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(58) Field of Search
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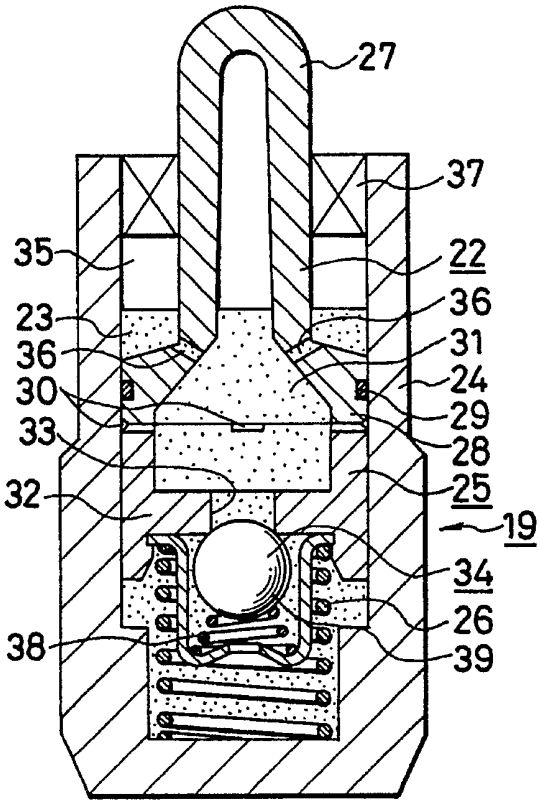
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(54) Damper apparatus for an autotensioner

(57) An autotensioner for use in applying a tension to a moving belt comprises a pivotally-mounted arm carrying a belt tensioning pulley, and a damper 19 acting on the arm, the damper 19 comprising a cylinder 24 for fluid divided into an upper chamber and a lower chamber by an upwardly spring-biased piston 25; a check valve 34 between the chambers which opens for flow from the upper to the lower chamber via a passage 33 in the piston; and a push member 22 acting on the piston from above. The lower part of push member 22 has a cavity 31 which is open to the passage 33 and communicates with the external part 35 of the upper chamber via vent holes 36. The damper 19 can follow a sudden change in tension of the belt so that the viscous fluid has a liquid surface kept high even when the push member 22 rises to its uppermost position to prevent air from entering underneath the piston 25. The pulley-carrying arm may also be biassed against the belt by a coil spring separate from the damper. The cavity 31 within the push member 22 may also extend into the upper part 27 of that member.

FIG. 4



At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1990.

