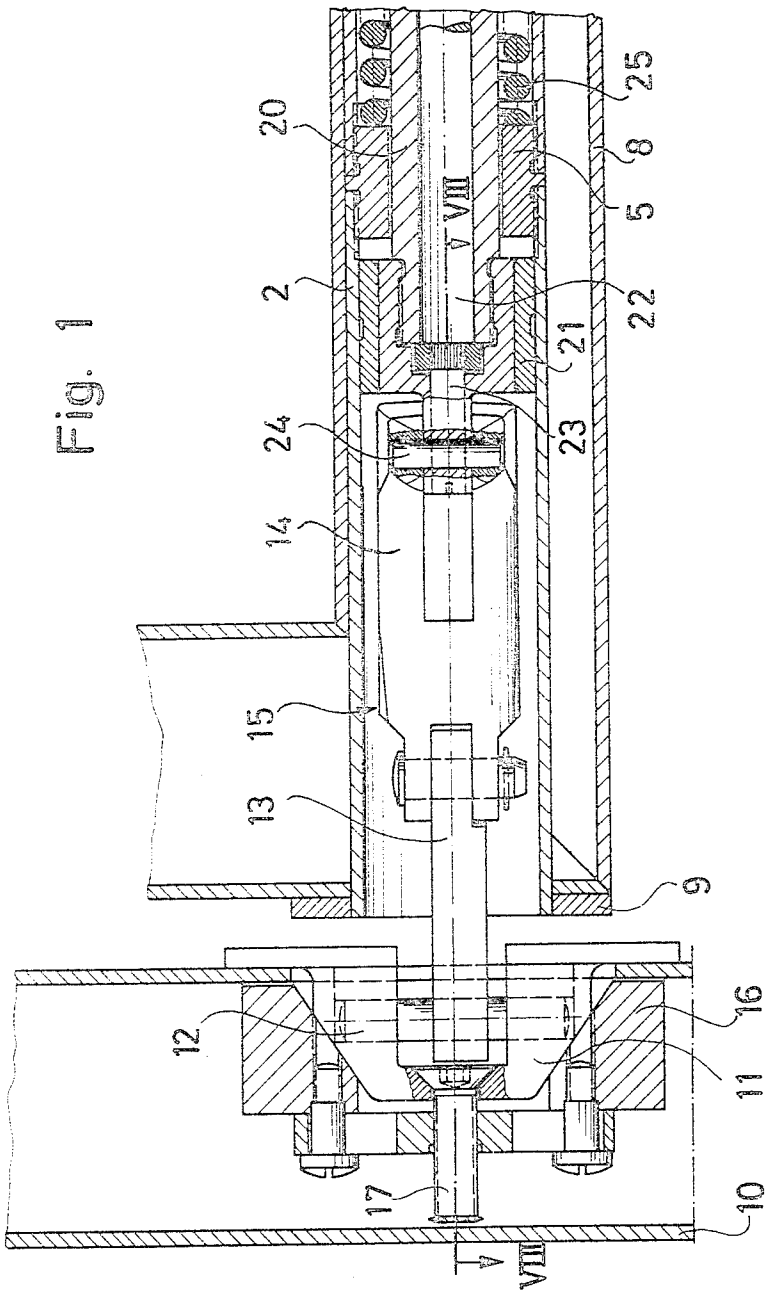
Dec. 16, 1969 R. VÖSTER ETAL 3,483,585

DOOR CLOSER WITH MEANS FOR DAMPING THE CLOSING MOVEMENT OF THE DOOR

Filed Nov. 7, 1967 6 Sheets-Sheet 1

Fig. 1



INVENTORS:
Bernhold Föster
Carl Dietz
BY Michael S. Striker,
ATTORNEY

Dec. 16, 1969 R. VÖSTER ET AL 3,483,585

DOOR CLOSER WITH MEANS FOR DAMPING THE CLOSING MOVEMENT OF THE DOOR

Filed Nov. 7, 1967 6 Sheets-Sheet 2

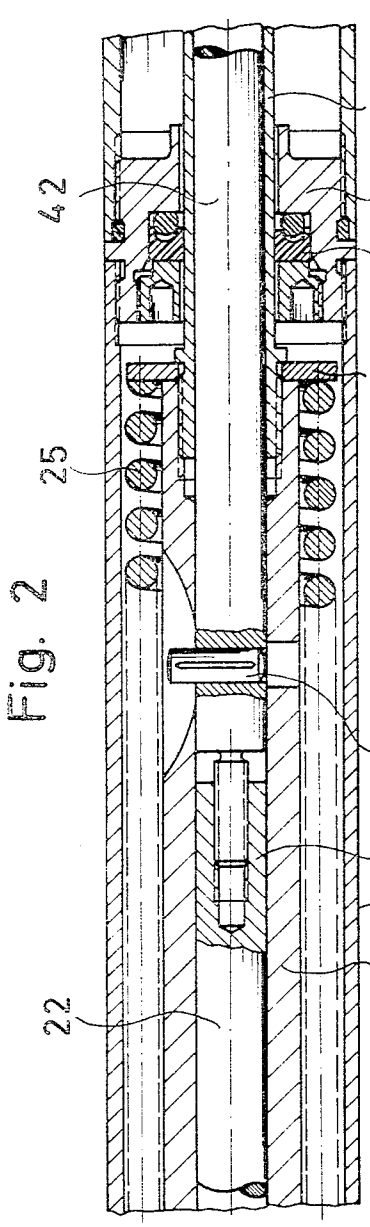


Fig. 2

