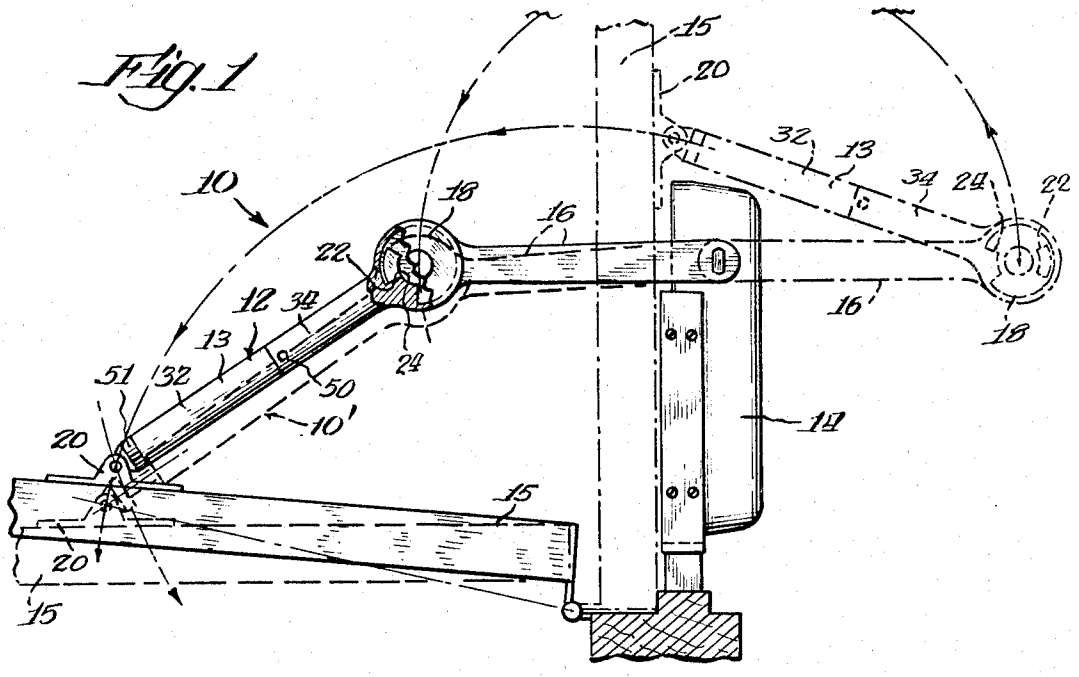
April 23, 1968 R. C. FLINT ETAL 3,378,878