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FIG. 1

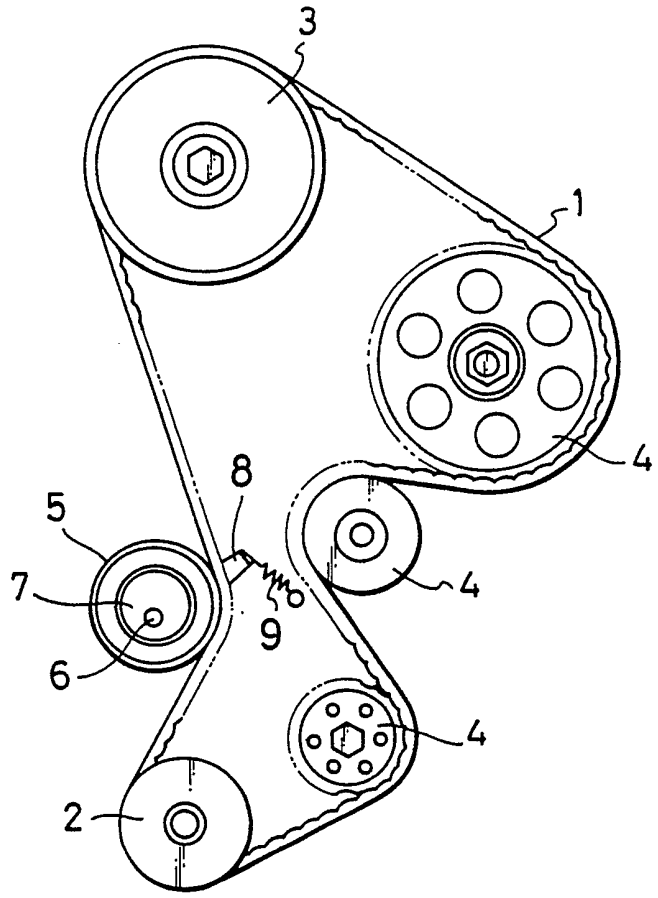


FIG. 2

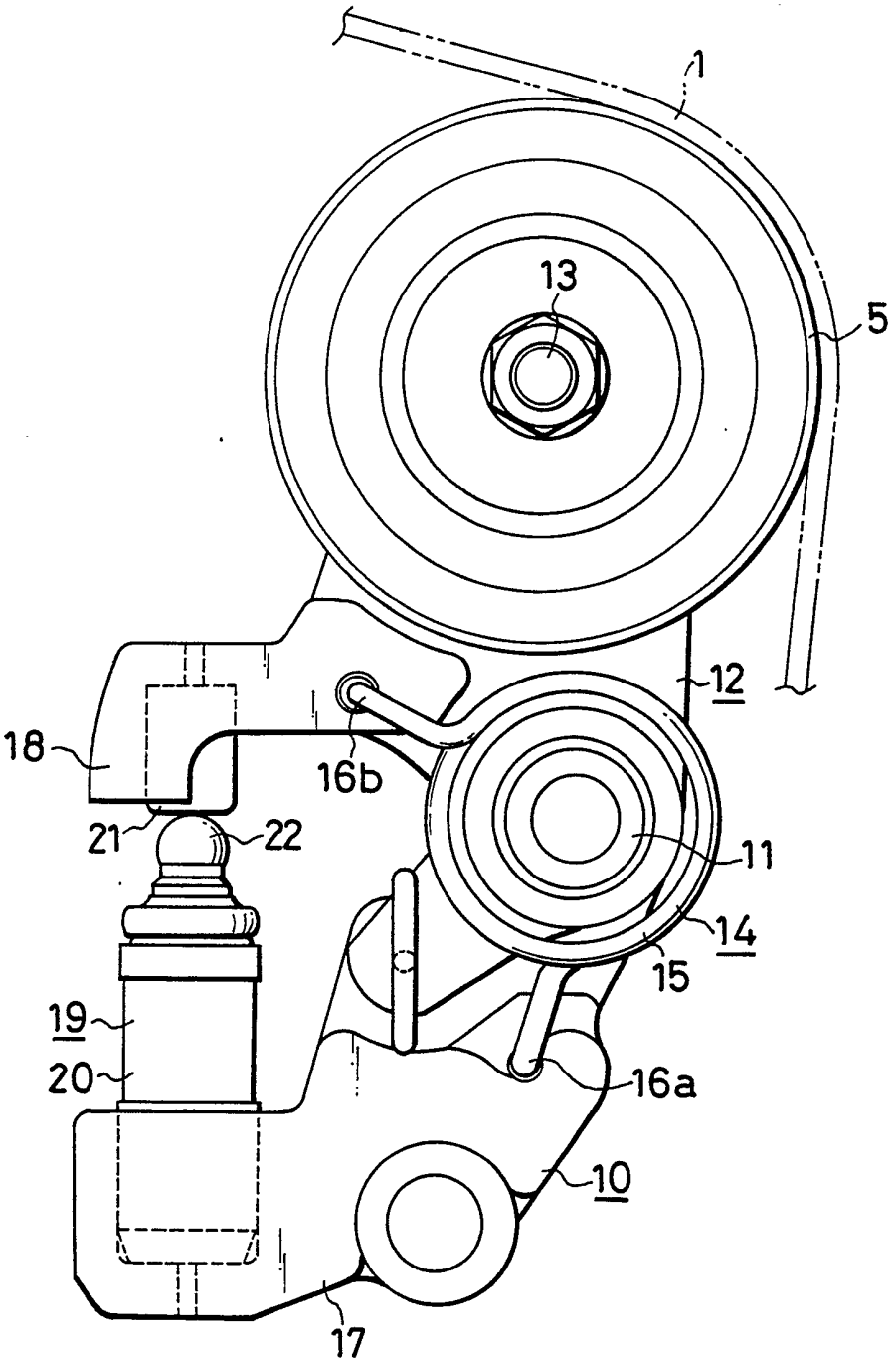


