Compressive Spiral Spring Door Closer Using Simple Spur Gear Train Arrangement

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Abstract

A door closer is a mechanical device that closes a door,which is open by push or pull action manually or automatic.The closer available in a market can involve the consideration of a variety of criteria. In addition to the closer's performance in fire situations, other criteria is resistance to opening forces (for use by disabled or infirm), control over the rate of closing, safety, durability, risk of vandalism, and aesthetics. This paper review the existing door closer available in a market.also gives the detail concept and mechanism for the new design of door closer , by using compressive sprial spring and simple gear train arrangement.

Keywords

Spiral torsion spring, Spur gear,Links,Bracket .

1.Literature review

1.1 Types of Door closer

There are two types of door closer

1.1.1 Automatic door closer

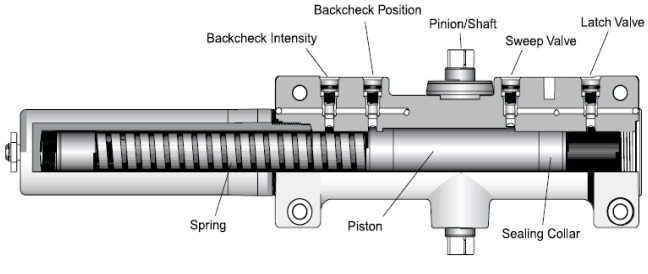
1.1.2 Manual door closer

1.1.1.Automatic Door Closer [1],[7]

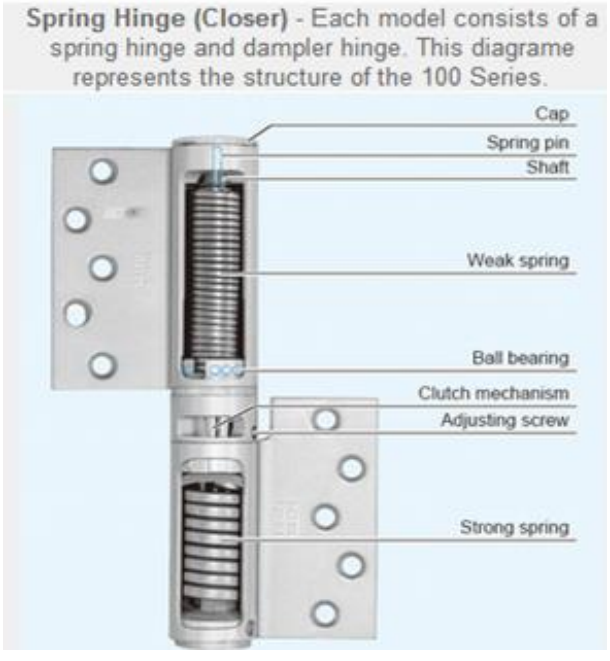
When door is open or close using sensors with opening and closing mechanisms without human interuption. Using a automatic sliding glass door is beneficial in both residential and industrial utility since it is very effective to maximize both small and large spaces. It contains a higher aesthetic value as compared to other normal hinged style.The price tag is definitely a worthy buy for a consumer looking for a steal.

1.1.2Manual door closer [6],[10]

A manual door closer stores the energy used in the opening of the door in a compression or torsion spring and releases it to close the door. Some closers allow for adjustment of the strength of the spring, making it easier or more difficult to push the door open. To limit the speed at which the door closes, most door closers use hydraulic (oil-filled) dampers, although spring mechanisms may also be used for damping. Some closers incorporate a back-check facility which prevents the door from being opened too fast. The speed at which the door closer closes the door may be adjustable by up to three adjustment valves. These valves are adjust the sweep speed and the latch speed of the door and some closers are optioned with a delayed action valve. The latch speed is the speed that the door travels in the last one third to 10 degrees as it closes and is closes fast so that the door can properly latch. The sweep speed is the speed which the door travels at along the first two thirds of its travel which is often set slower than the latch speed. The delayed action valve slows the sweep speed dramatically for roughly the first half of the sweep range. Door closers which provide this two or three-stage action and close doors at a determined rate are called 'controlled' door closers. Liam Anthony Flynn was the first developer of the manual door closer.



