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Sheckells

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[54] **COLLAPSING MECHANISM FOR REVOLVING DOOR WINGS**

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 161,552, July 12, 1971.

[52] **U.S. Cl.** **49/44,** 49/141, 292/DIG. 38

[51] **Int. Cl.** **E06b 3/90**

[58] **Field of Search** 49/42, 47, 141; 292/DIG. 38

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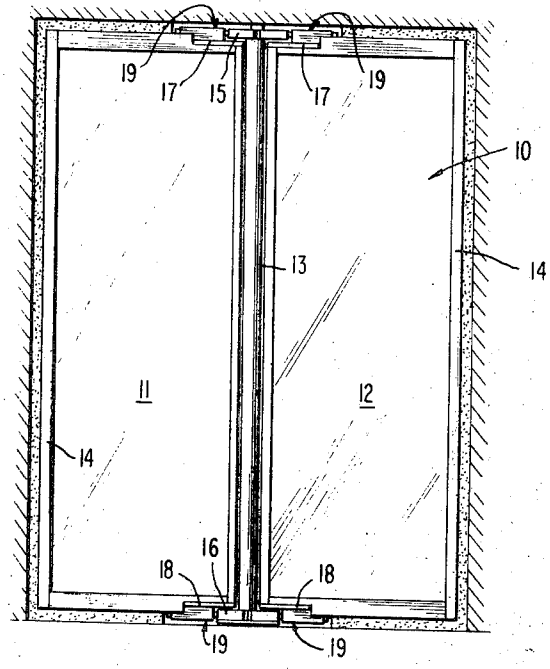
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[57] **ABSTRACT**

The right angular wings of a revolving door are secured releasably in normal radial use positions by the interlocking action of plastic plungers and cooperating notches in the peripheries of upper and lower hanger discs on the door center shaft. The plastic plungers may be housed on the horizontal portions of upper and lower hanger bars which serve to suspend the revolving door wings pivotally from the hanger discs. The arrangement assures safe collapsing or folding of the door wings in case of panic and prevents premature collapsing due to stack drafts found in many modern buildings or jarring by a user of the door.