FIG. 3

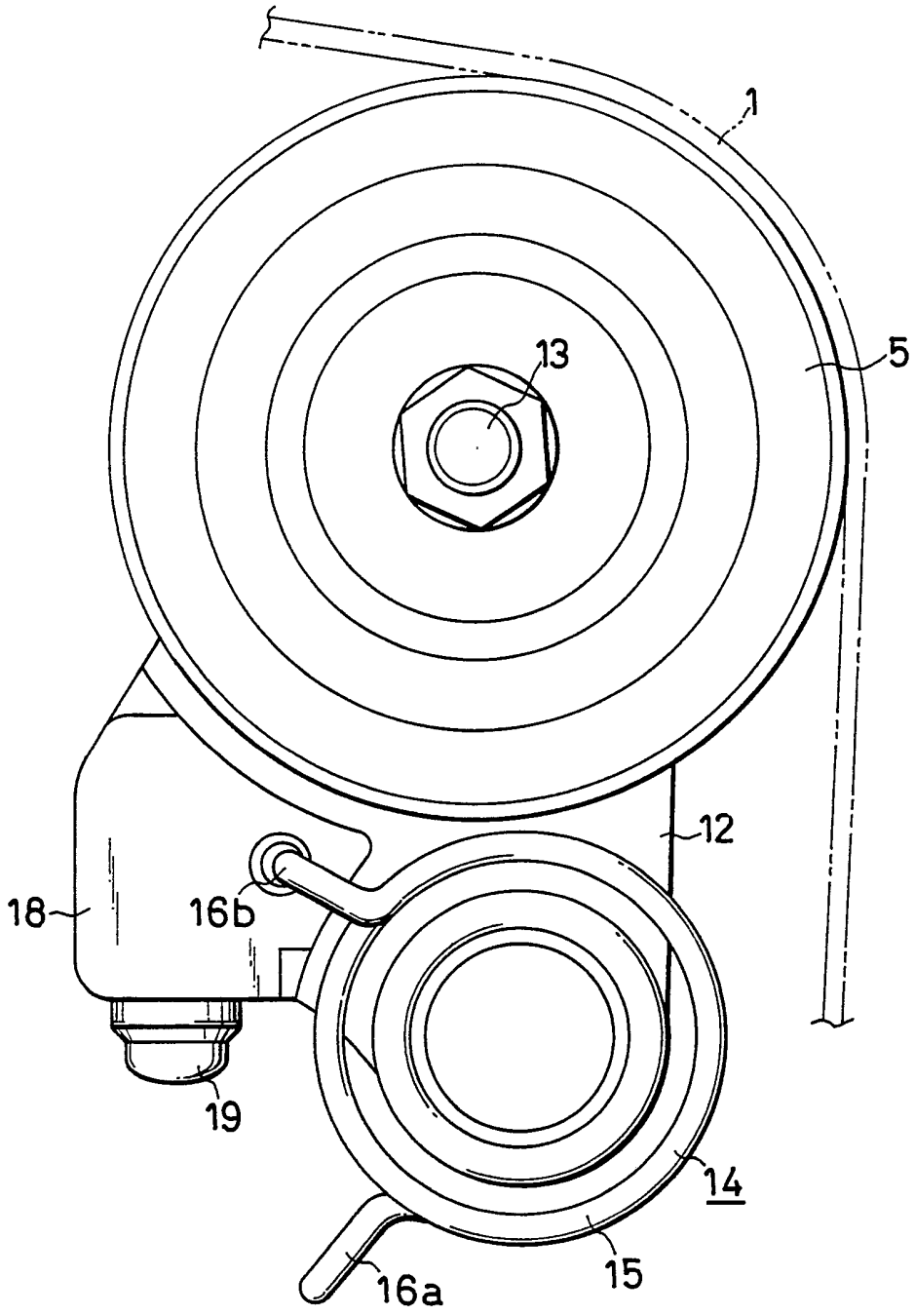


FIG. 4

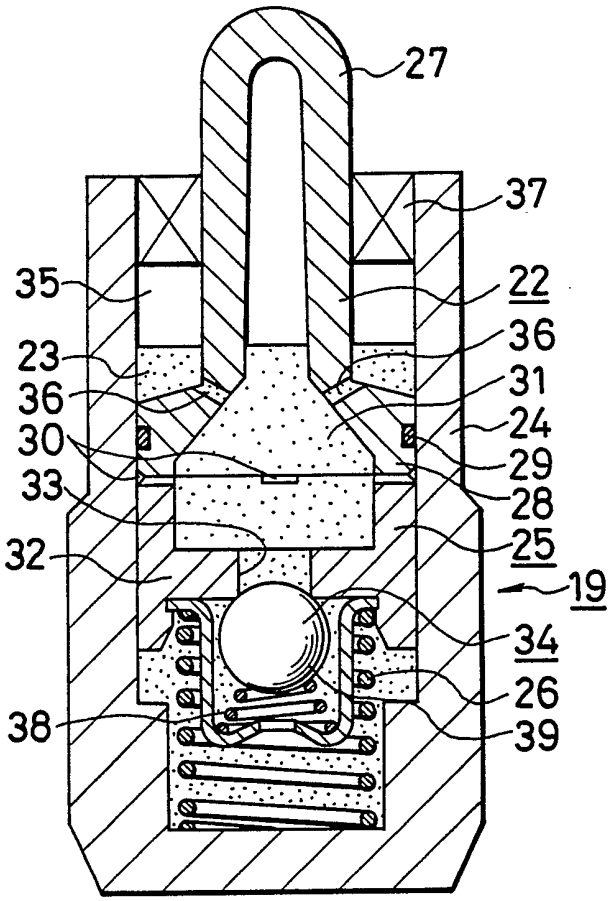


FIG. 5(A)