DECELERATOR AND DEAD STOP

Filed March 4, 1966 3 Sheets-Sheet 1

Fig. 1



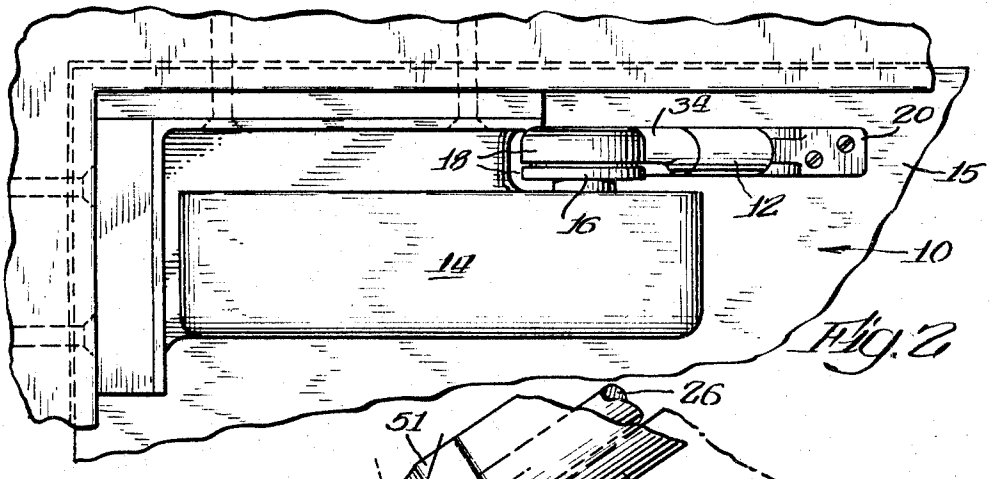
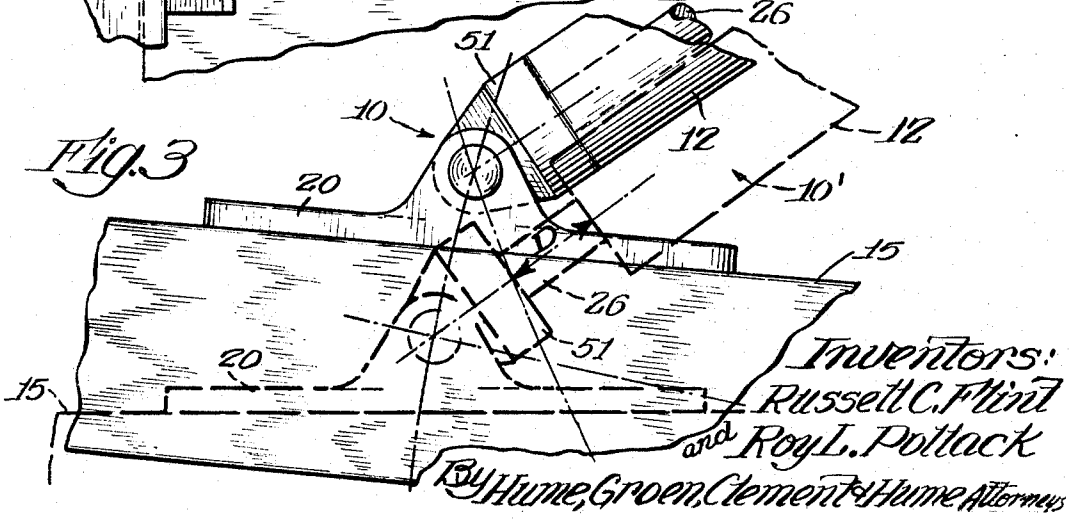


Fig. 2

Fig. 3



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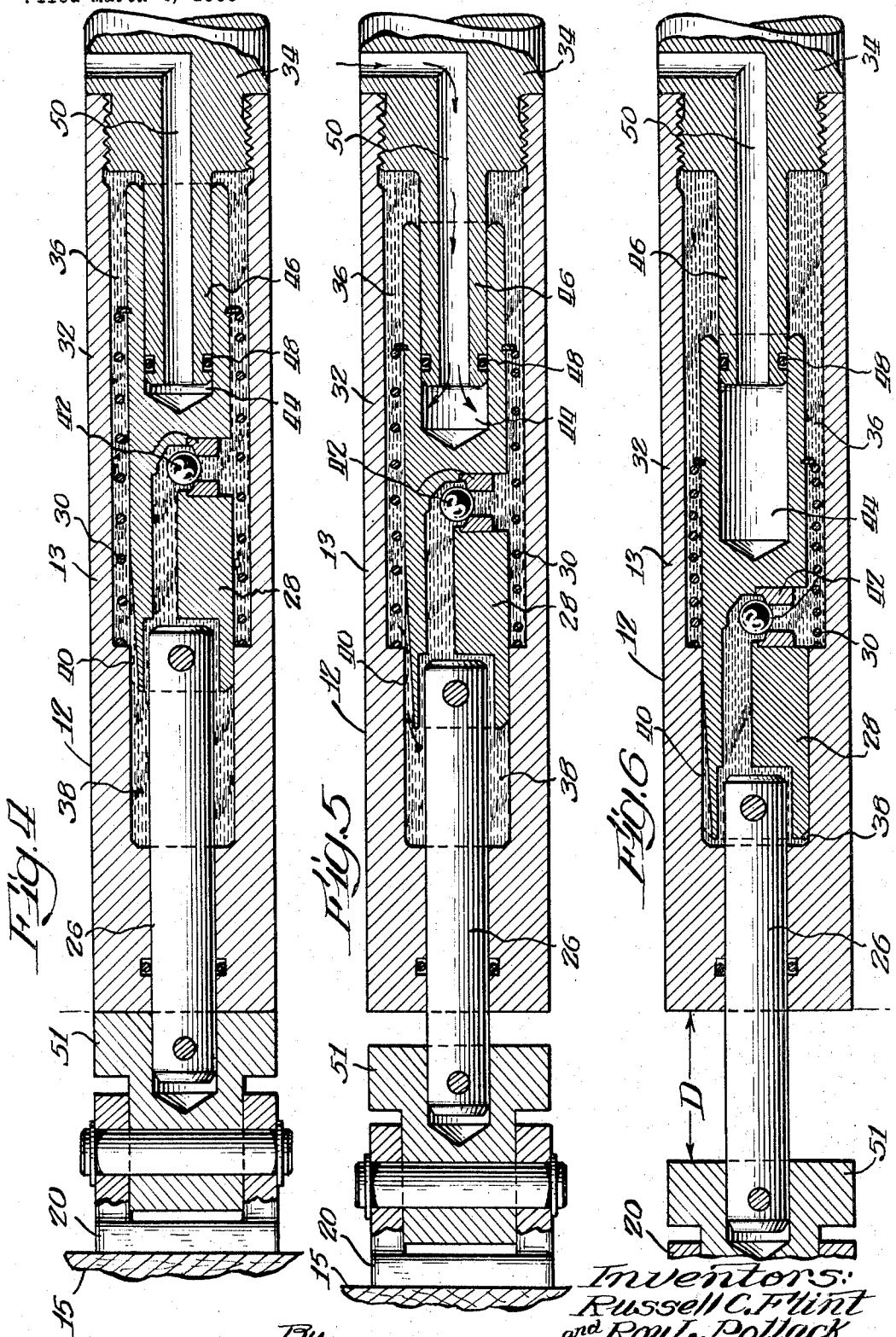