" Fig. 1 Manual door closer consist of spring and hydraulic cylinder mechanism"[2]



"Fig.2 Spring Hinge(Closer)"

The use of door closers[11][3] or spring hinges will come down to one thing; application. Closing devices are used on more than just fire doors. While they may or may not be required they make good application. For instance janitor closets, storeroom doors, security doors, and exterior doors are the most common openings that, if not rated, should be self-closing due to their application.

Door closers provide control of the door through adjustment valves[2]. These controls include back-check, closing speed, latching speed, and some closers have an option for delayed action. Some closers may also offer special arms and brackets such as stop arms and hold open arms (for non-rated doors). A door closer closes the door as required but with these valves and special arms does so with control .

Door closers are available in different sizes[5][11], types (floor, surface, concealed), and with different features so there are still more choices to be made but these choices will also be made by application.

2. Introduction

Now in a modern day's door closer is a basic need of door. To close the door in offices, schools, hospitals and in houses for fire safety and maintaining room temperature. The approach for development of product like door closer was that, the door closer available in market was all run on hydraulic cylinder.

Hydraulic cylinder have main disadvantage as that oil leakage, if the oil leakage start from the system then whole system must be replace. The replacement of single unit cannot take place. The aim of the project was to construct and design a door closer which work on gear system that has practically needs minimum maintenance, was simple in erection and fulfilled the required specifications. Main objective is that to optimize the cost of product by run the product for long time. The selected design was then studied thoroughly and elaborated. After elaborating the design, dimensioning and calculations we redesign and the final design was fabricated with exact selection of materials and parts. The model was tested and checked thoroughly for its working. All aspects were kept in view,all possible improvements and modifications done in a new design which resulted in a better performance of the door closer.

2.1 Problem identification

Door closer with hydraulic system mostly used overhead hydraulic system:It accomplishes this by using spring tension modulated by hydraulic fluid. As the user opens the door, hydraulic fluid passes from one reservoir to another, and as the spring pushes the door closed again, the hydraulic fluid passes back to the previous reservoir through a series of valves that control the speed.

The following problems are identified in the existing overhead hydraulic system.

If oil is leaking from your door closer, throw it away and buy a new one.

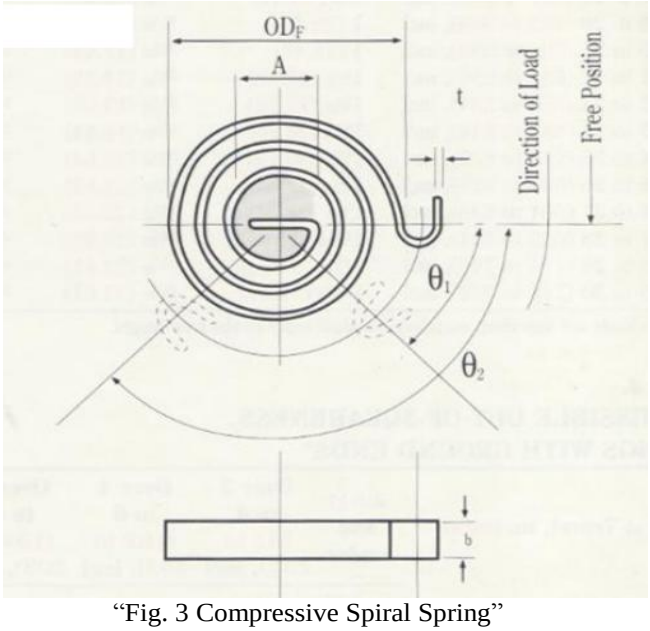
If your door closer is slamming the door and cannot be adjusted to do otherwise, either the fluid has leaked out or the valve seals are worn out. Either way, your best option is to replace it.

If the door closer has no spring tension and the spring tension adjustment turns round and round with no effect, the spring is broken the door closer must be replaced.

2.2 Material and Working of Compressive Spiral Spring Door Closer[8],[9]

So the strong steel spring can be used to close the door automatically. Here same thing can be achieved by using Compressive spiral spring intead of helical compressive spring.