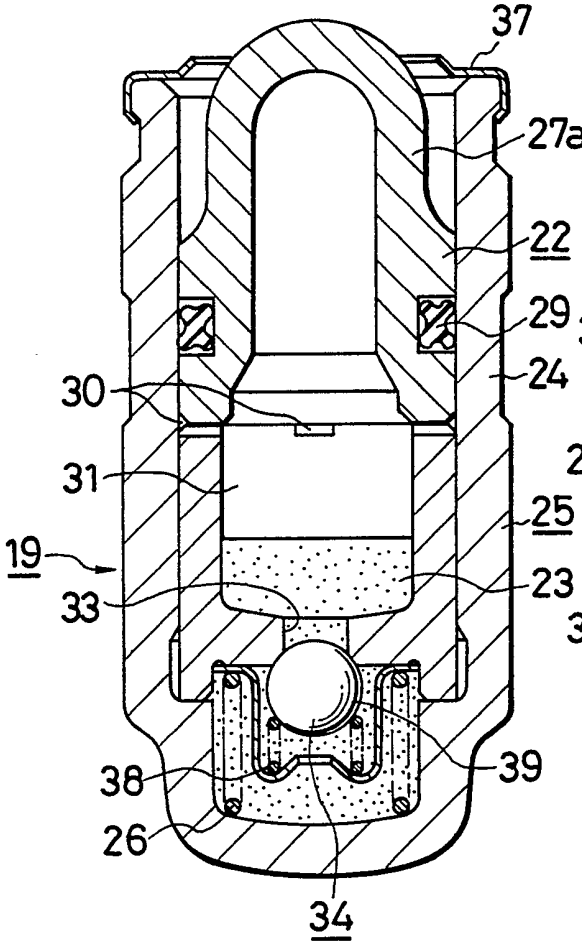

37
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FIG. 5(B)