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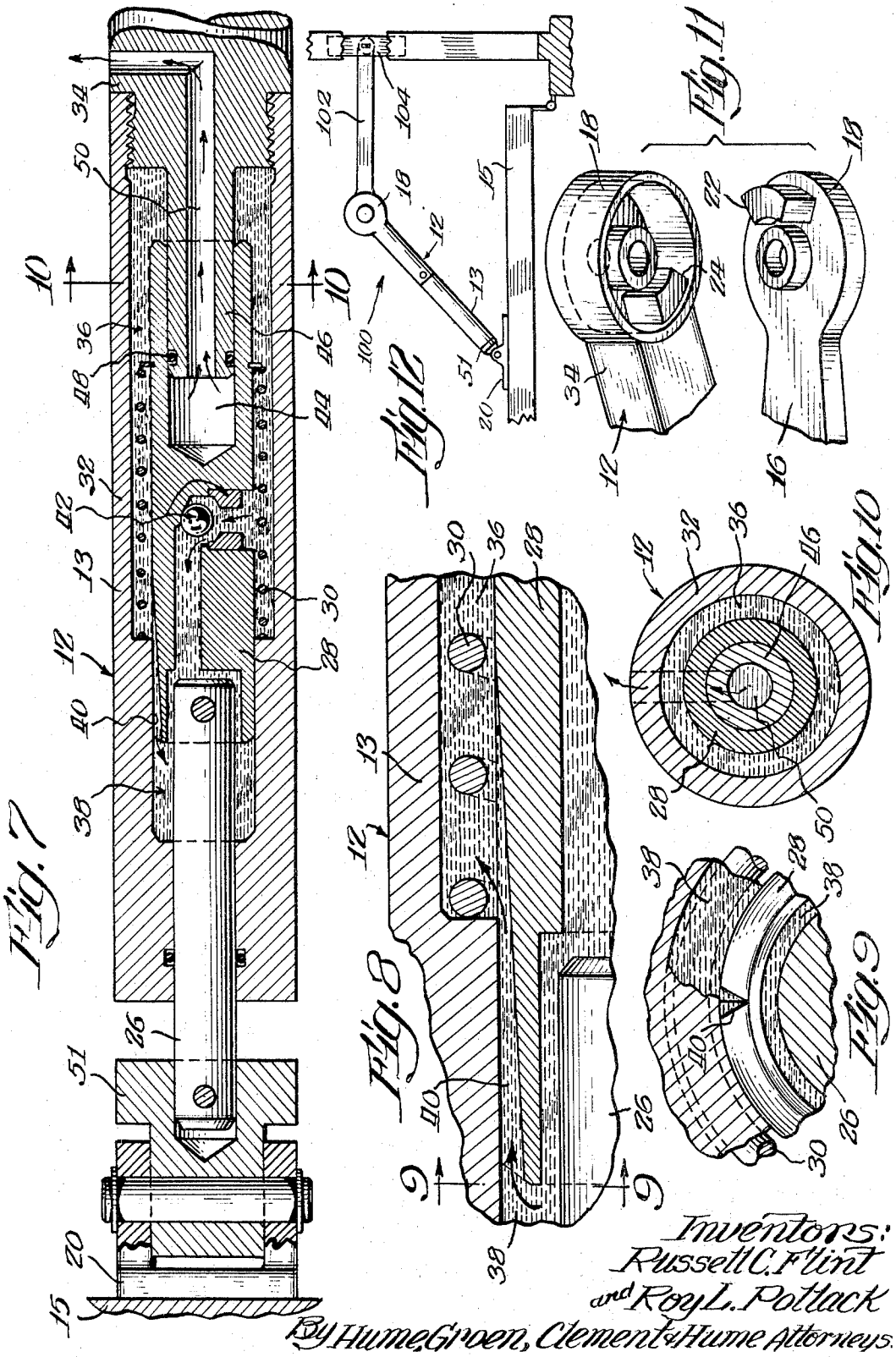
DECELERATOR AND DEAD STOP