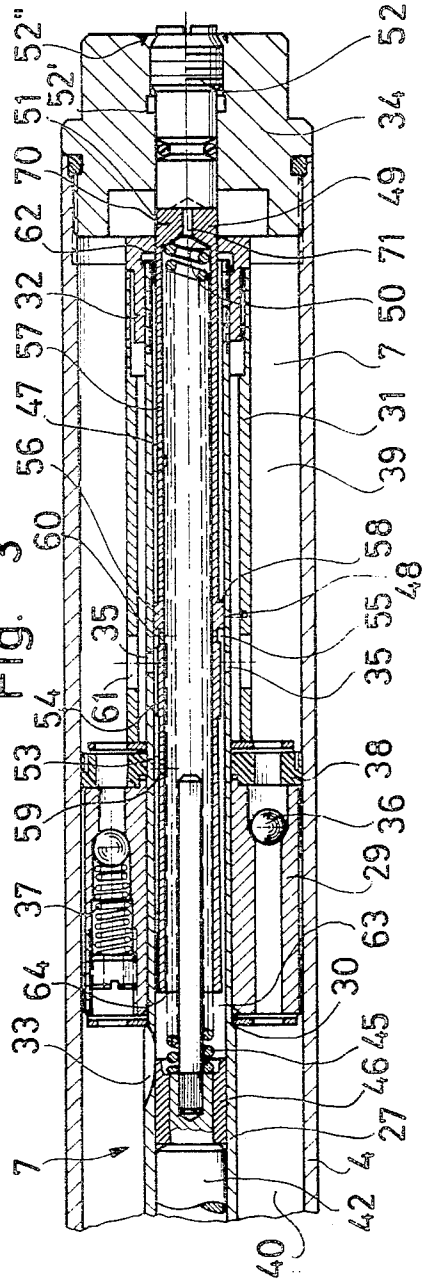


Fig. 3

INVENTORS;
Reinhold Vöster
Carl Dietz
BY Michael S. Striker,
ATTORNEY

Dec. 16, 1969 R. VÖSTER ETAL 3,483,585

DOOR CLOSER WITH MEANS FOR DAMPING THE CLOSING MOVEMENT OF THE DOOR

Filed Nov. 7, 1967 6 Sheets-Sheet 3

Fig. 3

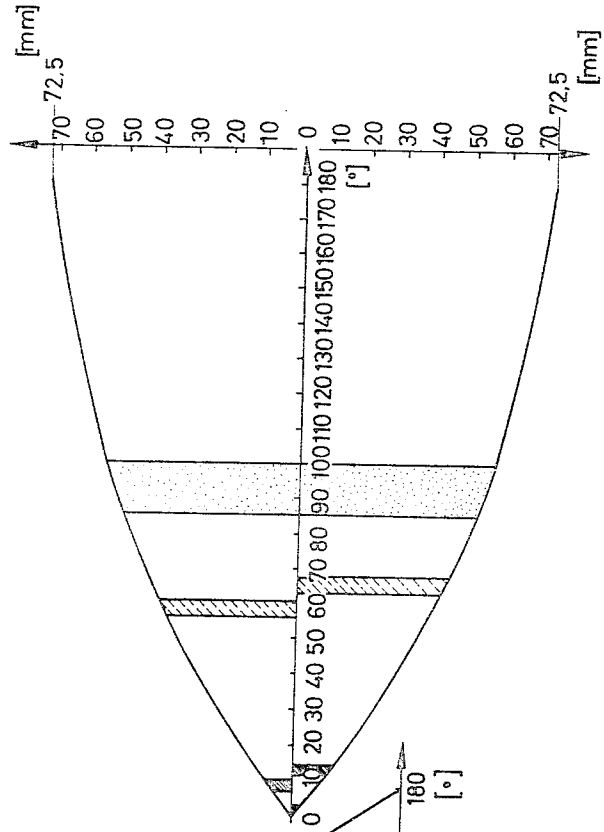
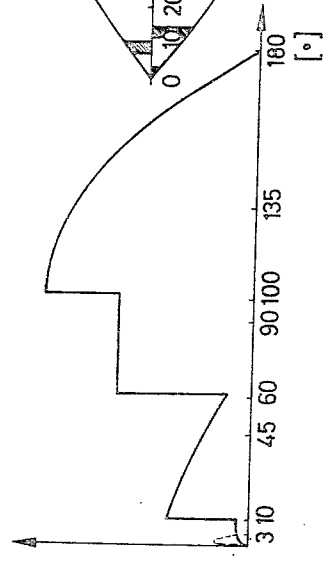


Fig. 4



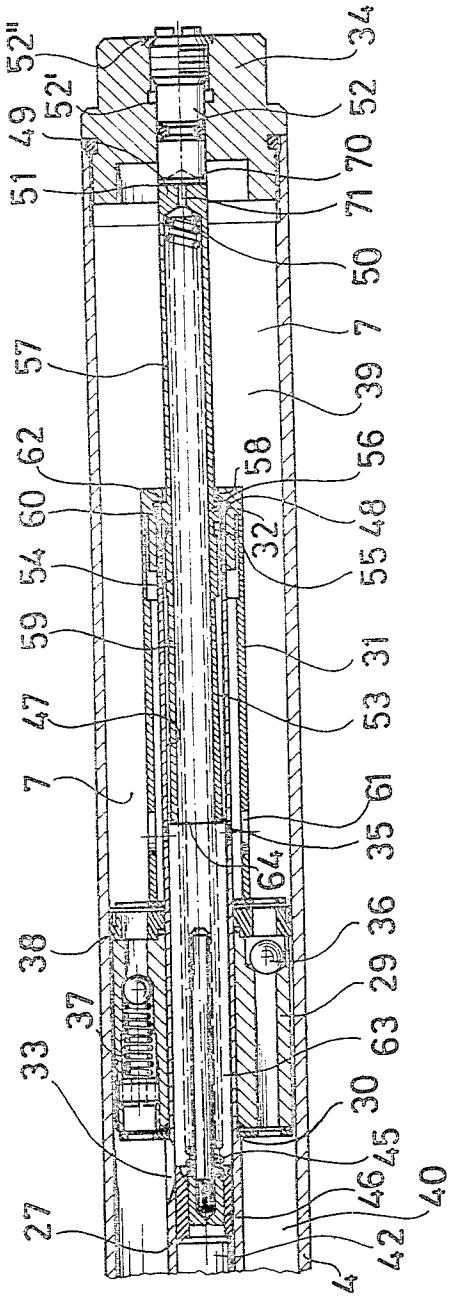
INVENTORS:
Reinhold Vöster
Carl Dietz
BY Michael S. Striker
ATTORNEY