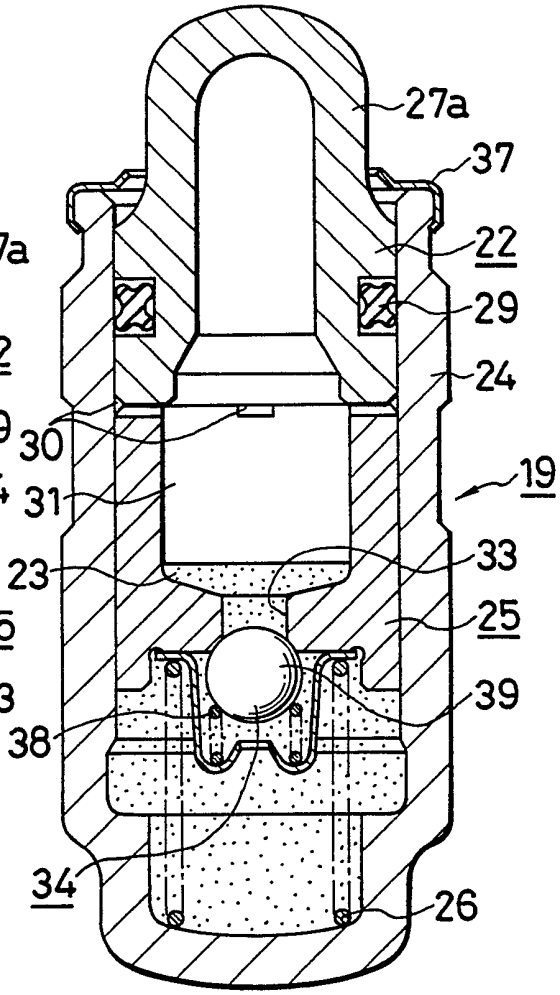

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FIG. 6

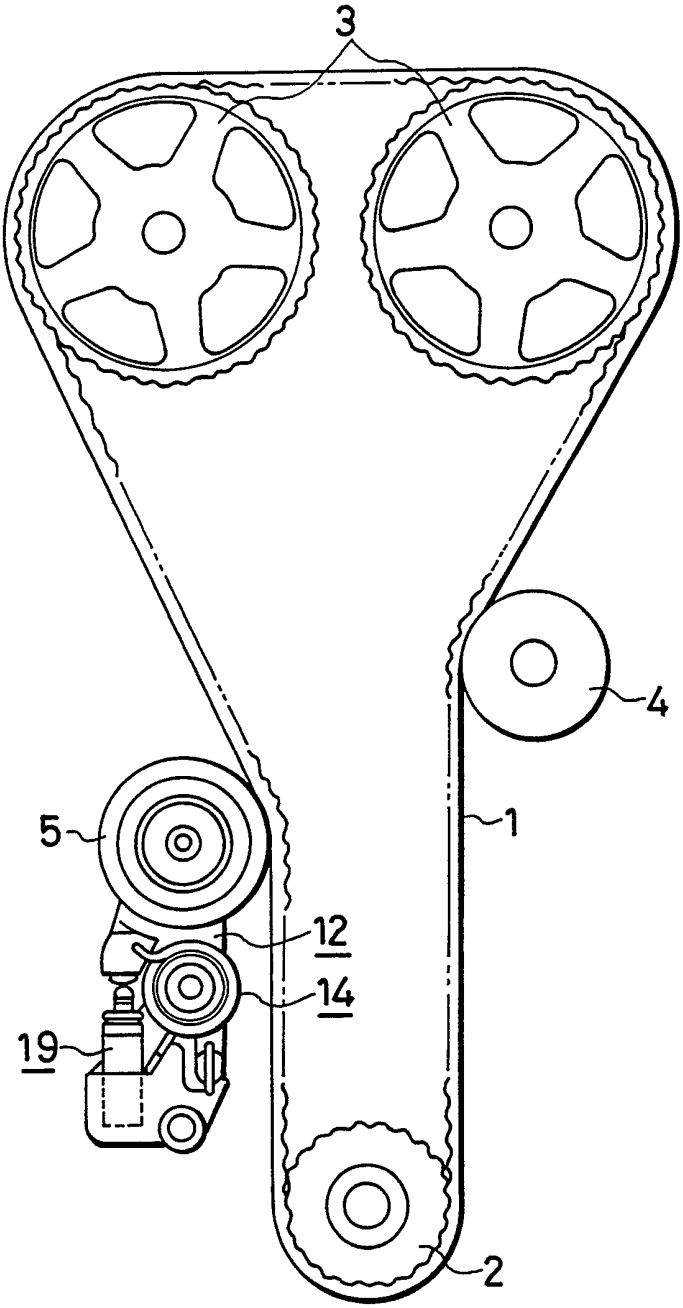


FIG. 7(A)

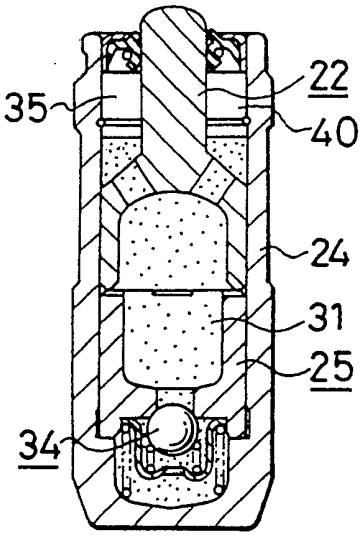


FIG. 7(B)

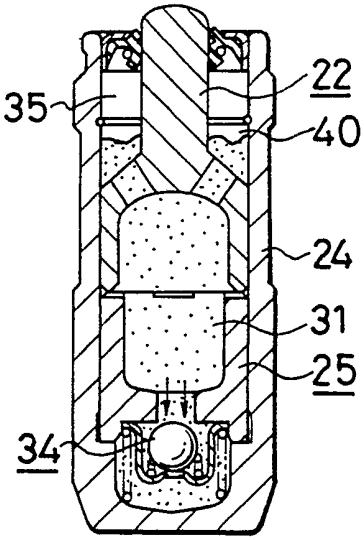


FIG. 7(C)

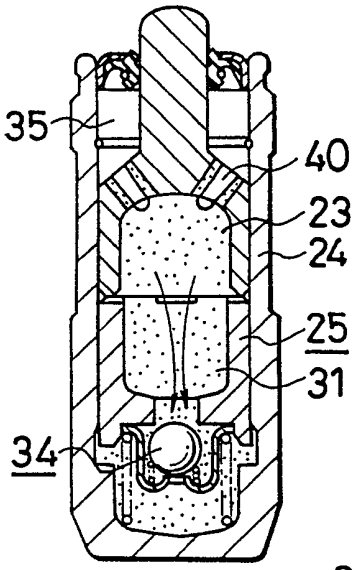


FIG. 7(D)

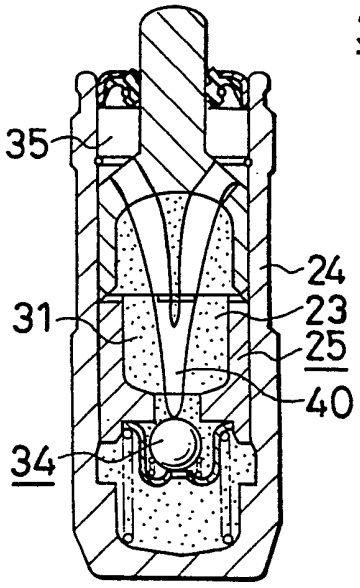


FIG. 7(E)

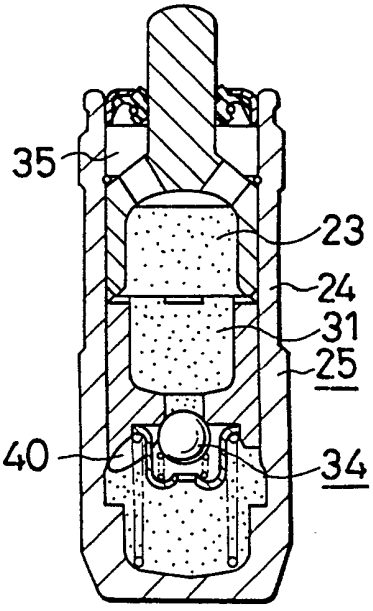


FIG. 8(A)