Filed March 4, 1966 3 Sheets-Sheet 3



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DECELERATOR AND DEAD STOP

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The present invention relates to a dead stop for doors or the like, and more particularly to a hydraulic decelerator and dead stop.

There are many situations in which it is desirable to "dead stop" the opening of a door or the like at a given angle of opening. For example, it may be required that the door be prevented from opening beyond a certain maximum angle so as not to interfere with an adjacent lane of traffic or door, or so as not to strike a wall or furniture. However, the door must be able to open freely to within a few degrees of this maximum angle. Present dead stops are provided by mechanical door holders or shock absorbers. These devices employ mechanical means such as springs, which are not effective to absorb the shock of stopping the opening movement of the door in the last five degrees or so of door opening. Accordingly, when wind or traffic throws a door open, these mechanical devices cause a nearly instantaneous stopping of the door which results in frequent breaking of glass and/or damage to the door including the hinges thereof.

It is a general object of the present invention to provide a new and improved dead stop and decelerator therefor which overcomes the above stated and other problems.

It is an object of the present invention to provide means for decelerating a door more smoothly to a maximum opening angle without shock or damage.

It is a further object of the invention to provide a combined door closer and hydraulic decelerator and dead stop in which the decelerator operates on a door only as the door closely approaches the desired dead stop position, yet provides a controlled, safe, deceleration of the door.

It is another object of the invention to provide a door holder with a hydraulic decelerator and dead stop having the above-mentioned advantages.

It is a more specific object of the present invention to provide a hydraulic door decelerator with a closed hydraulic system which does not require a separate fluid reserve chamber and does not develop a vacuum in the hydraulic system during its operation.

The invention, together with further objects and advantages thereof, will be better understood by reference to the following description taken in connection with the accompanying drawings, in which:

FIG. 1 is a top view of an exemplary decelerator and dead stop in accordance with the present invention, showing it as part of a door closer in this example;

FIG. 2 is a front view of the door closer of FIG. 1, with the door closed;

FIG. 3 is an enlarged portion of the view of FIG. 1;

FIG. 4 is a central cross-sectional view of the forearm of the door closer of FIGS. 1 and 2, illustrating the decelerator in its normal or unoperated condition;

FIG. 5 is the same view as FIG. 3, showing the decelerator as a door is being decelerated thereby;

FIG. 6 is the same as FIGS. 4 and 5, showing the decelerator where the door is in a fully dead stoped position;

FIG. 7 is the same as FIGS. 4–6, showing the decelerator during its return stroke or recovery movement as the door closes;

FIG. 8 is an enlarged portion of FIGS. 4–7, illustrating the variably restricted hydraulic path or V slot;

FIG. 9 is a cross-sectional view taken along the line 9—9 in FIG. 8;

FIG. 10 is a cross-sectional view taken along the line 10—10 in FIG. 7;

FIG. 11 is an exploded perspective view of the arm hub of the door closer of FIGS. 1 and 2, illustrating the respective stop; and

FIG. 12 shows a top view of another embodiment of the invention providing a door holder.