Dec. 16, 1969 R. VÖSTER ETAL 3,483,585

DOOR CLOSER WITH MEANS FOR DAMPING THE CLOSING MOVEMENT OF THE DOOR

Filed Nov. 7, 1967 6 Sheets-Sheet 4

Fig. 5

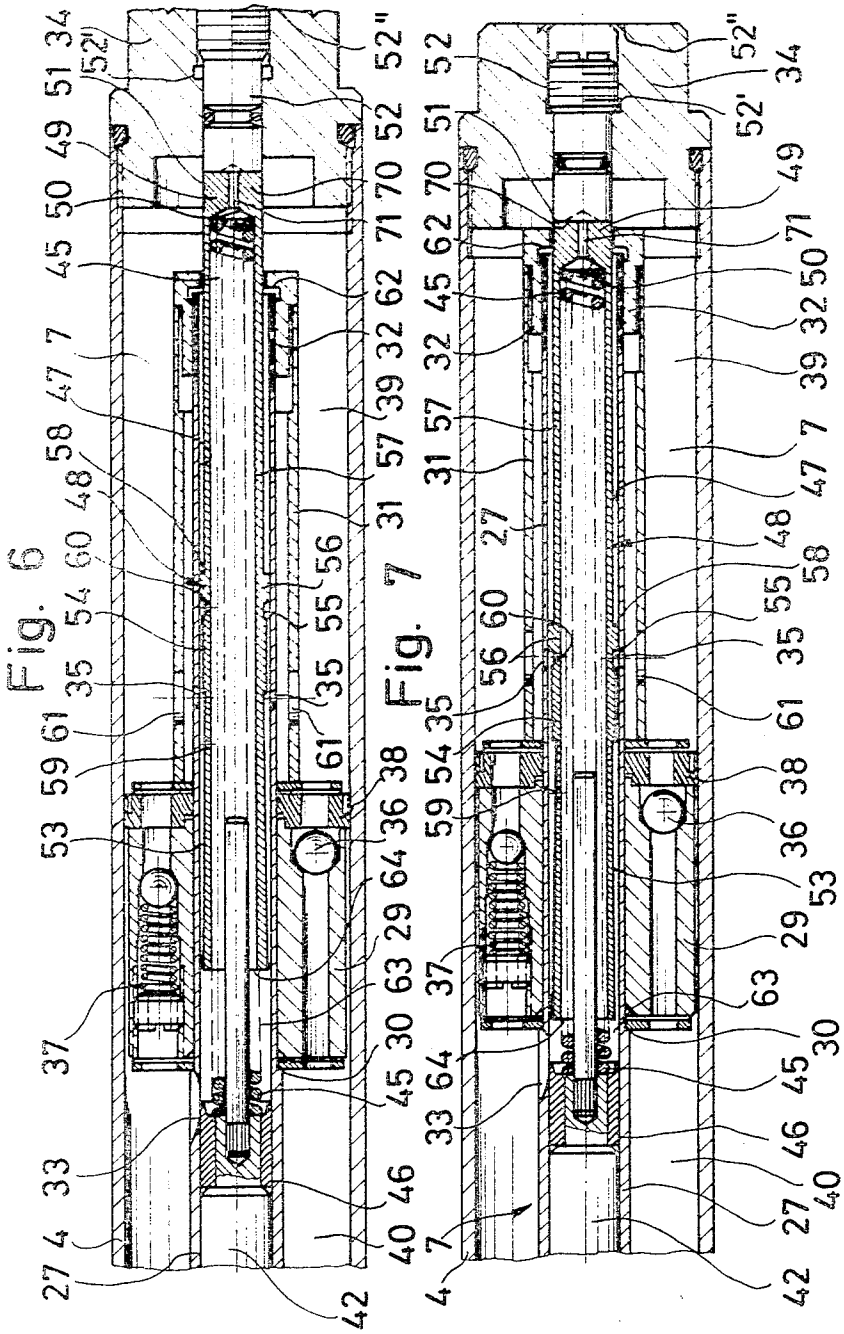


INVENTORS,
Bernhold Vöster
Carl Dietz
BY Michael S. Striker,
ATTORNEY

Dec. 16, 1969 R. VÖSTER ETAL 3,483,585

DOOR CLOSER WITH MEANS FOR DAMPING THE CLOSING MOVEMENT OF THE DOOR

Filed Nov. 7, 1967 6 Sheets-Sheet 6



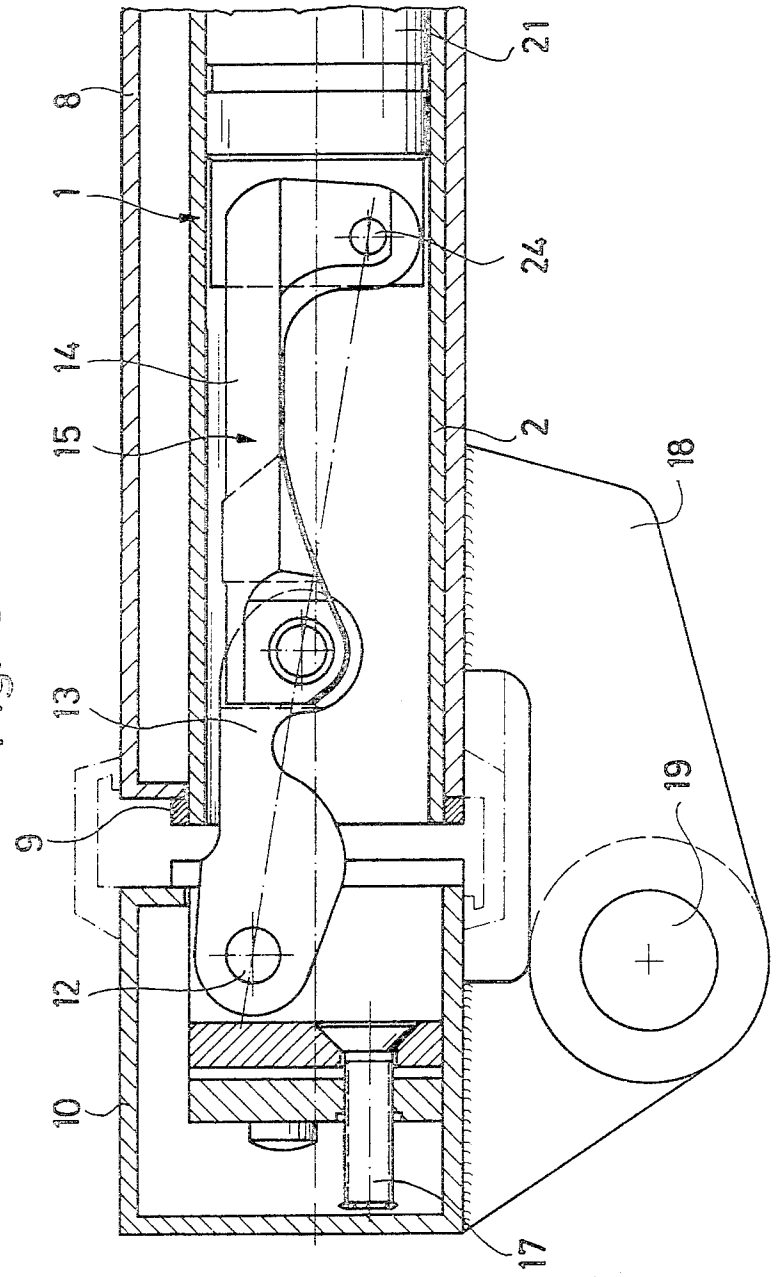
INVENTORS;
Reinhold Vöster
Carl Dietz
BY Michael S. Striker
ATTORNEY