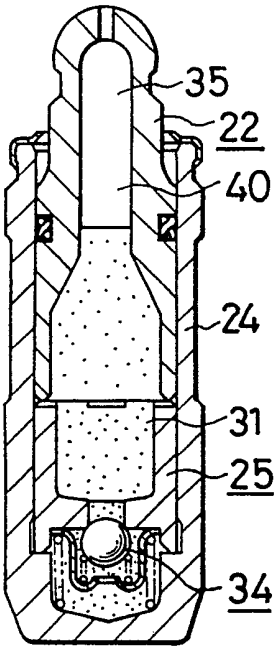


FIG. 8(B)

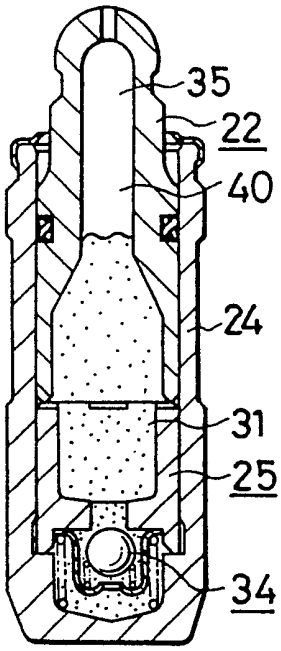


FIG. 8(C)

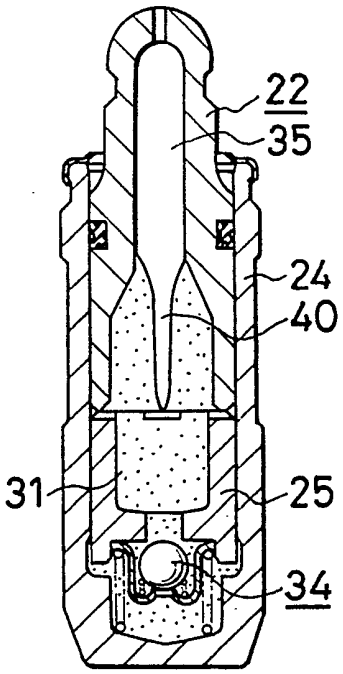


FIG. 8(D)

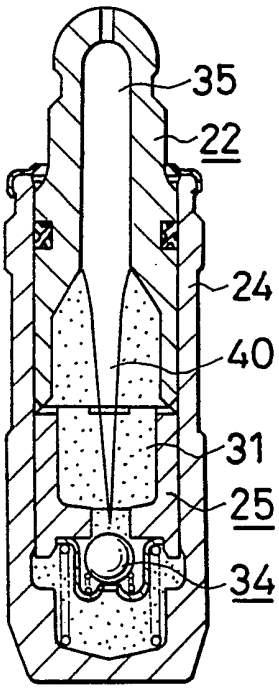


FIG. 8(E)

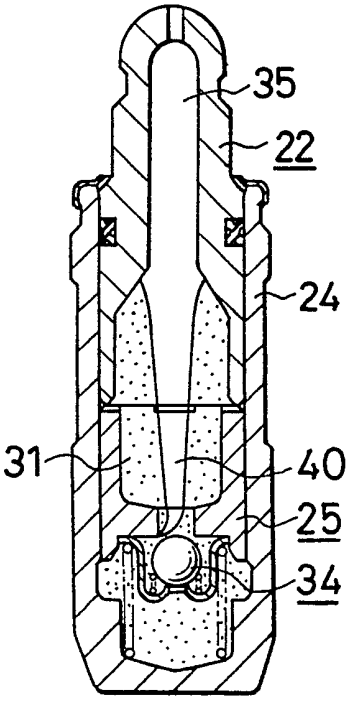


FIG. 8(F)