Information given about the spiral spring in a spring hand books,i.e Spiral torsion springs, which are usually made of rectangular section material, are wounded flat, generally with an increasing space between the coils. The torque delivered per reevolution is linear for the first 360º. At greater angular rotations, the ccoils begin to cclose on the arbor, and the torque per turn increases rapidly, for this reason,, springs of this type are usually used in applications requiring less than 360º of rotation.



"Fig. 3 Compressive Spiral Spring"

A spring is an elastic object used to store mechanical energy. Springs are usually made out of spring steel. Small springs can be wound from pre-hardened stock, while larger ones are made from annealed steel and hardened after fabrication. Some non-ferrous metals are also used including phosphor bronze and titanium for parts requiring corrosion resistance and beryllium copper for springs carrying electrical current (because of its low electrical resistance).

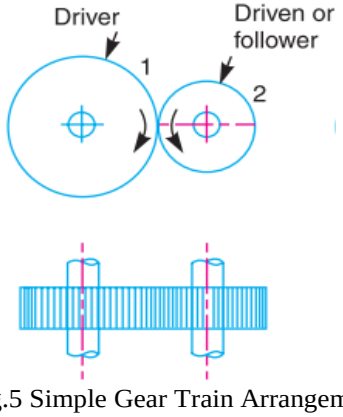
When a spring is compressed or stretched, the force exerts is proportional to its change in length. The rate or Spring constant of a spring is the change in the force it exerts, divided by the change in deflection of the spring. That is, it is the gradient of the force versus deflection curve. An extension or compression spring has units of force divided by distance, for example lbf/in or N/m. Torsion springs have units of force multiplied by distance divided by angle, such as N·m/rad or ft·lbf/degree. The inverse of spring rate is called compliance, i.e: if a spring has a rate of 10 N/mm, it has a compliance of 0.1 mm/N. The stiffness (or rate) of springs in parallel is additive, as is the compliance of springs in series.

Depending on the design and required operating environment, any material can be used to construct a spring, so long as the material has the required combination of rigidity and elasticity.

"Fig. 4 Compressive Spiral Spring"

2.3Simple Gear Train Arrangement[12]

When there is only one gear on each shaft, it is known as simple gear train. The gears are represented by their pitch circles.



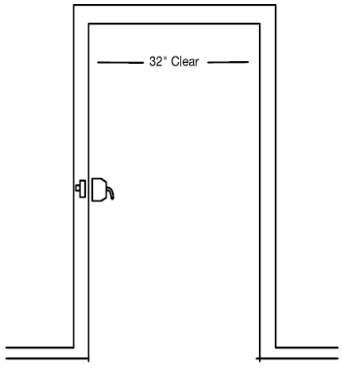
"Fig.5 Simple Gear Train Arrangement"

When the distance between the two shafts is small, the two gears 1 and 2 are made to mesh with each other to transmit motion from one shaft to the other, Since the gear 1 drives the gear2, therefore gear 1 is called the driver and the gear 2 is called the driven or follower. It may be noted that the motion of the driven gear is opposite to the motion of driving gear.

2.4 General information

2.4.1 Hinged Doors[2]

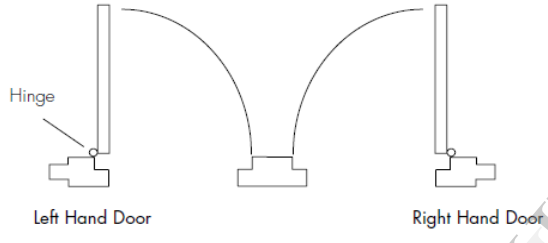
The 32-inch opening is required for door measured from the stop on the door jamb on the latch side and the face of the door when standing open in the 90° position.



