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(54) DOOR CLOSING DEVICE

(71) I, YOSHITAKA NAKANISHI a Japanese subject, of 12-9, 5-chome, Yawata, Ichikawa-shi, Chiba-ken, Japan, do hereby declare the invention, for which I pray that

a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a door closing device wherein a torsion spring stores energy during opening of a door and applies a biasing force to the door in a direction for closing the door and wherein mechanically frictional brake means controls the closing speed of the door to prevent too rapid closing, or slamming, of the door.

Prior door closing devices have been proposed which have a torsion spring for closing the door and a frictional brake means for preventing too rapid closing, or slamming, of the door. In practice few if any devices of that type are on the market. The reasons appear to be that such known devices do not work properly and smoothly in checking the closing speed of the door, and cannot be maintained in good condition for a long time. Also the devices are complex in structure, expensive, and are not compact.

According to the present invention there is provided a door closing device comprising a casing for connection to the door to be closed, a spindle mounted in the casing and rotatable in either direction, means connected to the spindle for connection to the frame of the door, means comprising a torsion spring circumferentially of said spindle for storing energy during opening of the door and applying a biasing force to said spindle in a direction for closing the door, a brake drum circumferentially of the spindle coaxial with the torsion spring, means connecting the brake drum to the spindle for rotation therewith, a plurality of brake shoes having arcuate braking surfaces biased into engagement with braking surfaces

biased into engagement with the brake drum peripherally thereof thereby to exert a braking force on the drum, a friction brake member coaxial with the drum, and spring means urging the drum and the friction brake member axially into frictional contact with one another, thereby to produce a further braking force coacting with the force exerted by the brake shoes to brake the rotation of the brake drum.

The brake drum, brake shoes and brake member can be made of resilient materials such as plastics or metals.

In the accompanying drawings:

Figure 1 is a perspective view of an embodiment of the door closer according to the present invention;

Figure 2 is a plan view of the door closer without an upper cover plate and an arm;

Figure 3 is a bottom view of the door closer without a lower cover plate and an arm;

Figure 4 is a vertical cross-sectional view of the door closer along the line IV-IV of Figure 2, partly cut away;

Fig. 5 is a longitudinal sectional view of the door closer along the line V-V of Fig. 4;

Fig. 6 is a vertical sectional view of the door closer along the line VI-VI of Fig. 4, partly cut away;

Fig. 7 is a perspective view of a brake drum, a brake shoe and a brake disc;

Fig. 8 is a perspective view of the brake drum viewed from the lower part thereof;

Fig. 9 is a perspective view of the brake disc viewed from the lower part thereof;

Fig. 10 is a perspective view of a rotor and a lining;

Fig. 11 is a vertical sectional view showing a modification of Fig. 4; and

Fig. 12 is a perspective view showing another embodiment of the brake drum.

In Figs. 1 to 4, a casing 1 is secured to the door (not shown) by means of brackets 2 on both sides thereof. A spindle 3 is

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rotatably supported in the casing 1.

The spindle 3 rotates in accordance with rotation of the door through the agency of an arm 5 having one end keyed to an end 5 keyed to an end of the spindle 3, and another arm 6 having one end pivoted to the other end of the arm 5 and the other end pivoted to a bracket 7 which is attached to the jamb of the door (not shown).

The casing 1 is substantially rectangular in horizontal section with outer walls 8, 9, 10 and 11 defining the sides. The casing is divided into an upper compartment 13 and a lower compartment 14 by a partition 12. The partition 12 has an aperture 15 in its centre and a cylinder 16 co-axial with the aperture extending downwardly from the partition integrally therewith.

The spindle 3 is disposed loosely in the hole 15 and passes through the cylinder 16. The spindle is square in cross section and provided intermediate its ends with an annular groove 17. The spindle is supported within the partition 12 by a washer 18 or C-shaped flat ring which engages the annular groove 17 and is mounted on the edge of the aperture 15 of the partition.