9 Claims, 6 Drawing Figures



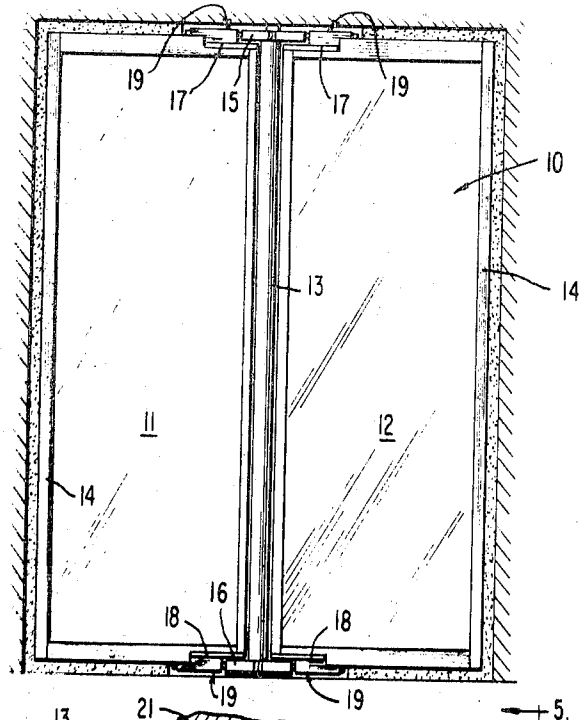


FIG 1

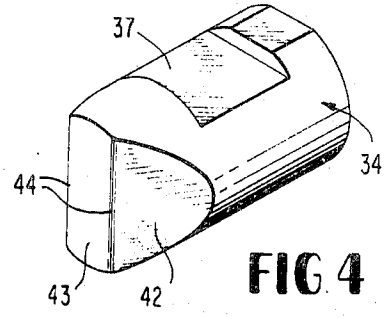


FIG 4

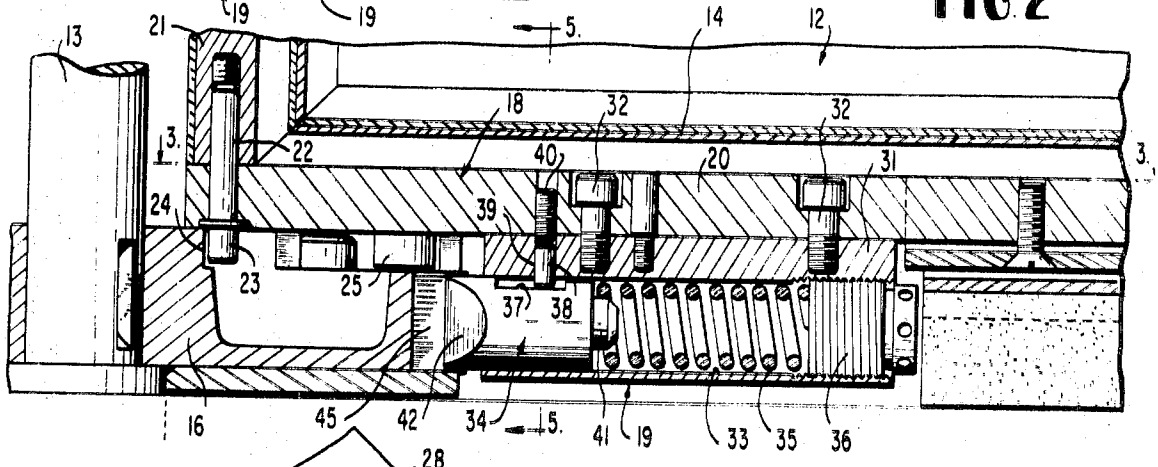


FIG 2

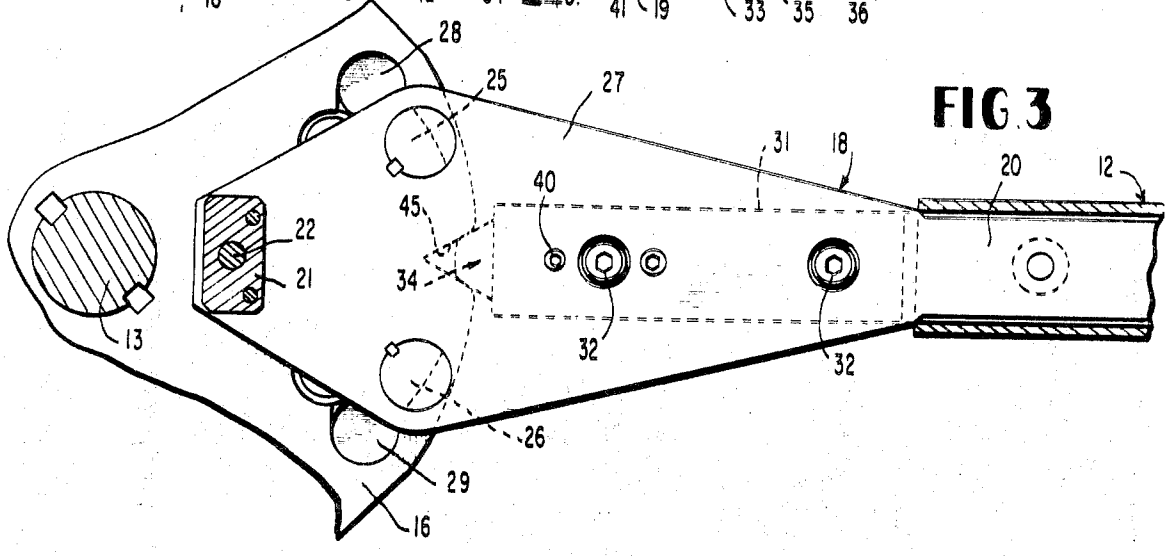


FIG 3

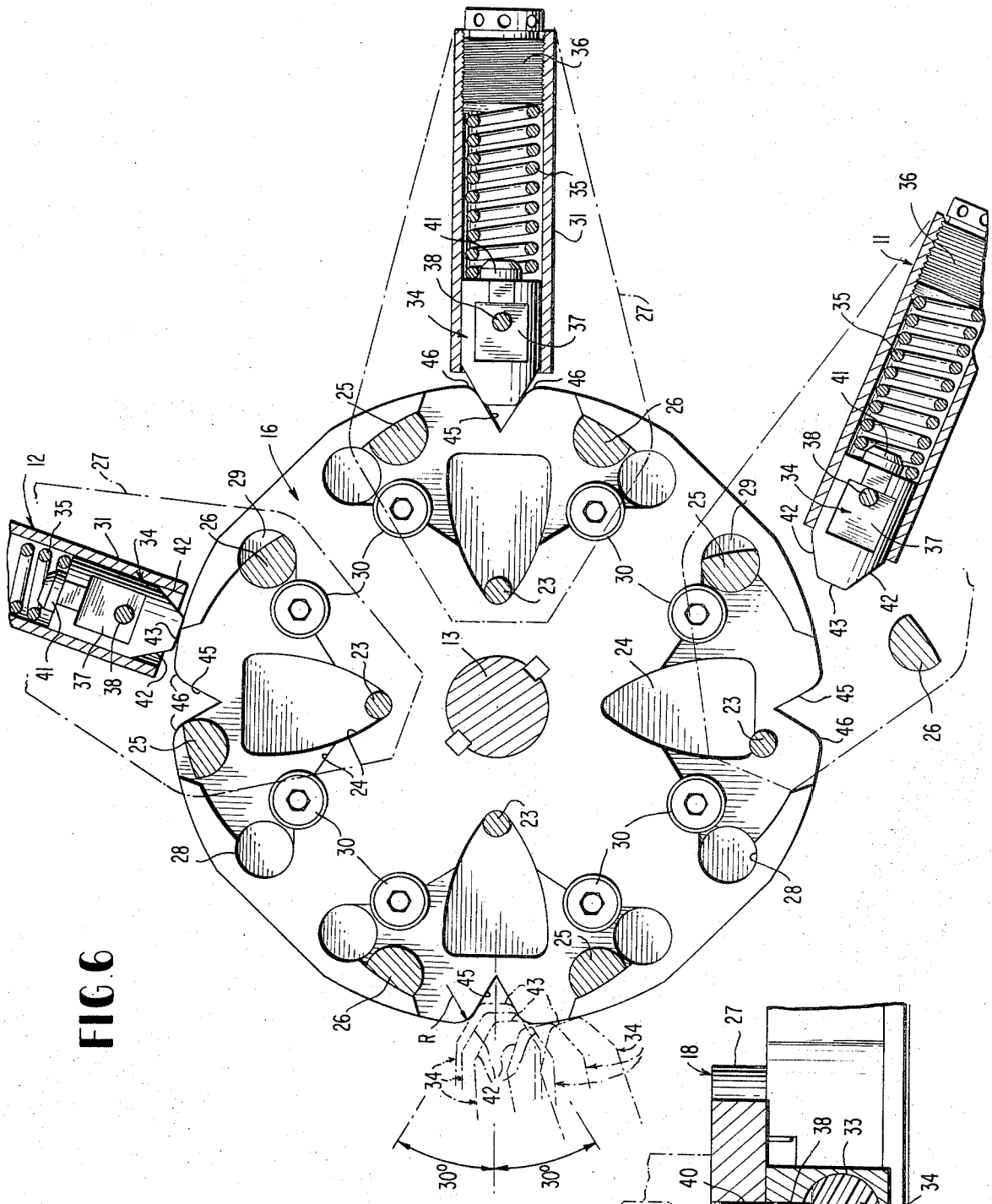


FIG. 6

FIG. 5

COLLAPSING MECHANISM FOR REVOLVING DOOR WINGS

This application is a continuation-in-part of prior copending application Ser. No. 161,552, filed July 12, 1971, for COLLAPSIBLE REVOLVING DOOR HAVING REMOVABLE WINGS.

Among the major demands on designers and producers of revolving doors is to maintain a high standard of safety in connection with the operation of the revolving door so as to protect the public. Of almost equally great importance from a practical standpoint is the requirement to provide a revolving door which is completely functional and convenient to use under ambient conditions found in all types of buildings including many modern high rise buildings where stack drafts exist in high degree. The above requirements, plus a number of others, must be satisfied without rendering the revolving door excessively costly and without detracting from its trim appearance required by modern architectural design.

The above-referenced parent application discloses a very satisfactory solution to several of the major problems confronting the revolving door industry. In that application, a structure is disclosed wherein the revolving door wings are rendered economically and easily removable while at the same time significantly improving the architectural appearance of the door. Additionally, in said prior application, a detent means for each revolving door wing is disclosed, whereby the wing will collapse or fold under a predetermined pressure to render the door safe as an exit in case of panic. The detent means possesses the ability to hold the door wings in their normal radial positions of use during other than panic situations.