"Fig.6 Hinged Door"

2.4.2 Door closer position[2]

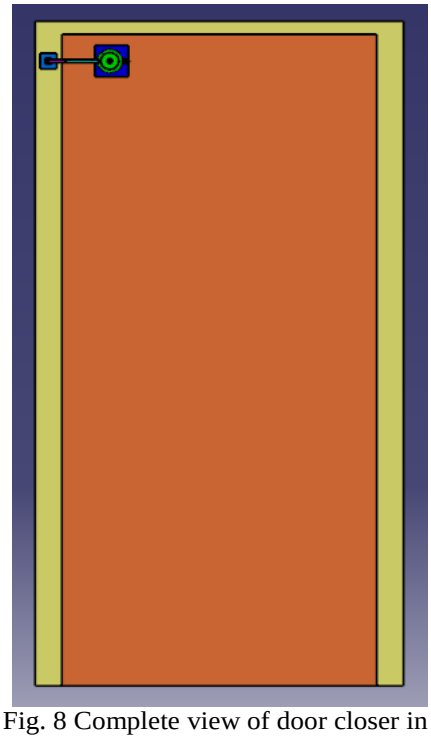
Many door closers are non-handed. This means they can be placed on a door in such a way that they will operate a left-opening or a right-opening door. In some cases the hand of the door must be specified.
There are mainly two types Left Hand Door or Right Hand Door



" Fig.7 Door closer position"

2.4.3 Sizes of door closer[2]

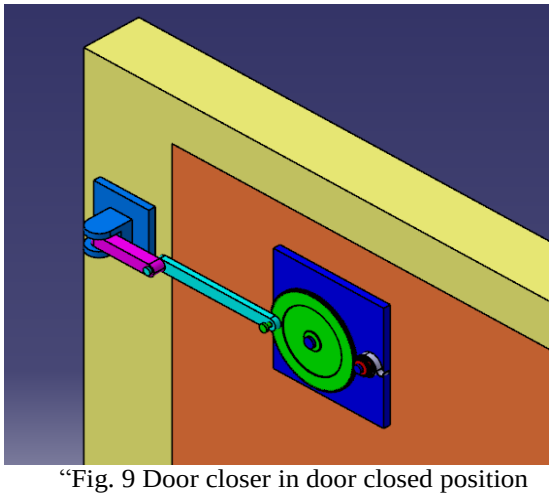
Each door closers are manufactured with different to cater for the size and weight variation of doors. The bigger and heavier the door, the greater the force required to close it. All the standard are taken from the recognized standard brochers ,in that provide the guide line for classifying door closers is by assigning the closer with a number value between 1 and 7 where the higher number indicates a larger capacity and force of close. The minimum recommended size door closer fitted to a fire door is 3. Air pressure on the door from wind is also a consideration, which could lead to a higher size number than the actual door weight being needed. This design provides precise control in the door's closing cycle.These illustrations simulate generic door closer function.The closer components will vary; however, the principle is the same.



" Fig. 8 Complete view of door closer in close position"

3.Construction of a new design door closer

Spiral Spring is fixed at bottom by 10mm offset distance of driven gear (Pinion) is allowed to rotates in bearing fixed on the base plate. Driven gear meshed with driver gear and driver gear also fixed in the bearing with the help of shaft.



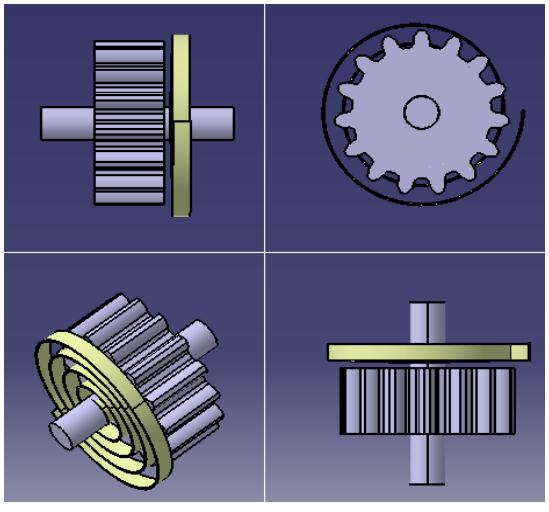
"Fig. 9 Door closer in door closed position view from back side of door"

Then complete gear train arrangement fixed on the base plate which fixed on the back side of door from top of the door 50mm lower.Connecting link-1 is fixed to the gear.Connecting link -2 get connected to connecting link-1 on other side connect with

bracket.Bracket is fixed to the door frame on the door hinge side.