A brake disc 19 is mounted on the upper surface of the partition 12, being tightly secured thereon by screws 22 received in threaded bores of the partition 12 and passing through apertures in the disc. The disc has an aperture 19a therein through which the spindle 3 passes loosely. The C-ring 18 is between the brake disc 19 and the partition 12. Thus the spindle 3 is not movable in the axial direction but is rotatable.

An annular space 23 is defined between the spindle 3 and the cylinder 16, and a torsion spring 24 is received therein. One end of the torsion spring is received in a hole 26 in the partition 12 and the other end 27 is selectively received in one of a plurality of holes 29 in a rotor 28. The lower end of the spindle is held in a central aperture in the rotor 28 in such a manner that the spindle is rotatable with the rotor.

Consequently, the torsional force of the spring 24 is adjustable by means of the rotor.

The rotor 28 is rotatable in the cylinder 16 and is supported by a cover plate 30. This cover plate 30 is secured to the wall 11 by means of brackets 31 bent upward at right angles from one side of the cover plate and screws 32 (see Figs. 5 and 6).

As more clearly shown in Figs. 3, 5 and 10, the rotor 28 has a projection 34 extending integrally from the circumferential periphery of the rotor in a radial direction in such manner that the projection is capable of swinging between the front and rear wall surfaces 8 and 11 through a recess portion 35 at the lower end of the cylinder 16. The

projection 34 has a surface 34a which engages with the inner periphery of the front wall 8 when the door on which the closer is used is at the closed position to prevent the door from rotating beyond the closed position. The projection also has a surface 34b which engages the inner periphery of the rear wall 10 when the rotor rotates in the direction of an arrow A to a position where the door is at maximum opened position, to prevent the door from rotating beyond the maximum opened position. When the spindle 3 is rotated by rotation of the door toward the opening direction, the torsion spring 24 is twisted by the movement of the rotor and stores energy. When the door is released this torsional energy in the spring causes the spindle 3 to rotate in a direction to close the door automatically.

As mentioned above, the rotor has a plurality of holes 29 into a selected one of which the end 27 of the spring 24 is inserted, and in this way the torsional force of the torsion spring can be adjusted. The outer periphery of the rotor is covered integrally with a plastics lining 36 which slides on the inner periphery of the cylinder to enable the rotor to rotate easily in the cylinder 16. The lining 36, as shown in Fig. 10, has a cylindrical portion 36a covering the outer periphery of the rotor and a flange 36b covering the upper surface of the rotor. A recess portion 36c is provided in the cylindrical portion and is engaged by the projection 34 to prevent relative slipping of the rotor and the lining 36. The rotor has an arcuate wall 28a extending integrally upward from the upper surface thereof, the partition 12 has an arcuate wall 28 extending integrally downward from the lower surface thereof, and these walls are in contact with the inner surface of the spring 24 to assist it in retaining its proper shape when it is being twisted and untwisted.

In the upper compartment 13 there is provided a brake drum 37 (shown in more detail in Figs. 7 and 8) having a rectangular opening at the centre thereof in which the spindle is received so that the brake drum is rotatable with the spindle and axially slidable on the spindle.

The brake drum 37 has an annular groove 38 which is coaxial with the drum and open at the top of the drum, and a coil spring 39 is disposed in the groove. On the top of the brake drum a disc 40 which is rotatable with the spindle 3 and axially movable along the spindle for covering the top of the groove 38, thereby to retain the spring 39 in the annular groove 38. A cover plate 41 is secured to the rear wall 11 of the casing by rear peripheral brackets 42 and screws 43 (see Fig. 6) in the same manner as the cover plate 30 of the lower part. The upper end of the spindle 3 ex-

tends upwards from the casing through a central aperture 44 in the plate 41.

The brake drum 37 and the disc 40 have the same diameter as one another, and as shown in Fig. 2, their circumferential peripheries are frictionally in contact with concave surfaces 45 which are provided on the inner surface of the front and rear walls 8 and 11 and have the same radius of curvature as the brake drum 37 and the disc 40. Accordingly, the spindle 3 rigidly connected with the brake drum 37 is able to rotate with the drum.