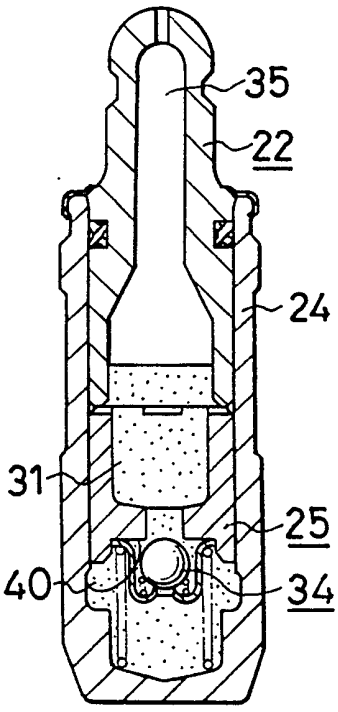


FIG. 9

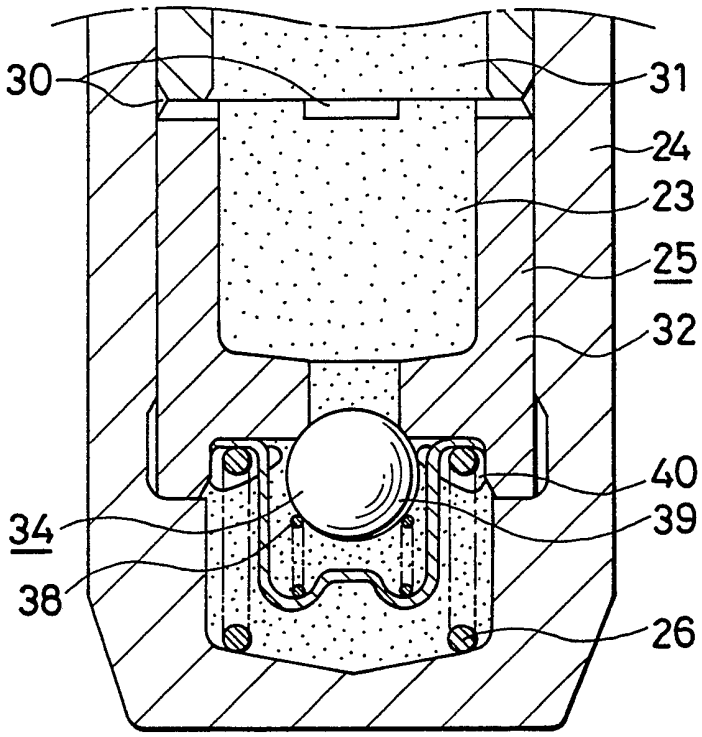


FIG. 10

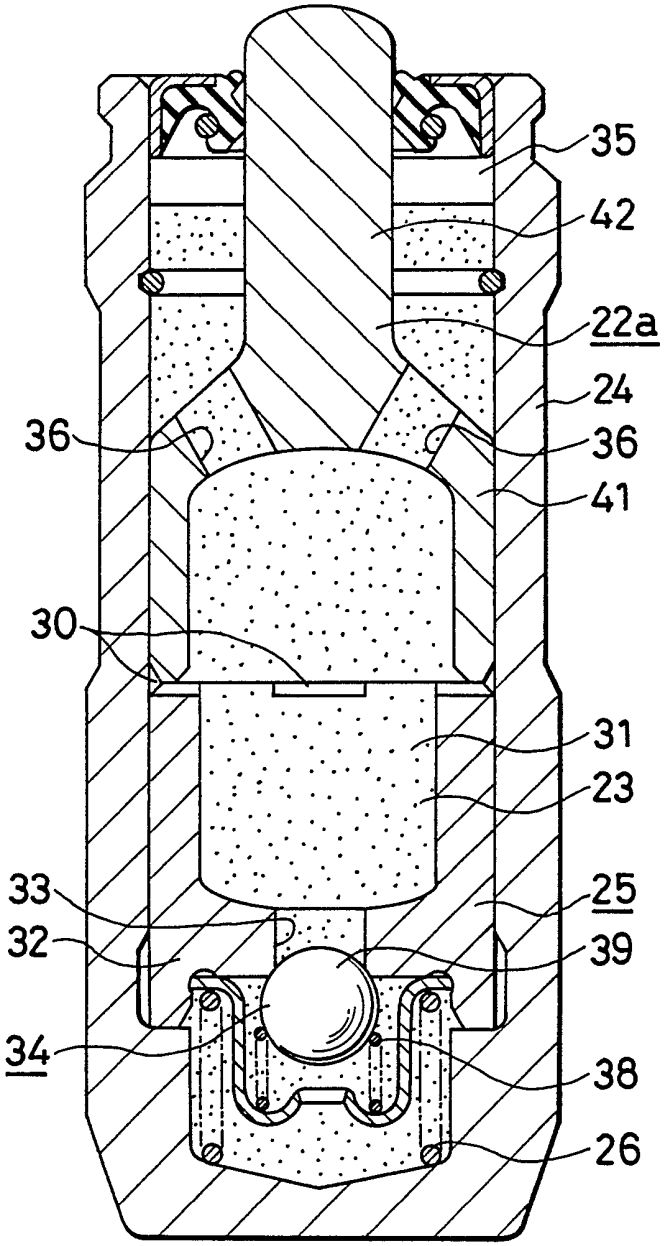


FIG. 11

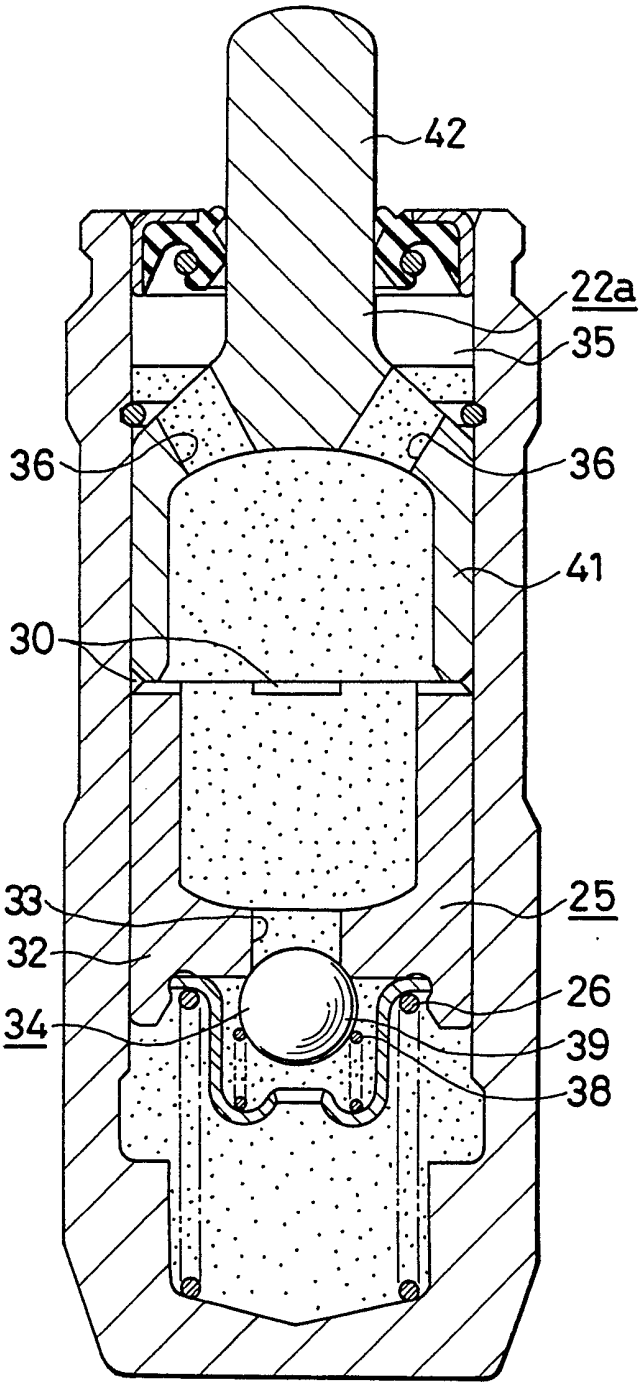