More recently, architectural trends are in the direction of taller buildings which frequently have few, if any, barriers to air drafts in the first several stories of the building. Coupling this fact with interior and exterior temperature differentials, very severe stack drafts are frequently created, resulting in heavy pressure on the wings of revolving doors tending to fold or collapse the wings even before any normal operating pressure is placed thereon by users of the door.

In endeavoring to cope with these stack drafts, the makers of revolving doors have been compelled to increase the tension on the wing detent mechanisms considerably to resist premature and unexpected collapsing. In the case of all prior art detent mechanisms, this has led to a dilemna on the part of manufacturers who are constantly pressed to maintain safety in terms of a reliable collapsing mechanism while at the same time meeting the standards caused by architectural trends which produce the excessive stack drafts tending to cause the door wings to collapse or fold at undesirable times.

It has been determined, after considerable study, that conventional door wing detent mechanisms employing all metal components, including the ball type detent and plunger detent disclosed in said prior application, cannot be adjusted and regulated to operate properly and safely under the range of conditions now existing in the field, particularly in connection with the more modern buildings with severe stack drafts. Consequently, it is the objective of this invention to completely solve this problem in an entirely practical and economic manner, and in a way that will not interfere

with the many other desirable features of the structure disclosed in said prior application, including the simplified and extremely sturdy wing hanger bar construction and the relative ease with which the door wings may be bodily removed when necessary.

The present invention achieves its main objective in providing a detent mechanism which can resist the stack draft pressure, tending to collapse the door wings, without loss of safety where wing collapse is mandatory in case of panic by a seemingly simple, although quite critical, improvement. In lieu of the metal ball detent or plunger detent of the prior art, a detent plunger formed of a certain plastics material with particular physical properties and a particular geometrical configuration has been devised after considerable study and experimentation which will fully meet the needs of the situation as explained above.

While the construction and operation of the improved detent mechanism will be fully described hereinafter, it will be stated here briefly that the nonmetallic plastics material detent plunger is so highly successful in this particular critical application for several important reasons. Among these reasons is the yieldability or shock absorbing ability of the preferred form of plastic detent plunger, in comparison to metals. Chiefly as a result of this characteristic, a revolving door wing can be set for a lower torque required to collapse the wing, but only after the wing has moved through a considerably increased distance circumferentially prior to the release of the detent mechanism, as made possible by the shock absorbing capacity of the plunger material itself.

Additionally, in contrast to all metal parts, the improved detent or collapsing mechanism is not adversely effected by temperature variations, dust or other solid pargicles, moisture and other contaminants in which the mechanism must continually operate. The plastic detent plunger is highly resistant to abrasion and galling and actually tends to clean and polish the surfaces of the hanger disc with which it has sliding contact. In contrast to this, the conventional steel ball detent has a substantial tendency to gall and requires frequent lubrication and even then is likely to bind completely under certain conditions which must be met in practice.

While the ball detent provides basically a single line of contact with the mating hanger disc and seat, the present plastic detent plunger features a rather wide area of contact with the cooperating metal hanger disc and plunger seat, as will be fully described. No lubrication is required with the improved mechanism and maintenance, as well as initial cost, is rendered considerably less. When abrasive particles do work their way into the critical areas of the improved mechansim, the plastic plunger has a remarkable ability to embed and engulf such foreign matter without any resulting damage to parts or their smooth operation. Wear in the mechanism is much less than what is encountered with all metal parts and therefore the detent or collapsing mechanism has a much longer useful life with complete safety and without losing its ability to withstand the collapsing pressure caused by building stack drafts. In short, by means of the invention, the above-discussed dilemna brought on by the recent architectural trends, has been completely overcome, thus removing a very serious obstacle to continued satisfactory performance of revolving doors.

It has also been possible to eliminate a number of parts heretofore required in the all metal detent mechanisms. These include the hanger barrel shell and hardened steel insert disclosed in the prior copending application. With the use of the plastic detent plunger, considerably more freedom in terms of dimensional tolerances has been achieved, particularly in the vertical direction, resulting in even greater economies.

The greater shock absorbing ability of the detent mechanism results in greater safety to individuals who might be trapped between wings of a revolving door.

Most importantly of all, the use of the particular plastic detent plunger allows dependably a 50 percent increase in the holding torque as compared to previous designs, thus meeting the architectural demands, while at the same time maintaining a relatively constant torque required to cause wing collapse. This has been not possible in the prior art. It is believed that it is possible under the invention, mainly due to the fact that the coefficient of friction is stable because the plastic plunger does not gall or rust and all tendency for sticking has been eliminated.