The bottom surface of the brake drum 37 bears on the top surface of the brake disc 19 and is biased axially into frictional contact with the top surface of the brake disc by the spring 39.

The top of the brake disc 19 has a friction producing jagged surface which comprises, for example, a plurality of long narrow projections 63 (see Fig. 7) which extend radially from the centre of the brake disc, and a plurality of segmental grooves 63a lying between the projections 63. Similarly the bottom of the brake drum 37 has a friction producing jagged surface which comprises, for example, a plurality of long narrow grooves 64 (see Fig. 8) extending radially from the centre of the drum and engaging with the projections 63 of the disc, and a plurality of segmental projections 64a lying between the projections 64 and engaging with the grooves 63a of the disc.

Two brake shoes 46 are disposed symmetrically on each side of the brake drum 37 in frictional contact with the drum. Each of the brake shoes 46 has an arcuate surface 50 in frictional contact with the cylindrical surface of the brake drum for braking the rotation of the drum. Each shoe 46 has side plates 51 integrally therewith and extending away from the arcuate surface 50 (see Fig. 2 and 7). The top ends 52 of the side plates 51 are in slidable contact with the inner surfaces of the cover 41. The bottom ends 52 of the side plates 51 are in slidable contact with the upper surface of the partition 12. The side surfaces 53 of the plates 51 are in slidable contact with the inner surfaces of the front and rear walls 8 and 11. The brake shoe 46 is thus movable from side to side smoothly and easily.

Springs 47 are disposed in their respective spaces between the brake shoes on the one hand and the right and left walls 9 and 10 on the other, for biasing the brake shoes into frictional contact with the drum.

As the two brake shoes 46 are disposed symmetrically on each side of the brake drum 37 and are pressed against the brake drum on both sides along a straight line passing through the axis of the drum and

at right angles thereto, the spindle co-axially secured with the drum is in neutral condition under the biasing force of the spring and maintained at its correct position.

In order to control the compression strength of the springs 47, the following means can be adopted. Square plates 54 are disposed between the outer ends of springs 47 and inner surfaces of the respective side wall 9 and 10. Each of square plates has a projection 55 extending rigidly from the inner surface of the plate into the coiled spring 47 and has a recess 56 formed on the outer surface of the plate corresponding to the projection. Screws 57 engage into threaded openings of the side walls 9 and 10 of the casing, and each of screws has one of its ends inserted a respective recess and the other of its ends at the outside of the casing. The plate 54 is movable axially of the screw 57 by turning the screws, clockwise or anticlockwise.

If a large braking force is applied to the brake drum 37 by the brake shoes 46, the diameter of the brake drum along the line of application of that braking force becomes shorter and the diameter in a direction at right angles thereto becomes larger. This is possible because of the presence of the annular groove 38. Accordingly, the brake drum is changed from a circular cross-section to an elliptical cross section. Thus as the drum rotates it alternately contracts and expands along any given diameter and this deformation further increases the braking effect.

The brake drum 37 may have a circumferential periphery comprising a knurled or jagged surface. Such a surface may comprise a plurality of narrow, elongate, small grooves 62 cut axially into the periphery of the drum shoulder to shoulder (Fig. 7), or small projections 63d extending radially from the periphery of the drum and having triangular or V-shapes (Fig. 12).

The jagged surface can occupy the whole circumferential periphery of the drum (not shown) or occupy part thereof (as in Figs. 7 and 10). When partial jagged surfaces are provided on the circumferential periphery of the drum this is done in such a manner that when the door is at the maximum open position, the jagged surfaces are not in frictional contact with the brake shoes. As the door closes, the area of frictional contact between the jagged surfaces and the brake shoes increases. This means that the faster the closing speed of the door becomes, the stronger the braking action becomes.