Dec. 16, 1969 R. VÖSTER ETAL 3,483,585

DOOR CLOSER WITH MEANS FOR DAMPING THE CLOSING MOVEMENT OF THE DOOR

Filed Nov. 7, 1967 6 Sheets-Sheet 6

Fig. 8



INVENTORS:
Reinhold Vöster
Carl Dietz
BY Michael S. Striker
ATTORNEY

United States Patent Office 3,483,585 Patented Dec. 16, 1969

3,483,585

DOOR CLOSER WITH MEANS FOR DAMPING THE CLOSING MOVEMENT OF THE DOOR

Reinhold Vöster, Stuttgart-Degerloch, and Carl Dietz, Stuttgart, Germany, assignors to Vereinigte Baubeschlagfabriken Gretsch & Co. G.m.b.H., Leonberg, Wurttemberg, Germany

Filed Nov. 7, 1967, Ser. No. 681,151
Claims priority, application Germany, Nov. 12, 1966, V 32,344, V 32,346
Int. Cl. E05f 3/02
U.S. Cl. 16—52 19 Claims

ABSTRACT OF THE DISCLOSURE

A door closer including an elongated damping cylinder adapted to be mounted in a door, a piston connected to the door frame and arranged in the damping cylinder so as to be reciprocated therein during turning of the door about its turning axis, and control means extending in the cylinder to opposite sides of the piston for throttling flow of damping fluid from one to the other side of the piston during closing movement of the door to a varying degree depending on the turned position of the door relative to the doorframe.

BACKGROUND OF THE INVENTION

The present invention relates to a door closer having a piston subjected to the action of a closer spring and provided with a one-way valve. The piston is reciprocably arranged in a damping cylinder and movable by a tubular piston rod connected to the piston. An elongated control member extending through the piston is slidably guided in the tubular piston rod and defines between the inner surface of the tubular piston rod and the outer surface of the control member an annular throttling gap of a cross section which varies along the length of the control member.

Such tubular or telescoping door closers are known in the art and they can be easily incorporated at any height into a door, especially into a metal door. The closer spring is arranged to be tensioned during opening of the door so that when the door is released it will return under the action of the closer spring to its closed position. Especially in doors which may be turned from the closed position through an angle of substantially 180°, the closer spring will be considerably stressed in the open position of the door so that the door would close at high speed if the closer would not be provided with a damping device. In known door closers of the aforementioned kind which are provided with a damping device, it is however not possible to change the closing speed of the door in accordance with the door opening angle and these known door closers are therefore suitable only for doors which are provided with a latch adapted to hold the door in closed position.

Furthermore, known door closers of the aforementioned kind create, especially during fast opening of the door, a partial vacuum in the damping cylinder to one side of the piston therein, since the damping medium which is usually a damping fluid, for instance oil, cannot flow fast enough from the other side of the piston into the cylinder space at the one side of the piston. Due to this partial vacuum the damping liquid will partially evaporate and the thus forming gas will prevent a quick start of the damping action when the door closes again, since the damping will start only after the gases have been again absorbed in the damping liquid.

It is an object of the present invention to overcome the aforementioned disadvantages of door closers provided with damping means of the aforementioned kind.

It is a further object of the present invention to provide a door closer with damping means in which the damping action will start substantially at the moment the door begins to close.

It is also an object of the present invention to provide a door closer of the aforementioned kind which can be advantageously used with doors provided with a latch as well as with doors having no latch.

It is an additional object of the present invention to provide a door closer in which the closing speed may be controlled in dependence on the opening angle of the door.

It is yet an object of the present invention to provide a door closer of the aforementioned kind which prevents jamming of the control member in the tubular piston rod and in which control of the closing speed will be substantially independent of temperature conditions.

Finally, it is also an object of the present invention to provide a door closer of the aforementioned kind which is simple in construction so that the door closer may be manufactured at reasonable cost and will stand up trouble-free under extended use.

SUMMARY OF THE INVENTION

With these objects in view, the door closer according to the present invention mainly comprises a damping cylinder adapted to be mounted in a door and having a longitudinal axis extending substantially normal to the turning axis of the door, a piston reciprocably arranged in the damping cylinder and dividing the interior of the latter into a first space between one of the closed ends of the cylinder and the piston, and a second space between the piston and the other closed end of the cylinder, a hollow piston rod fixedly carrying the piston and projecting to opposite sides of the latter and having one end extending fluid-tightly sealed through one of the closed ends of the cylinder, lever means connected to the one end of the piston rod for moving the latter in a direction away from the other closed end of the cylinder during opening movement of the door and in the opposite direction during closing movement of the door, biasing means connected to the piston rod for biasing the same in the aforementioned opposite direction, a one-way valve in the piston, permitting free flow of fluid from the first into the second space during movement of the piston rod in the one direction while preventing flow of fluid from the second into the first space during movement of the piston rod in the opposite direction, a throttle opening through the wall of the hollow piston rod between the one side of the piston and the one closed end of the cylinder and providing communication between the interior of the piston rod and the first cylinder space, an elongated control member having a cross section varying along its length and being telescopically arranged in the hollow piston rod to define with the inner surface of the latter an annular throttle gap, and second biasing means cooperating with the control member and biasing the latter in abutment with a portion of the second closed end of the cylinder so that the control member will, during part of the stroke of the piston, remain in abutment with said portion of said closed end of the cylinder.