Other features and advantages of the invention will become apparent during the course of the following description.

In the drawings:

FIG. 1 is a side elevation of a revolving door embodying the invention;

FIG. 2 is an enlarged fragmentary vertical section taken through a lower revolving door hanger disc, hanger bar and detent mechanism;

FIG. 3 is a fragmentary horizontal section taken on line 3—3 of FIG. 2;

FIG. 4 is a perspective view of a plastic detent plunger embodied in the invention;

FIG. 5 is a fragmentary vertical section taken on line 5—5 of FIG. 2; and

FIG. 6 is an enlarged horizontal cross section taken through lower detent mechanisms of a revolving door substantially in the plane of the lower hanger disc and illustrating different positions of door wings relative to the hanger disc and also illustrating the travel of one detent plunger with relation to its associated hanger disc and detent notch.

Referring to the drawings in detail and referring first to FIG. 1, there is shown a revolving door 10 having a pair of diametrically opposed wings 11 and 12 radiated from a center shaft 13, it being understood that customarily there is a second pair of wings arranged perpendicular to those illustrated in FIG. 1. Each revolving door wing consists of a glass panel bounded by a marginal frame 14. Securely attached to the top and bottom ends of the door center shaft 13, as disclosed in said prior application, are hanger discs 15 and 16, from which the several door wings are pivotally suspended on hanger bar assemblies 17 and 18. The improved wing collapsing or detent mechansims 19 forming the principal subject matter of the present invention are preferably secured to the hanger bar assemblies in the manner shown in the drawings and will be fully described.

Referring now to the other FIGURES of the drawings, the lower hanger disc 16, a lower hanger bar 18 and one complete detent assembly or mechanism 19 are shown in FIGS. 2 through 5. In these FIGURES, the illustrated lower hanger bar 18 for door wing 12 comprises a horizontal bar section 20 and a vertical section 21. These two sections are rigidly connected in right angular relationship, FIG. 2, by a vertical shouldered screw 22 having a lower end cylindrical head 23 which projects into a recess 24 of hanger disc 16 and forms a primary pivot for the door wing 12 to facilitate the folding or collapsing thereof in some situations. Additional pivot elements 25 and 26 depend from the enlarged head portion 27 of hanger bar section 20 and are received by portions 28 and 29 of the hanger disc recess 24 on opposite sides of the primary pivot 23. During collapsing of a door wing, initial pivoting occurs on the axis of pivot element 23, until one or the other of the elements 25 or 26 enters a recess portion 28 or 29, depending upon the direction of pivoting. When this occurs, as fully described in said prior application, the remainder of the pivotal action of the door wing takes place around the axis of one of the elements 25 or 26 while the other two pivot elements for the particular door wing assume positions such as indicated in FIG. 6. Also as fully disclosed in said prior application, a series of shoulder bolts 30 in the hanger disc 16 limit the extent to which a particular door wing can be pivoted because of ultimate contact with one of the pivot elements 25 and 26. The removal of the bolts 30 by swinging the particular door wing to the limit of its pivotal movement, first in one direction and then in the opposite direction, allows the complete separation of the wing from the hanger disc 16. In connection with all of these operations, it will be understood that identical structures are provided at the top and bottom of the revolving door for the mounting and pivoting of the door wings. Therefore, a complete description of the mounting of one end of one wing will suffice to describe the complete mounting of every door wing on the upper and lower hanger discs 15 and 16 through the medium of the hanger bar assemblies 17 and 18 described in connection with FIG. 1.

Each of the detent mechanisms 19 consists of a detent plunger housing 31 securely bolted to the bottom surface of hanger bar section 20 by a pair of countersunk screws 32. As shown in FIG. 5, the housing 31 is rectangular in cross section but has a cylindrical bore 33 for the reception of a detent plunger 34 and a backup compression spring 35 which exerts a constant forward thrust on the detent plunger. Behind the spring 35 in the housing 31 is an adjustable threaded plug 36 by means of which the spring pressure acting on the detent plunger may be adjusted through a rather wide range.

