary clutch and an output member of the electromagnetically controlled rotary clutch is secured to the non-rotatable support means.

3. A closing device according to claim 1 or claim 2, in which the electromagnetically controllable rotary clutch is rated for sustained control by a

holding current.

4. A closing device according to claim 2 or claim 3, when appendant to claim 2, in which the series disposed electromagnetically controllable rotary clutch and the friction clutch are arranged co-axially.

5. A closing device according to claim 4, in which the common axis of rotation of the elctromagnetically controllable rotary clutch and the friction clutch is displaced from but parallel to the axis of rotation of the rotor.

6. A closing device according to claim 5, including a chain transmission which extends between the rotor and an input member of the clutch group.

7. A closing device according to any one of the preceding claims in which the rotor includes a drum which encloses a flat spiral spring forming the force storage means, which drum mounts one end of the flat spiral spring while the other end of the spring is non-rotatably held, preferably in such a way that the tension in the spring can be adjusted.

8. A closing device according to claim 7, in which the inner end of the flat spiral spring is carried on a core sleeve which is rotationally adjustably supported on a carrier.

9. A closing device according to any one of the preceding claims, including freewheel means disposed between the rotor and an input member of the clutch group, which freewheel means is in a drive condition when the door member is closing and is in a freewheel condition when the door member is opening.

10. A closing device according to claim 9, in which an output member of the freewheel means which is disposed at the input side of the rotor is carried on a shaft which passes through the rotor and which is non-rotatably coupled to the transmission member of the clutch group.

11. A closing device according to claim 10, in which the shaft is non-rotatably connected to a drivable member of the restraint means and the rotor and the drivable member of the restraint means are disposed coaxially.

12. A closing device according to any one of claims 1 to 10, in which the rotor and a drivable member of the restraint means are disposed coaxially.

13. A closing device for a door member mounted for movement along a guide track substantially as hereinbefore described and illustrated with reference to the accompanying drawing.

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