3.1 Pinon with Compressive Spiral Spring

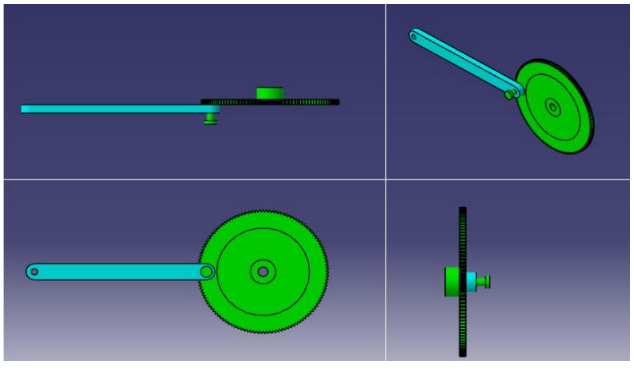
Pinion Gear plays a key role here to close the door automatically.On a shaft Pinion Gear and compressive Spring is mounted and that assembly is fixed to the bearing which gives rotation to the Pinion Gear. And the complete assembly is fixed to the base plate



"Fig.10 Pinion gear with spring"

3.2 Gear

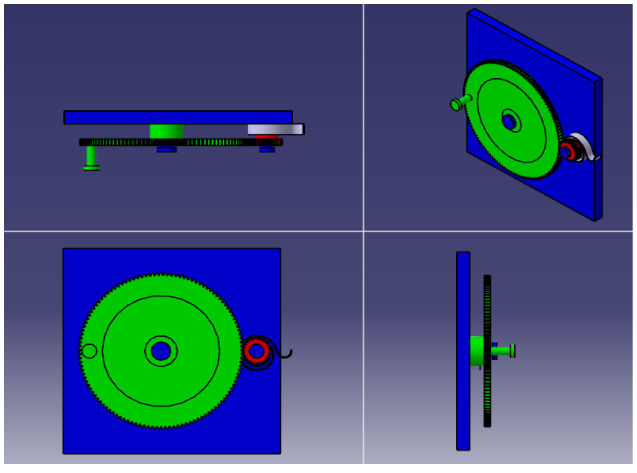
Gear acts as a driver while opening a door and driven when closing the door. This gear is keyed to the shaft, so that when shaft rotates gear will also rotates.To this gear connecting link -1 is fixed which is offset distance from the centre shaft.The connecting link-1 rotate in a path .This assembly also fitted to the base Plate.



"Fig.11 Gear with Link"

3.3 Gears with Base Plate Assembly

Two roller bearing is keyed to the base plate which allow the gears shaft keyed to the bearings. And the base plate is fixed to the door at 50mm either distance from the door at its top end.



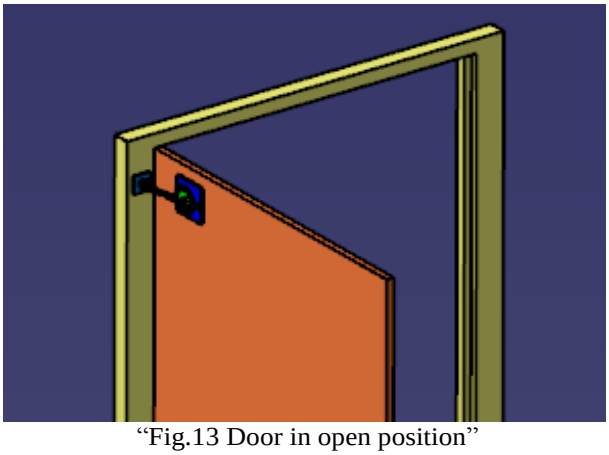
"Fig.12 Gear arrangement with base plate"

3.4 Links with Arm link

To gear connecting link-1 is fixed and to that connecting link-2 .At bracket hinge connecting link -2 connected provide rotation motion which is paraell to door.Connecting link-1 ,connecting link-2 and hinge point of bracket in horizontal line and parallel to door panel. Bracket connected to the door frame by nut and bolt.