The detent plunger 34 forms an important and critical element of the invention in allowing the revolving door to resist collapsing under the influence of severe stack drafts without sacrifice of the ability of the door wings to collapse under reasonable manual pressure in a panic exit situation. The detent plunger 34 is preferably molded from an acetal resin composition derived by polymerization of formaldehyde, manufactured and sold by E. I. duPont deNemours & Co., Inc. of Wilmington, Del., under the trademark "Delrin." The plunger material may also be identified as a homopolymer acetal plastics material. It is a tough self-lubricating wear-resistant material and sufficiently yielding or resilient to possess excellent shock-absorbing characteristics while retaining a high degree of tensile, shear and compressive strength. This material is excellent for sliding contact with a mating metal part, in the present case the bronze hanger disc 16.

The plunger 34 is cylindrical and is provided between its ends and at one point on its circumference with a board flat surface 37 parallel to the major axis of the plunger and normal to its ends. In assembly, FIG. 2 and FIG. 5, the flat surface 37 receives a small locator pin 38 mounted slidably in a radial opening 39 of housing 31 and backed up by an adjustable set screw 40 with a small space remaining between the set screw and the locator pin so that the latter will be free in the bore 39. A cylindrical projection 41 on the rearward end of the detent plunger 34 serves to center the coil spring 35 properly with the plunger. The pin 38 prevents turning of the plunger 34 on its longitudinal axis.

At its forward end, the plunger has a pair of opposite side converging flat faces 42 and an intervening center leading end flat face 43. These flat surfaces are quite critical and are formed very smooth and free of defects in the molding process. The three flat surfaces 42 and 43 are symmetrical with the longitudinal axis of the plunger 34 and are joined on smoothly rounded radii portions 44 of approximately one-sixteenth inch radius each. The flat faces 42 and 43 extend entirely across the plunger 34 from top to bottom in relation to the position shown in FIG. 4 and FIG. 2. The plunger 34 has a free sliding fit within the bore 33 of housing 31 without excessive play therein. The location of the plunger 34 in the vertical direction is much less critical than in the case of a ball type detent, and therefore the tolerances in this direction particularly concerning the housing 31 need not be extremely close. For the most satisfactory operation of the wing detent or collapsing mechanism, the included angle between the two converging flat faces 42 is 60° as indicated in FIG. 6. However, satisfactory operation can be obtained when this included angle is in the range of 60° as the lower limit to 75° as the upper limit.

Referring to FIG. 6, each hanger disc is provided in its peripheral edge adjacent to each door wing of the revolving door with a cooperating V-shaped detent notch 45 for the adjacent detent plunger 34. Each such notch 45 spans an included angle of 60° between its divergent side walls with the apex of the detent notch lying on a radial line intersecting the central axis of the hanger disc 15 or 16. The V-shaped notch 45, therefore, closely matches the taper of the plunger 34 formed by the angled faces 42. The mouth of each detent notch 45 is smoothly rounded on opposite sides by radius portions 46, and the radii forming these mouth or shoulder portions of the notch are approximately one-fourth inch. These rounded portions 46 are important as they reduce considerably the shearing stresses on the plunger 34 and consequently minimize wear. The notches 45 of each hanger disc 15 and 16 extend entirely therethrough from top face to bottom face as shown in FIG. 2. This construction renders dimensional tolerances in the vertical direction much less stringent than those required for ball type detents.

A major advantage of the detent plunger 34 as described over ball detents and the like resides in the presence of rather wide areas of sliding contact between the critical surfaces of the detent plunger and the opposing hanger disc 16 including the contact surfaces of the detent notch 45. This is in contrast to essentially a single line of contact with a ball type detent where there is a much greater tendency for the parts to bind particularly after wear and galling occurs. At the left hand side of FIG. 6 in phantom lines, a sequence of positions of the detent plunger 34 are shown during its travel from a fully seated locking position within a detent notch 45 to a fully unseated or release position, where the end face 43 has ridden up onto the peripheral edge of the hanger disc 16. In all intermediate positions, it may be observed in FIG. 6 that fairly wide surface contact areas are maintained between the plastic plunger and bronze disc, in contrast to mere line contact. The illustration in FIG. 6 also graphically shows the rather large extent of angular or pivotal movement a door wing can undergo relative to the hanger discs and center shaft 13 before total interlocking engagment of the detent plunger 34 and detent notch 45 will occur. In practice, with a typical door wing of 3' width radially, the outer edge of the wing can travel up to 8" circmferentially around the axis of the center shaft 13 before the improved detent mechansim will fully release to cause collapsing or folding of the wing. This is a great improvement over the situation with a ball type detent or any known detent mechanism employing all metallic parts. The longer path of travel is due in part to the geometry of the cooperating plunger and notches and it is also due in part to the resiliency and shock-absorbing ability of the plunger 34 formed of the particular identified plastics material.