Turning now to the drawings, and referring particularly to FIG. 1, there is shown therein an exemplary door closer **10** having an integral decelerator and dead stop in accordance with the present invention. The forearm **12** of the door closer **10** incorporates a controlled hydraulic decelerator **13** which begins operation only as the door opening approaches the desired dead stop position (maximum opening angle). The component movements in the decelerator **13** during its operation are clearly illustrated in various above-identified views in the drawings. The decelerator **13** preferably acts only in approximately the last five degrees of door opening prior to the actual dead stop, yet in this brief operating period smoothly and completely decelerates the door and prevents damage to either the door closer or to the door itself.

Considering the door closer **10** as a whole, it includes a housing **14** which may be fixed to the vertical side jam of a door **15** or other suitable location. An elongated main arm **16** is rotatably mounted at one end to the door closer housing. The door closer housing **14** preferably is a known door closer mechanism, and need not be described herein. It provides a torque on the main arm **16** tending to pull the door closed and also provides a dampening of the closing movement of the door. The end of the main arm **16** opposite the end at the housing **14** preferably forms part of an arm hub **18**. The arm hub **18** provides a pivotal connection between an end of the forearm **12** and an end of the main arm **16**. The hub **18** allows the arms to freely unfold with respect to one another and extend as the door is opened. The end of the forearm **12** opposite the arm hub **18** preferably pivotally connects with a shoe **20** which is mounted to the door **15** at a location spaced substantially from the door hinges.

Referring to FIG. 11, it may be seen that the arm hub **18** preferably contains a mechanical restrictive stop therein. This restrictive stop prevents angular rotation of the forearm **12** with respect to the main arm **16** beyond a predetemined maximum angle. FIGS. 1 and 3 show the door closer **10** component positions as this dead stop angle of the opening door **15** is reached. The surface **22** on the main arm **16** in the hub **18** is rotated into abutment with the surface **24** on the forearm **12** to provide a restrictive stop. The two arms are thus no longer pivotable with respect to each other and further door opening is not allowed in this manner. Thus without the decelerator **13** the door would be instantly dead stopped at the dead stop angle. However, the decelerator **13** begins its operation at this position and provides a small additonal movement D in which a safe and controlled deceleration is provided. The arm positions in the fully open or completely dead stopped portion of the door are shown by the dotted outline **10'** in FIG. 1.

Considering now the forearm **12** and the hydraulic decelerator **13** therein, it may be seen that the decelerator **13** replaces the conventional rigid forearm connecting the door shoe **20** and the arm hub **18**. In fact for any door movement except movement beyond the dead stop angle the forearm **12** serves as a conventional non-extendable forearm. Only when the door is forced beyond the dead stop angle does the decelerator **13** operate.

Considering the specific structure of the exemplary decelerator 13 it may be seen that a piston rod 26 extends from the decelerator and is pivotally connected at one end thereof to a shoe connector 51 which is in turn pivotally connected to the shoe 20. This is the sole connection between the shoe 20 and forearm 12. The opposite end of the piston rod 26 is connected to a piston 28 inside the decelerator 13. The piston 28 and the piston rod 26 are axially movable with respect to the decelerator 13 so as to be extendable or retractible from the forearm 12, thereby effectively extending or retracting the overall length of the forearm 12. However, the piston 28 is normally held in a fully retracted position by a strong coil spring 30.

Preferably the principal portion of the forearm 12 comprises an elongate cylinder body 32. One end of the front cylinder body 32 is preferably tightly screwably engaged to an end member 34, which end member is integral with the arm hub 18. The other end of the cylinder body 32 preferably normally abuts the shoe connector 51.

Preferably the cylinder body 32 contains a large cylindrical fluid chamber 36 which communicates with a smaller cylindrical chamber 38. Both the chamber 36 and chamber 38 are completely filled with hydraulic fluid and are completely sealed. All hydraulic fluid in the decelerator is confined within these two chambers. It may be seen that the piston 28 is dimensioned in diameter to fluid tightly slidably fit the smaller chamber or dashpot 38. The principal portion of the piston 28 is located in the fluid chamber 36 and as the decelerator 13 is operated the piston 28 advances into the smaller chamber 38, exerting pressure against the fluid therein. The sole outlet from the smaller chamber 38 for the fluid compressed therein is a tapered V slot 40 cut axially along the surface of the piston 28. Thus as the piston 28 is pulled into the chamber 38 by the piston rod 26 all displaced hydraulic fluid must flow out through the V slot 40 into the larger fluid chamber 36. The V slot 40 is tapered so that as the piston moves into the smaller chamber 38 the opening offered by the V slot becomes progressively smaller in area, thus allowing a much smaller flow of liquid to pass therethrough. This has the effect of progressively slowing down the allowable piston velocity and thereby causing an increasing deceleration of the door 15. As the piston approaches the end of its opening travel (at the position 10') the V slot 40 becomes so small so as to permit almost no fluid flow at all, and accordingly, the door motion must stop completely.