By way of example, the drum may be made of acetal resin or polyamide resin, with which is mixed asbestos powder. For instance, the drum may be made of a mix-

ture which comprises 100 parts by weight of Duracon (Trademark of Cellanese Co., U.S.A.) and from 10 to 45 parts by weight of asbestos powder. A brake drum of this mixture has high durability, high friction co-efficient and rigidity, materials, a low creep and low hygroscopicity. As the brake drum wears on its circumferential periphery, the brake drum maintains its rigidity and friction for reason that the brake drum has the asbestos powder distributed therein uniformly.

Furthermore, the asbestos powder gives thermal resistance to the brake drum which reduces thermal expansion and thermal strain caused by contact friction. Instead of Duracon, nylon can be used.

It is preferable to form the brake disc and brake shoe of the same material as the brake drum, as this improves the braking action, and the jagged portion on the periphery of the drum is better able to withstand being broken.

As the spindle 3 has its ends protruding from both the top 40 and the bottom 30 of the casing 1 either end of the spindle can be connected to the arm 5, so that the device can be used with part 40 of the casing either at the top or at the bottom 30 of the casing, according to whether the door is to swing right handed or left handed. When the arm 5 is connected with the top end of the spindle and not with its bottom end, the bottom end is covered with a cap 70, made for example of synthetic resin. The cap has a projection extending rigidly and laterally from the edge of the cap and engaging with the edge of the hole 33, of the cover plate 30.

Fig. 11 shows a modification of the device in which the spring 39 is provided at the lower portion of the brake disc 19 instead of pressing the brake drum downwardly into frictional contact with the brake disc 19, and the spring 39 presses the brake disc 19 upwardly into frictional contact with the brake drum. A cylinder 65 is provided coaxially in the cylinder 16 and extends downwardly from the partition 12. The spring 39 is located in a space 67 between the cylinder 65 and the spindle 3, and is supported by a flange 66 provided at the lower end of the cylinder. The C-ring 18 is engaged with the groove 17 of the spindle and is positioned between the flange 66 and the lower end of the spring 39.

Instead of using screw 22 to fix the disc 19 to the partition 12, an axially extending pin 68 is provided rigidly on the bottom surface of the disc 19, which is received in a hole 69 of the partition 12 movably into the axial direction, so that the brake disc is not rotatable.

The casing 1, the partition 12 and the

cylinders 16 65 may be integrally formed by die casting but it is also possible to form each member separately and to assemble them together for example with screws.

When the door is opened, the spindle is rotated through the arms 5 and 6, and the torsion spring 24 is twisted to store energy and apply a biasing force to the spindle in a direction to close the door.

When the door is closed by the energy of the torsion spring, the brake shoes are biased into contact with the brake drum symmetrically on both its sides by the springs 47 so that the door is closed without slamming. The door can be closed smoothly and quietly by the frictional contact between the brake drum and the disc, biased axially towards each other by the spring 38 or 39 in addition to the frictional contact between the brake drum and shoes.

WHAT I CLAIM IS:—

1. A door closing device comprising a casing for connection to the door to be closed, a spindle mounted in the casing and rotatable in either direction, means connected to the spindle for connection to the frame of the door, means comprising a torsion spring circumferentially of said spindle for storing energy during opening of the door and applying a biasing force to said spindle in a direction for closing the door, a brake drum circumferentially of the spindle coaxial with the torsion spring, means connecting the brake drum to the spindle for rotation therewith, a plurality of brake shoes having arcuate braking surfaces biased into engagement with braking surfaces biased into engagement with the brake drum peripherally thereof thereby to exert a braking force on the drum, a friction, brake member coaxial with the drum, and spring means urging the drum and the friction brake member axially into frictional contact with one another, thereby to produce a further braking force coacting with the force exerted by the brake shoes to brake the rotation of the brake drum.

2. A door closing device according to claim 1, in which the brake drum has an external knurled surface.

3. A door closing device according to either preceding claim, in which the friction brake member is disposed circumferentially of the spindle, and in which the spring means is disposed internally of the brake drum.