Due to the described longer path of movement before collapsing of the wing, wing collapsing can be avoided when a wing is accidentally bumped by an individual or when it is influenced by a strong stack draft. The wing will move for a considerable distance circumferentially but will return automatically to the normal locked position unless full separation of the plunger 34 and notch 45 occurs. This allows for setting a revolving door for lower total torque necessary to produce collapsing in a panic situation but with increased ability for the door to withstand bumping or stack draft forces prior to collapsing. This is a great improvement over the prior art which can only be obtained by the particular combination of materials disclosed herein as well as by the particular construction and shaping of the critical detent components.

In view of the foregoing description, it is thought that the operation of the detent or collapsing mechanism has already been described essentially. It should suffice to state in connection with FIG. 6 that the door wing at the right hand side of this FIGURE shows the detent mechansim fully engaged or locked with the wing in the normal use position and extending radially of the door center shaft. At the top of FIG. 6, the wing 12 is shown collapsing immediately after the detent plunger 34 has separated from the adjacent notch 45 and is riding on the peripheral edge of the hanger disc 16. The wing at the bottom of FIG. 6 is shown in a further and almost fully collapsed position after the plunger 34 has completely separated from the hanger disc 16.

Another feature which should be mentioned here in connection with FIG. 6 is the long and gradual approach contact between the plastic detent plunger 34 and the peripheral edge of the disc 16 whenever a door wing is returned to the normal locked or engaged position with respect to the disc 16. This gradual contact is evident with the wings 11 and 12 at the bottom and top of FIG. 6.

Another point which should be noted is that the plunger 34, FIG. 2, will simply gradually move to a slightly lower elevation and still continue to operate efficiently as slight wear takes place on its lower side.

The use of the plastic detent plunger **34** allows dependably a 50 percent increase in the holding torque of the machanism compared to all previously known designs and thus meets architectural demands without sacrifice of safety requirements since the detent mechanism will still release properly in panic conditions. Also, the improved detent mechanism will hold a relatively constant torque resistance once adjusted to a desired tension and this constant holding force has not been attainable with prior designs.

As a comparison example between revolving doors having conventional all metal spring-pressed ball detents and the present plastic detent plunger of this invention, the following FIGURES are illustrative.

With a standard 3' wing and a conventional detent mechanism and with a **140**No. force applied to the wing near its outer vertical edge, the wing can resist approximately 420 foot pounds of torque before collapsing. When the conventional detent mechanism is adjusted to resist as much as **200**No. against the wing or 600 foot pounds of torque without collapsing, a condition is reached with conventional detent mechansim where absolute binding of the detent may occur so that the wing cannot be collapsed even in a panic exit situation.

In contrast to this, with the improved detent mechanism of the invention, the identical revolving door wing may be adjusted through the detent mechanism to collapse under a load as low as 100 No. applied against the wing or 300 foot pounds of torque. At the other extreme, with the improved mechanism, in a tall building with a strong stack draft, the detent mechanism may be adjusted so that the wing will not collapse with 900 foot pounds of torque on it. However, even under this loading, the detent will not bind or become frozen and the wing will still collapse for safety in a panic exit situation.

It is desired to emphasize and to summarize the operation of the critical portions of the detent mechanism particularly as illustrated in FIG. **6**. Again referring to the phantom line positions of the detent plunger **34** in FIG. **6**, it may be observed that when the plunger is fully seated in the V-shaped recess **45** and begins its withdrawal movement, one of the angled flat faces **42** of the plunger is in sliding contact with a corresponding flat side wall of recess **45** or notch. After further withdrawal movement, the rounded shoulder **44** of the plunger will smoothly ride over the rounded shoulder **46** at the mouth of the notch **45**. Up to this point, the detent plunger is not yet fully disengaged from the detent notch and would tend to reseat itself in the notch if pressure were relieved on the door wing. After still further withdrawal movement of the plunger **34**, the leading end flat face **43** finally rides up onto the peripheral edge of the hanger disc **16** and these two surfaces are in sliding contact. The detent plunger is now fully disengaged from the notch **45** and would no longer tend to re-enter the notch automatically. It may be noted here, as previously explained, that up to 8 inches of movement of the outer vertical edge of a door wing may occur before complete separation of the plunger **34** from the notch **45** takes complete separation of the plunger **34** from the notch **45** takes place. The advantages of this have already been fully explained.