The arrangement in which the control member remains during part of the movement of the piston in engagement with the portion at the other closed end of the cylinder and moves, during opening movement of the door, therefore out of the piston rod, prevents creation of a substantial vacuum for instance up to a door opening angle of 70° in the second cylinder space which could lead to a partial evaporation of the damping liquid therein.

The piston rod is preferably provided with at least one other opening through its wall at the other side of the

piston and providing communication between the interior of the piston rod and the second cylinder space. The control member is preferably in tubular form and has a bottom facing the other closed end of the cylinder. This bottom is formed with a bore therethrough adapted to provide communication between the interior of the tubular control member and the second cylinder space. This bore through the bottom is closed when the bottom abuts against a portion of the other closed end of the cylinder. This arrangement prevents undesirable axial movements of the control member relative to the piston rod under the influence of pressure differences in the two cylinder spaces which could lead to an undesired blocking of the openings in the tubular piston rod and thereby blocking of the door closer. The bore through the bottom of the tubular control member will permit a sufficiently fast pressure equilization between the two cylinder spaces so that the control member will not be moved axially inwardly into the piston rod against the force of the second biasing means during increase of the pressure in the second cylinder space.

To maintain flow of damping liquid through the throttle opening in the piston rod independent of the temperature dependent variations in the door closer of the present invention preferably includes also a throttling body arranged in the region of the throttling opening, and means connecting the throttling body to a portion of the piston rod distant from the throttling opening and changing its length according to the temperature so as to control the free cross section of the throttling opening in dependence on the temperature.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWING

FIGS. 1–3 are three successive portions of the door closer according to the present invention shown in axial cross section of which FIG. 1 is the left portion, FIG. 2 the intermediate portion, and FIG. 3 the right end portion of the closer;

FIG. 4 is a graph illustrating the closing speed of the door in dependence on the opening angle thereof;

FIGS. 5–7 illustrate the various elements of the door closer as illustrated in FIG. 3, likewise in axial cross-section, and in positions differing from the positions shown in FIG. 3;

FIG. 8 is a cross-section taken along the line VIII—VIII of FIG. 1; and

FIG. 9 is a graph illustrating the stroke of the piston in dependence on the opening angle of the door.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings and more specifically to FIGS. 1–3 and 8 of the same, it will be seen that the door closer according to the present invention includes a closer tube **1** which is composed of three axially aligned tube members **2**, **3** and **4** respectively connected at adjacent ends by tube couplings **5** and **6**, whereby the tube member **4** serves as a damping cylinder **7**. The closer tube **1** is mounted in a lower portion of a door **8** and a flange **9** fixed to one end of the tube **1** abuts against an edge face of the door and is connected thereto in any convenient manner. A holding member **11** is fastened by means of clamping jaws **16** and a screw **17** in the interior of an upright portion of a door frame **10**, only partially shown in FIGS. 1 and 8, and lever means **15** comprising two pivotally connected levers **13** and **14** are connected to the holding member **11** by a pivoting bolt **12**. A plurality of arms **18**, only one of which is shown in FIG. 8, are connected at one of the ends thereof to the door and pivotally connected at the other end thereof to corresponding projections extending laterally from the door frame **10** by pivot pins **19** so that the door may turn about the common axis of the latter which is substantially normal to the longitudinal axis of the closer tube **1**.

A tube **20**, located in the closer tube **1** passes with clearance through the coupling **5** and is at one end threadingly connected to a slide member **21** which in turn is axially movable guided in the tube **2**. A rod **22**, guided in the tube **20**, can be turned about its axis by means of an extension **23** projecting through the slide member **21**. The lever **14** is connected by a bolt **24** to the slide member **21** for tilting movement about the bolt axis.

A closer spring **25** is coiled, within the closer tube **1**, about the tube **20** abutting with one end against the pipe coupling **5** and at the other end against a disc **26** located at the right end of the tube **20**, as viewed in FIG. 2. Disc **26** is held in place by a shoulder on a tubular piston rod **27** which is threadingly connected with the right end of the tube **20**. The tubular piston rod **27** extends fluid-tightly sealed by the annular seal **28** through the pipe coupling **6** into the damping cylinder **7**. The piston rod **27** carries a piston **29** slidingly engaging with its peripheral surface the inner surface of the damping cylinder **7**. The piston **29** may be moved onto the piston rod **27** from the free end of the latter until it abuts with one end against a shoulder **30** provided on the piston rod, and a sleeve **31**, engaging the other end of the piston, is pressed toward shoulder **30** by means of a nut **32** which is threadingly connected to the right end of the piston rod **27**, as viewed in FIG. 3. The tubular piston rod **27** is formed between the pipe coupling **6** and the piston **29**, and closely adjacent to the latter, with a slot-shaped trottle opening **33** extending in longitudinal direction of the piston rod and with another opening **35** located at the other side of the piston **29**. The piston **29** divides the interior of the damping cylinder **7** into a first cylinder space **40** located between the pipe coupling **6** and the piston **29** and a second cylinder space **39** located between the piston **29** and a cover **34** threadingly and fluid-tightly connected to the right end of the tube **4**, as viewed in FIG. 3.

The piston **29** is provided with a one-way valve **36** permitting flow of damping fluid from the first cylinder space **40** into the second cylinder space **39** during movement of the piston toward the left, as viewed in FIG. 3, while preventing such flow from the second to the first cylinder space during movement of the piston towards the right. A spring pressed safety valve **37**, likewise provided in the piston **29**, permits flow of fluid from the cylinder space **39** into the cylinder space **40** during movement of the piston toward the right, as viewed in FIG. 3, when the pressure of the damping fluid in the second cylinder space **39** becomes excessive. A seal **38** on the piston **29** seals the latter against the inner surface of the tube **4**. A rod **42** extending into the tubular piston rod **27** is threadingly connected at **41** to the rod **22** and the rod **42** is guided longitudinally movable in the tubular piston rod **27**, but prevented from turning relative to the latter by a pin **43** extending with an end portion into a longitudinal slot of the tube **20**. The rod **42** carries at its right end, as viewed in FIG. 3, a throttling body **46** located in the region of the throttle opening **33** and sealingly engaging the inner surface **47** of the tubular piston rod **27**. The rod **42**, and preferably also the rod **22** threadingly connected thereto, is formed from material, for instance aluminum, which has a relatively high coefficient of expansion. At low temperatures the rods **42** and **22** will contract and move thereby the throttling body **46** towards the left, as viewed in FIG. 3, so that the free cross-section of the throttle opening **33** is increased. Therefore, when viscous liquids, such as oil, are used as a damping medium, the increase of the viscosity at lower temperatures will be compensated by enlarging the open cross-section of the throttle opening **33** so that the resistance of the liquid

to flow through the throttle opening will be substantially independent of the temperature.