As the door closes it is desired that the piston 28 return rapidly to its original retracted position. This is allowed by having an unrestricted fluid return to the smaller chamber 38 from the chamber 36 through a one way ball check valve 42 located in the piston. The ball in the check valve 42 is seated by gravity and by fluid pressure thereagainst as the door opens. As shown in FIG. 7, on the return stroke, as the door closes, the ball valve 42 automatically unseats and allows fluid to pass unrestrictedly from the chamber 36 to the smaller chamber 38, thereby providing an unrestricted return stroke of the piston 28.

Another feature of the decelerator 13 is that it preferably has a completely closed hydraulic system and does not require either a separate fluid reservoir or the admission of air into the hydraulic chamber. Further no vacuums are created at any time anywhere in the system, even though only a single piston rod is provided. This greatly reduces fluid sealing problems and eliminates air leakage into the system. To achieve this result a constant total volume is maintained in the sealed system throughout the decelerator operation. Thus the fluid movement consists simply of a transfer of fluid from one side of the piston to the other through the V slot 40 or check valve 42.

The maintenance of a constant total volume for the sum of the volumes in the chambers 36 and 38 is preferably provided by the disclosed arrangement wherein the piston 28 is substantially elongated and has axially therein an elongated cylindrical air chamber 44. Fixed to the end member 34 and extending axially therefrom into the air chamber 44 is a tube 46. The tube 46 is thereby fixed in position with respect to the cylinder body 32, and the piston 28 moves axially with respect to it. The tube 46 preferably has an exterior configuration which defines a cross-sectional area exactly equal to that of the piston rod 26 over that portion of the piston rod 26 which moves into and out of the chamber 38 during the operation of the decelerator. Preferably there is an O ring seal 48 near the outermost projecting end of the tube 46 to provide a fluid tight seal between the interior surface of the air chamber 44 and the exterior of the tube 46.

The tube 46 has a large passageway 50 extending completely therethrough. The passageway 50 extends to the exterior surface of the end member 34 and communicates with the atmosphere. Thus through the passageway 50 the air chamber 44 is in continuous unobstructed communication with the atmosphere. As the piston 28 is moved in or out with respect to the cylinder body 32 and end member 34, air moves in or out through the passageway 50 to prevent either a pressure or vacuum from forming in the air chamber 44, and thereby to prevent air from being forced into the fluid chamber 36, or fluid from being drawn from the chamber 36 into the air chamber 44.

As the decelerator 13 is operated the piston rod 26 is partially drawn out of the smaller chamber 38. This reduces the volume of the piston rod 26 which is occupying space in the chamber 38. This would result in an overall volume increase in the system and thereby a vacuum except that for the fact that simultaneously with the withdrawal of the piston rod 26 from the chamber 38 an equal length of the tube 46 is drawn out from the air chamber 44 into the fluid chamber 36, thus maintaining constant the total volume in the two chambers 36 and 38.

Summarizing now the overall operation of the door closer and dead stop 10, it may be seen from FIG. 1 that with the door closed the pair of arms 12 and 16 are initially substantially folded together. Assuming by way of example a desired positive dead stop at a 90° door opening, the arm hub 18 is adapted to provide a restricted stop at approximately 85° of door opening, i.e. at approximately 85° the forearm 12 and main arm 16 are prevented from rotating further with respect to each other at the arm hub 18.