When the flat end face of the plunger is riding on the peripheral edge of the hanger disc **16**, there will be no tendency for scoring or galling of the disc or plunger due to the nature of the materials, and in fact the relatively broad surface contact between these parts will have a tendency to clean and polish the edge of the bronze disc which is highly desirable. These features of the invention are restated so as to emphasize the critical part of the invention which constitutes so great an improvement over the usual metal ball detent. The metal ball detent, due to a single line of contact, has a strong tendency to score and gall the disc and may also stick or bind in the depth notch. It does not have the resiliency or the geometric shape to allow the rather long circumferential travel relative to the disc **16** before separation from the notch **45**, as is seen to occur with the non-metal plunger **34**. The metal ball detent will separate from the notch or re-enter the notch with a much more abrupt snapping action, and here again the ball detent has a much stronger tendency to freeze in the detent recess and cause a dangerous situtation when spring-loaded sufficiently to resist stack drafts and jarring.

During the fabrication of the polymerized acetal resin detent plunger **34**, its physical properties including tensile strength, modulus of elasticity and coefficient of friction may be varied by the addition to the compound of glass fibers, teflon fibers, or the like.

The terms and expressions which have been employed herein are used as terms of description and not of limitation, and there is not intention, in the use of such terms and expressions, of excluding any equivalents of the features shown and described or portions thereof but it is recognized that various modifications are possible within the scope of the invention claimed.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In a revolving door of the type which turns about an upright center axis of rotation and has plural radiating door wings, hanger assemblies for the door wings at the tops and bottoms of the door wings, said hanger assemblies comprising upper and lower hanger discs, hanger bar means carried by each door wing and having pivotal connections with said hanger discs, and yielding detent means on the hanger assemblies releasably locking said wings in radially extended use positions but allowing collapsing of the wings independently around said center axis of rotation in panic exit conditions, each detent means comprising a detent plunger formed of a tough high strength wear-resistant shock-absorbant polymerized resin, a pair of side, forwardly converging flat faces on the leading end of the detent plunger separated by an intervening center leading end flat face, said side and end faces providing detent contact surface areas; holder means for said detent plunger including adjustable spring tension means exerting a variable force on the detent plunger in an inward radial direction, and each hanger disc having a peripheral, substantially V-shaped, detent notch for each detent plunger, each notch having opposed flat faces providing coacting contact surface areas slidably receiving the converging flat faces of the detent plunger during seating and unseating movements of the plunger with relation to the notch.

2. The structure of claim **1**, and said hanger disc comprising a bronze disc, and said detent plunger formed of acetal resin derived by polymerization of formaldehyde.

3. The structure of claim 1, and said forwardly converging flat faces of said detent plunger defining an included angle of not less than about 60° and not more than 75°, said V-shaped notch of said hanger disc defining substantially the identical included angle between the side faces of said notch.

4. The structure of claim 3, and the entrance to the V-shaped notch having smoothly rounded shoulders leading into the notch on the opposite sides thereof, said shoulders formed on said hanger disc, said shoulders allowing the detent plunger to travel smoothly from said notch onto the peripheral edge of the hanger disc during the collapsing or repositioning of a door wing.

5. The structure of claim 1, and said detent contact surface areas on said detent plunger extending in vertical planes, said detent notch being formed vertically through said hanger disc from the top to the bottom face thereof, and means on said holder means engaging the detent plunger to prevent turning thereof on a horizontal axis through the plunger.

6. The structure of claim 5, and said last-named means comprising a flat face on the detent plunger, and a coacting radial locator pin on the holder means engaging said flat face.

7. The structure of claim 1, and said holder means comprising a housing secured to said hanger bar means and having a bore, said detent plunger being externally cylindrical and engaging slidably within said bore, a compression spring within said bore engaging the rearward end of the plunger, and a screw-threaded spring tension adjusting plug in the rearward portion of said bore.

8. The structure of claim 7, and a central reduced diameter spring centering extension on the rearward end of the detent plunger.

9. The structure of claim 1, and said pair of converging end faces extending equidistantly rearwardly from said leading end faces, said plunger being externally cylindrical and having a horizontal cylindrical axis normal to the leading end face and lying midway between said converging flat faces.

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