A tubular control member **48** is telescopically arranged in the tubular piston rod **27** and extends with its right substantially closed bottom end **49** through an opening in a nut **32**, screwed onto the right end of the piston rod, as viewed in FIG. 3. A coil compression spring **45** abutting with one of its ends against the throttling body **46** and with the other end against the inner face **50** of the bottom **49** of the control member **48** biases the latter towards the right, as viewed in FIG. 3, into engagement with a portion of the right closed end of the tube **4**, which portion is preferably formed by an axially adjustable set screw **52** threaded into the cover **34** which closes the right end, as viewed in FIG. 3 of the tube **4**.

The outer diameter of the tubular control member **48** varies along its length. At the end opposite its bottom **49** the control member has a frustoconical outer surface portion **53** of small apex angle and having its largest diameter, only slightly smaller than the inner diameter of the tubular piston rod **27**, at the open end of the tubular control member, subsequently thereto a second cylindrical outer surface portion **54** having a diameter substantially equal to the largest diameter of the frustoconical portion, an annular groove **55** following the cylindrical portion and having a diameter smaller than the latter, a cylindrical guide portion **56** following the groove and having an outer diameter substantially equal to the inner diameter of the hollow piston rod and finally a cylindrical portion extending between the guide portion and the right end of the control member, as viewed in FIG. 3, and having a diameter smaller than the guide portion to form at the junction of the last-mentioned two portions a shoulder **58**. A transverse bore **59** is formed through the wall of the control member **48** in the frustoconical part **53** thereof and at least one additional transverse bore **60** extends through the wall portion in the region of the annular groove **55**. The wall of the sleeve **31** is formed to the right side of the piston **29** with a plurality of relatively large openings **61** and a bore **71** extends coaxially through the bottom **49** of the control member **48**.

By the specific construction of the tubular control member **48** and its cooperation with the other elements of the door closer according to the present invention the following advantageous closer speeds may be derived during closing of a door from an opening angle of 180°. The beginning of the closing movement of the door will occur practically without any damping action and the first braking of the closing moment will occur at a door angle of about 100°, after which the door will close with substantially uniform speed until the door reaches an opening angle of about 60° at which a second braking is provided to avoid any danger of persons passing through the door. During further closing the door speed increases again slightly until at an opening angle of about 10 to 15° a third braking of its speed will occur so that the door closes very softly. If a door with a latch is used, the braking or damping action of the door closer may be stopped at an opening angle of the door of about 4°, in the manner as will be explained later on in detail, so that the door closes with a certain impact necessary to engage the latch.

FIG. 3 illustrates the position assumed by the various elements of the door closer when the door is in its closed position and when the door closer is adjusted for closing the door without any impact, that is when the door closer is used with a door without a latch. In the position as shown in FIG. 3 the bore **60** and the annular groove **55** in the tubular control member **48** are arranged laterally displaced in direction towards the cover **34** from the bores **35** in the tubular piston rod **27**.

During opening of the door **8**, the lever means **15**, comprising the levers **13** and **14** will pull the slide member **27** in the direction toward the flange **9**, since the linkage bolt **12** is transversely displaced from the turning axis **19** of the door. During this movement of the slide member **21** towards the left, as viewed in FIG. 1, the tube **20** together with the tubular piston rod **27** connected thereto and the piston **29** as well as the rod **22** and the rod **42** connected to the latter are likewise moved in the same direction so that the closer spring will be compressed by the disc **26**. The control member **48** at first does not follow this movement of the rod **42**, but the closed end of the control member **48** remains under the influence of the spring **45** in engagement with the set screw **52**. Only after the hollow piston rod **27** has moved through a predetermined distance towards the left, as viewed for instance in FIG. 5 the shoulder **58** on the tubular control member **48** will be engaged by a corresponding abutment face **62** of the nut **32**, after which the control member **48** will be moved likewise in the direction towards the left, as viewed in FIG. 5.

During the opening of the door and resulting movement of the piston **29** toward the left, as viewed in FIG. 3, the interior space in the damping cylinder **7** is increased since part of the tubular piston rods **27** moves out of the interior of the damping cylinder. This increase of the interior space in the damping cylinder is compensated in part in the second cylinder space or in the damping space **39** up to a door opening angle of for instance 61° by the movement of the control member **48** out of the tubular piston rod **27**. Creating of underpressure due to the aforementioned movement of the piston is reduced by the flow of the damping medium through the one-way valve **36** and by the passage of the medium through the throttle opening **33** into the space **63** between the throttling body **46** and the control member **48** which increases during this movement. In this way a proper damping will start right at the begining of the closing movement when the door is opened only to an angle of about 60°.

During closing movement of the door from a 180° turned position up to an opening angle of 60°, the damping medium will flow during movement of the piston **29** toward the cover **34** from the second cylinder space **39** through the opening **61** in the sleeve, the opening **35** in the tubular piston rod **27**, through the interior of the latter and through the throttle opening **33** to the first cylinder space **40**. The damping action of the closer and therewith the closing speed of the door during this movement may be regulated by adjusting the open cross-section of the throttle opening **33**. This can be done by turning the rod **22** by means of its projection **23**, for instance with a screwdriver, from the side of the flange **9** so that the rod **42**, which is prevented from turning with the rod **22** by the pin **43**, is screwed with its left end more or less into the female thread **41**. During turning of the rod **42**, in one or the other direction, the throttling member **46** carried on the right end of rod **42** will thus be moved to the left or the right and the open cross-section of the throttle opening **33** will be enlarged or decreased.