The wind or other force attempting to further open the door exerts a substantial tension force on both the forearm and main arm 16 once the restrictive stop is reached. The door, through the shoe 20 and shoe connector 51, pulls on the piston rod 26. This tension overcomes the force of the coil spring 30 and begins to pull the piston 28. The above described graduated hydraulic resistance provides a controlled smooth deceleration, with the resistance to the piston movement progressively increasing until the hydraulic resistance is great enough to overcome even a very strong force opening the door and bring the door to a complete stop. Yet due to the gradual nature of the increased resistance, door stoppage is achieved without damaging shock under any normally encountered circumstances. It may be seen that where the decelerator 13 operates only in the range between 85° and 90° of door opening the door stoppage must be accomplished in the small angular distance of only 5°. Yet with the disclosed device this provides a sufficient distance for controlled deceleration. Further, there remains an ample reserve piston travel in the device to cover severe applications. Part of the energy absorbing ability of the device lies in the favorable leverage position provided by its location in the forearm.

When the door is released the spring 30 acts to return the piston 28 rapidly to its original retracted position,

assisted by the check valve 42. As the door returns to less than 85° of opening the decelerator 13 automatically becomes inoperative and the normal door closer operation occurs. Regardless of the door operation and even under the most severe piston excursions the hydraulic fluid is confined completely in a constant volume chamber which is not subject to a vacuum or the introduction of air at any time during its operation.

The decelerator and dead stop described herein is well suited for use with a door closer or door holder having a hold open action. Such hold open action may be provided by various well known or other suitable mechanisms, such as a mechanical retention in the arm hub on elbow 18 holding the arms in the fully open position.

FIG. 12 shows the use of the decelerator and dead stop of the invention in a door holder 100 rather than in a door closer. It may be seen that the same forearm 12 and decelerator 13 may be employed, which may operate in the same manner. The main arm 102 differs in that it is pivotally connected to a mounting bracket 104 on the door stop or door holder, rather than connected to a door closer. The mounting bracket 104 provides a door frame mounting means for the arms as does the door closer housing.

It will be appreciated that while the above described embodiments of the invention are preferred, numerous variations and modifications thereof will be apparent to one skilled in the art and it is intended to cover in the appended claims all such variations and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A door decelerator and dead stop comprising:
door frame mounting means;
door mounting means;
an articulated pair of elongated arms extending between said door frame mounting means and said door mounting means;
restrictive stop means limiting the maximum angular displacement between said pair of arms;
a short stroke hydraulically restrained piston extendable and retractible from one of said arms, said piston being extendable from said arm only after said maximum angular displacement between said pair of arms has been reached;
and spring retaining means in said one arm pulling said piston into retraction.

2. The door decelerator and dead stop of claim 1 wherein said piston is hydraulically resisted in extension by a hydraulic resistance which increases progressively with extension.

3. A door decelerator and dead stop comprising:
door frame mounting means;
door mounting means;
an articulated pair of elongated arms pivotally connected to and extending between said door frame mounting means and said door mounting means;
one of said elongated arms being adapted for extension and retraction in length; and
hydraulic means in said one arm progressively hydraulically resisting said extension,
said hydraulic means including a sealed hydraulic fluid confining enclosure, a piston operating in said enclosure, and a piston rod connected to said piston and extendable and retractible from said enclosure,
said hydraulic means having compensating means maintaining a constant volume in said fluid confining chamber as said piston extends and retracts.

4. The door decelerator and dead stop of claim 3 wherein said compensating means includes an air chamber in said piston freely communicating with the atmosphere through a tubular member fixed in said enclosure, said tubular member slidably extending into said air chamber and having a cross-sectional area equal to that of said piston rod.

5. The door decelerator and dead stop of claim 4 wherein said door frame mounting means is a door closer housing.

6. A door decelerator and dead stop comprising:
a door frame mounting means;
door mounting means;
an articulated pair of elongated arms extending between said door frame mounting means and said door mounting means;
said pair of arms having a preset maximum angular opening therebetween at which said arms become fixed from further angular opening movement therebetween,
one of said elongated arms being adapted for extension and retraction in length;
hydraulic decelerator means in said one arm hydraulically resisting said extension,
said hydraulic decelerator means being operative only after said preset maximum angular opening between said pair of arms has been reached,
and retaining means in said one arm normally holding said arm in retraction.

7. The door decelerator and dead stop of claim 6 wherein one of said elongated arms is connected to a hydraulic door closer.

8. The door decelerator and dead stop of claim 6 wherein said hydraulic decelerator means hydraulically resists said extension increasingly with said extension.

9. The door decelerator and dead stop of claim 6 wherein said hydraulic decelerator means has a sealed hydraulic system and includes means for maintaining a constant total volume in said hydraulic system throughout the operation of said hydraulic decelerator means.

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