4. A door closing device according to any preceding claim, including a rotor circumferentially of the spindle and rotatable therewith, the rotor being disposed coaxially with the torsion spring, and means on the rotor for connecting the torsion spring and rotor for variable adjustment of the torsion force developed by the said



ture which comprises 100 parts by weight of Duracon (Trademark of Cellanese Co., U.S.A.) and from 10 to 45 parts by weight of asbestos powder. A brake drum of this mixture has high durability, high friction co-efficient and rigidity, materials, a low creep and low hygroscopicity. As the brake drum wears on its circumferential periphery, the brake drum maintains its rigidity and friction for reason that the brake drum has the asbestos powder distributed therein uniformly.

Furthermore, the asbestos powder gives thermal resistance to the brake drum which reduces thermal expansion and thermal strain caused by contact friction. Instead of Duracon, nylon can be used.

It is preferable to form the brake disc and brake shoe of the same material as the brake drum, as this improves the braking action, and the jagged portion on the periphery of the drum is better able to withstand being broken.

As the spindle 3 has its ends protruding from both the top 40 and the bottom 30 of the casing 1 either end of the spindle can be connected to the arm 5, so that the device can be used with part 40 of the casing either at the top or at the bottom 30 of the casing, according to whether the door is to swing right handed or left handed. When the arm 5 is connected with the top end of the spindle and not with its bottom end, the bottom end is covered with a cap 70, made for example of synthetic resin. The cap has a projection extending rigidly and laterally from the edge of the cap and engaging with the edge of the hole 33, of the cover plate 30.

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Instead of using screw 22 to fix the disc 19 to the partition 12, an axially extending pin 68 is provided rigidly on the bottom surface of the disc 19, which is received in a hole 69 of the partition 12 movably into the axial direction, so that the brake disc is not rotatable.

The casing 1, the partition 12 and the

cylinders 16 65 may be integrally formed by die casting but it is also possible to form each member separately and to assemble them together for example with screws.

When the door is opened, the spindle is rotated through the arms 5 and 6, and the torsion spring 24 is twisted to store energy and apply a biasing force to the spindle in a direction to close the door.

When the door is closed by the energy of the torsion spring, the brake shoes are biased into contact with the brake drum symmetrically on both its sides by the springs 47 so that the door is closed without slamming. The door can be closed smoothly and quietly by the frictional contact between the brake drum and the disc, biased axially towards each other by the spring 38 or 39 in addition to the frictional contact between the brake drum and shoes.

WHAT I CLAIM IS:—

1. A door closing device comprising a casing for connection to the door to be closed, a spindle mounted in the casing and rotatable in either direction, means connected to the spindle for connection to the frame of the door, means comprising a torsion spring circumferentially of said spindle for storing energy during opening of the door and applying a biasing force to said spindle in a direction for closing the door, a brake drum circumferentially of the spindle coaxial with the torsion spring, means connecting the brake drum to the spindle for rotation therewith, a plurality of brake shoes having arcuate braking surfaces biased into engagement with braking surfaces biased into engagement with the brake drum peripherally thereof thereby to exert a braking force on the drum, a friction, brake member coaxial with the drum, and spring means urging the drum and the friction brake member axially into frictional contact with one another, thereby to produce a further braking force coacting with the force exerted by the brake shoes to brake the rotation of the brake drum.

2. A door closing device according to claim 1, in which the brake drum has an external knurled surface.

3. A door closing device according to either preceding claim, in which the friction brake member is disposed circumferentially of the spindle, and in which the spring means is disposed internally of the brake drum.

4. A door closing device according to any preceding claim, including a rotor circumferentially of the spindle and rotatable therewith, the rotor being disposed coaxially with the torsion spring, and means on the rotor for connecting the torsion spring and rotor for variable adjustment of the torsion force developed by the said

spring when the door is opened.

- 5 5. A door closing device according to claim 4, including a casing having a first and a second compartment, the spindle extending axially through the compartments, the spring and rotor being disposed in one of the compartments and the friction brake member and brake drum being disposed in the other of the compartments.
6. A door closing device, substantially

as herein described with reference to Figures 1 to 10 or Figures 1 to 10 as modified by Figure 11 or 12 of the accompanying drawings.

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