FIG. 5 illustrates the position the elements of the door closer will assume at a door opening angle of 61.5° and in which the control member **48** is just starting to engage with the outer face **51** of its bottom **49** to the end face **70** of the set screw **52**. During further closing movement of the door, the piston rod **27** will move further toward the right, as viewed in FIG. 5 and the controlling edge **64** of the control member **48** will move over the openings **35** in the hollow piston rod **27** so that a considerable braking of the closing movement will occur. Subsequently thereto the closing movement will again increase since the cross-section of the annular gap between the outer surface of the frustoconical portion **53** of the control member and the inner surface of the tubular piston rod **27** increases and the damping fluid will flow through the bore **60** and the throttle opening **33** into the cylinder space **40**.

At a door opening angle of 10° the position as shown in FIG. 6 will be reached. In this position the cylindrical outer surface portion **54** will move into the region of

the openings 35 in the piston rod 27 so that a further considerable braking of the door closing movement will occur. The damping fluid will, in this position of the closer, flow through the transverse bores 59 and 60 into the interior of the control member 48 and pass from there through the throttle opening 33 into the first cylinder space 40. Finally, when the door is closed, the various members of the closer will assume the positions relative to each other as shown in FIG. 3. When the door is closed very fast by exterior forces, it is possible that such pressure differences will be created between the cylinder space 39 and the interior of the control member 48 so that the greater pressure in the space 39 acting against the outer surface 51 of the bottom of the control member 48 would press the latter against the action of the spring 45 inwardly so that the controlling edge 64 having an outer diameter substantially equal to the inner diameter of the hollow piston rod 27 would just pass the bores 35 and then remain at standstill preventing thereby fluid flow from the cylinder space 39 into the space 40. To avoid such an occurrence, the central bore 71 is formed through the bottom 49 of the control member. In this way, pressing of the control member 48 into the tubular piston rod 27 is avoided, since any difference in the pressures in the cylinder space 39 and the interior of the control member 48 can be quickly equalized through the bore 71 so that the force of the spring 45 will always be sufficient to maintain the shoulder 58 on the control member in engagement with the abutment face 62 of the nut 32. A higher pressure in the cylinder space 39 will also develop when the door reaches the opening angle in which the outer surface 51 of the bottom of the control member 48 engages the end face 70 of the set screw 52. When due to manufacturing tolerances the outer face 51 at the bottom of the control member does not over its whole surface abut against the end face 70, the overpressure in the cylinder space 39 would act against the end face 51 of the control member 48 and move the latter inwardly so that in certain positions of the control member the openings 35 would be closed by the cylindrical guide portion 56 of the control member so that a further closing of the door would be prevented. However, since during such inward movement of the control member 48 the bore 71 through its bottom would again be opened, a fast pressure exchange will take place between the interior of the tubular control member 48 and the cylinder space 39.

When the door closer according to the present invention is to be used in connection with a door provided with a latch, then it is only necessary to screw the set screw 52 inwardly until it abuts against the abutment 52' as shown in FIG. 7. In this position of the set screw the control member 48 will, during its movement toward the right, as viewed in FIG. 7, abut sooner against the set screw 52 so that the braking will occur at a slightly larger opening angle of the door. In this position of the set screw, the openings 35 in the piston rod 27 will be located in the region of the annular groove 55 respectively in the region of the cross bore 60 in the control member 48 when the door reaches a position of about 3° before its closed position so that the flow resistance of the damping fluid will be greatly reduced and the door will engage the latch with a certain impact. Therefore, the door closer according to the present invention can be simply adjusted before being mounted in the door by turning the set screw 52 in such a manner that the door will close with or without an impact. When the door closer is to be used for a door without a latch, the set screw 52 will be turned outwardly until its outer end engages the outer abutment 52''.

The speed of the closing movement of the door in relation to its opening angle is illustrated in the graph of FIG. 4. The closing movement which starts from zero at an opening angle of 180° will obtain its maximum value at an opening of 100° at which the first braking occurs. A greater braking will be initiated by the control member 48 when the door reaches an opening angle of about 60° and at about 10°, and the braking will be reduced at an opening angle of 3° if the door should close with an impact so that the closing speed of the door will increase again during the last part of the closing movement as indicated in dotted lines in FIG. 4. The aforementioned conditions are also illustrated in the diagram of FIG. 9 in which the stroke of the piston is shown on the coordinate of the diagram and the corresponding opening angle on the abscissas. The door moves from an opening angle of 180° to an angle of 100° substantially without damping since in this region the gas developed during formation of underpressure will be again absorbed in the damping liquid, then follows a braking action since the damping liquid has to flow from the cylinder space 39 through the openings 61 in the sleeve 31, the openings 35 in the tubular piston rod 27, and the throttle opening 33 into the cylinder space 40. The two following braking regions are also indicated in FIG. 9 at the hatched portions of this diagram. The upper part of the diagram illustrates the action of the door closer in which the door has to close without an impact, whereas the lower portion of the diagram illustrates the action of the door closer when the latter is adjusted for closing with an impact. From the diagram of FIG. 9 it will be seen that in the latter case the braking regions start at larger door opening angles than in the upper portion of the diagram and at about 3° opening angle the flow resistance of the medium is reduced so that the door will close with an impact.

At an opening angle between 180 and 120° no braking forces should be produced in direction towards the frame 10 since the lever arrangement 15 is unstable during pressure action.

The set screw 52 serves at the same time as ventilating or filling screw. During filling of the door closer with damping liquid the closer tube 1 will be held in vertical position so that the cylinder space 7 may be filled with damping liquid through the bore in the cover 34 into which the set screw 52 is screwed.

The door closer according to the present invention has especially the advantages that the damping device will respond quickly, even if the door is only partly opened and that the door closer can be easily adjusted so that the door will close with or without an impact. The closing speeds may be influenced in a desired manner by shaping the control member 48 correspondingly. The door closer according to the present invention will function properly independent from temperature conditions and it is simple in its construction, operation and adjustment.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of door closers differing from the types described above.

While the invention has been illustrated and described as embodied in a door closer with means for damping the closing movement of the door, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt if for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims.