4. Principle of door closer

As we assume the door gets open manually by push or pull action only 90º for calculation . The connecting link-1and connecting link-2 get rotate parallel to door by 90º. Which rotate the gear. The shaft connected to the gear which complete the half rotation of driver gear and proportionate rotatation of pinion gear.



"Fig.13 Door in open position"

Here the gear ratio of 3 is maintain. Due to pinion gear rotation compression of spring take place which store energy.That energy is used to close the door automatically. The force generated by the compressed spring provides precise control in the door closing

cycle. i.e. closing force and energy stored in them is called closing moment .Closing moment is different for different sizes of door i.e. depend upon the door width and door weight .

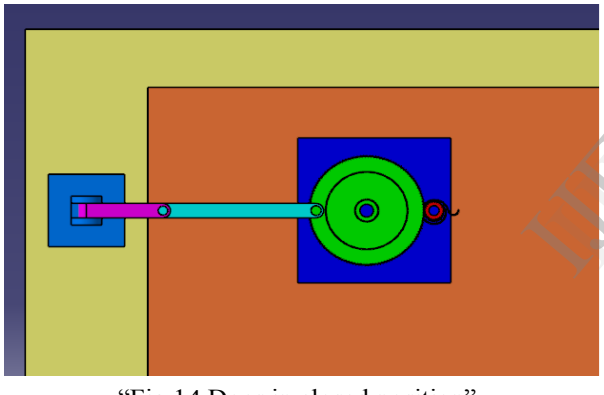
5. Working of door closer

Each door closer having different spring assembly provides a closing force on which a Door Closer Works.

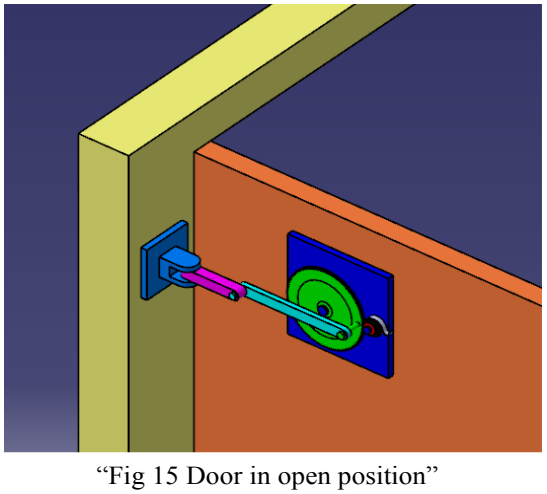
The basic function of a door closer is to provide a smooth,controlled closing action to the door after the door has been opened and released. A modern compression spiral spring with gear arrangement provides the function in the following manner.

As the door is opened, by pulling or pushing action according to A.D.A. standard[2],[7] the link moves as the door open .Link transmit the motion to gear train assembly ,in which drive gear rotate the pinion gear in a proportionate ratio. This compresses the spring which provide the energy necessary to close the door.

In the door opening cycle, the gear teeth of the driver rotate the pinion/shaft. The compressed spring get compressed. The gear ratio and spring tension controlling the door closing speed.



"Fig 14 Door in closed position"



"Fig 15 Door in open position"

During the closing cycle the applied force released ,the compressed spring start releasing and the reverse or back action start. The compressed spring rotate the pinion gear and driver gear in reverse direction. Due to closing force of the spring the door get automatically close.

6.Conclusion

The present study is centered toward the design of a door closer that would conveniently alleviate the problem of oil leakage which effect the life of the product.This is inovative design.To verify the mechanism provide to the arrangment working model has been fabricated which run successfully . The analysis of the arrangement done but that is not given in this paper. Some modification also required in this arrangement by which the force required for latching we get .

7.Result

By using this new design we tried to develop the new mechanisum which is simple in construction ,parts available in a market ,replacement of single part done and that's why it is long life product.

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