What is claimed is:

1. A door closer comprising, in combination, a damping cylinder adapted to be mounted in a door and having a longitudinal axis extending substantially normal to the turning axis of the door, said damping cylinder having opposite closed ends; a piston reciprocably arranged in

said damping cylinder and dividing the interior of the latter in a first cylinder space between one of the closed ends of the cylinder and the piston and a second cylinder space between the piston and the other closed end of the cylinder; a hollow piston rod carrying said piston and projecting to opposite sides of the latter and with one end fluid-tightly sealed through one of said closed ends of said cylinder; lever means connected to said one end of said piston rod for moving the latter in a direction away from said other closed end of said cylinder during opening of the door and in the opposite direction during closing the door; biasing means connected to said piston rod for biasing the same in said opposite direction; a one-way valve in said piston permitting free flow of fluid from said first into said second cylinder space during movement of said piston rod in said one direction while preventing flow of fluid from said second into said first cylinder space during movement of said piston rod in said opposite direction; there being through the wall of said hollow piston rod between one side of said piston and said one closed end of said cylinder and providing communication between the interior of the latter and said first cylinder space; an elongated control member having a cross-section varying along its length and being telescopically arranged in said hollow piston rod to define with the inner surface of the latter an annular throttling gap; and second biasing means cooperating with said control member to bias the latter in abutment with a portion of said second closed end of said cylinder so that said control member will during part of the stroke of said piston abut against said portion.

2. A door closer as defined in claim 1, wherein said piston rod is provided with at least one other opening through its wall at the other side of said piston and providing communication between the interior of the piston rod and said second cylinder space.

3. A door closer as defined in claim 2, wherein said control member is a tubular member having a closed end facing said other closed end of said cylinder and an opposite open end and being formed in the wall thereof between said ends with at least one bore therethrough.

4. A door closer as defined in claim 3, wherein said tubular control member has a first frustoconical outer surface portion having its largest diameter, substantially equal to the inner diameter of said hollow piston rod, at said open end of said control member, a second cylindrical outer surface portion following said frustoconcial surface portion and having a diameter substantially equal to said largest diameter, there being an annular groove following said cylindrical surface portion and having a bottom face of a diameter smaller than that of said cylindrical surface portion, a cylindrical guide portion following said groove and having an outer diameter substantially equal to said inner diameter of said hollow piston rod, and a cylindrical portion extending between said guide portion and said closed end of said control member and having an outer diameter smaller than that guide porton to form at the junction of said guide portion and said last cylindrical portion a shoulder, said one bore extending from said annular groove through the wall of the control member, and including a second bore extending from the frustoconical surface likewise through the wall of the control member.

5. A door closer as defined in claim 4, wherein said portion of said other closed end of said cylinder is in the form of an axially adjustable set screw, and wherein depending on the axial adjustment of said set screw and when the door is nearly closed, said other opening in said hollow piston rod will be in the region of said first mentioned cylindrical outer surface portion of said control member, respectively in the region of said annular groove thereof.

6. A door closer as defined in claim 5 and including a pair of axially spaced abutments on said other closed end of said cylinder and cooperating with said set screw so that the latter may be axially adjusted between two end positions.

7. A door closer as defined in claim 1, wherein said elongated control member is a tubular member having a bottom at one end facing said other closed end of said cylinder and wherein said second biasing means comprises a compression spring located in the interior of said tubular control member and abutting with one end against said bottom and including abutment means in said hollow piston rod against which the other end of said spring abuts.

8. A door closer as defined in claim 1, wherein said control member is tubular and has a bottom facing said other closed end of said cylinder, said bottom being formed with a bore therethrough adapted to provide communication between the interior of said tubular control member and said second cylinder space, said bore being closed when said bottom abuts against said portion of said other closed cylinder end.

9. A door closer in claim 8, and including cooperating means on said piston rod and said control member for moving the latter against the force of said second biasing means to disengage said bottom of the control member from said portion of said other closed end of the cylinder after said piston rod has moved over a predetermined distance in said one direction.

10. A door closer as defined in claim 9, wherein said bore through said bottom of said control member is coaxially arranged with the axis of the latter.

11. A door closer as defined in claim 8, wherein said portion of said other closed end of said cylinder is constituted by an axially adjustable set-screw having an end face completely covering the outer face of said bottom of the control member when the latter abuts against said end face.

12. A door closer as defined in claim 8, wherein said piston rod has a transverse shoulder face adjacent and facing away from said throttle opening, wherein said piston is mounted with slide fit on said piston rod and abutting with one end against said shoulder face, and including a sleeve substantially coaxial with and radially outwardly spaced from said piston rod and abutting with one end against the other end of said piston and formed between the ends thereof with at least one transverse aperture, and a nut threadingly connected to the other end of said piston rod and engaging the other end of said sleeve for pressing said one end thereof against said piston and the latter against said shoulder face, said nut having a transverse face extending inwardly beyond the inner surface of said hollow piston rod and adapted to engage said shoulder of said control member during movement of said piston rod in said one direction.

13. A door closer as defined in claim 1, and including adjusting means in the interior of said hollow piston rod in the region of said throttle opening for adjusting the open cross section thereof.

14. A door closer as defined in claim 13, wherein said adjusting means comprises a throttling body snugly received in said hollow piston in the region of said throttle opening and elongated connecting means having a length varying with the temperature and connecting said throttling body to a portion of said piston rod distant from said throttle opening to change the piston of said throttling body relative to said throttle opening in dependence on the temperature of said connecting means.

15. A door closer as defined in claim 14, wherein said cylinder spaces are filled with a viscous liquid and wherein said connecting means include rod means formed from a material having a coefficient of expansion corresponding to the change of the viscosity of said liquid during change of the temperature of the liquid.

16. A door closer as defined in claim 15, wherein said rod means are formed from aluminum.

17. A door closer as as defined in claim 16, wherein said rod means comprise two coaxial and means connected said

rods to each other for changing the overall length of the rod means independent of the temperature thereof.

18. A door closer as defined in claim **13**, wherein said throttle opening is in form of a slot extending in axial direction of said piston rod.

19. A door closer as defined in claim **1**, wherein said portion at said other closed end of said cylinder is in the form of a set screw threaded in a correspondingly threaded opening in said other closed end and serving to fill damping liquid in said cylinder or discharge the liquid therefrom.

References Cited

UNITED STATES PATENTS

2,315,531	4/1943	Lucht	188—96.9
2,890,770	6/1959	Smallpeice	188—96.9
2,899,023	8/1959	Rumsey	188—96
3,079,629	3/1963	Millard et al.	16—52

DONALD A. GRIFFIN, Primary Examiner