FIG. 12(A)

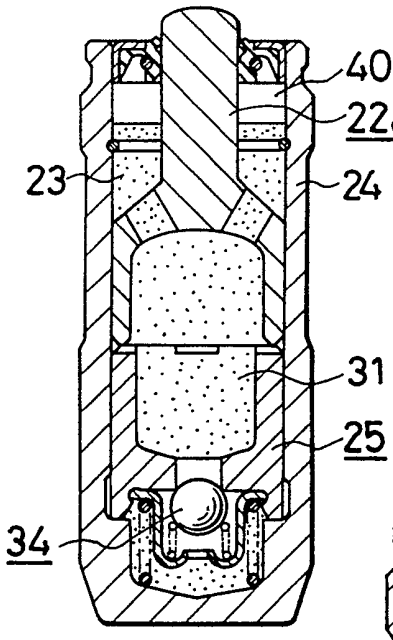


FIG. 12(B)

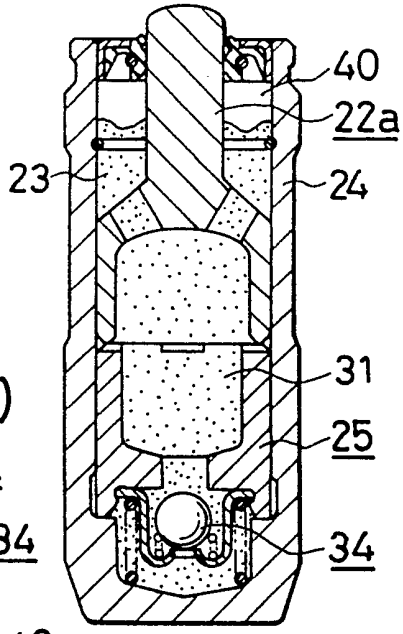


FIG. 12(C)

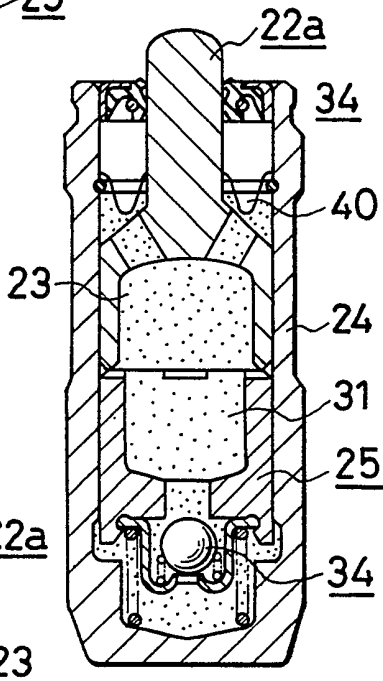


FIG. 12(D)

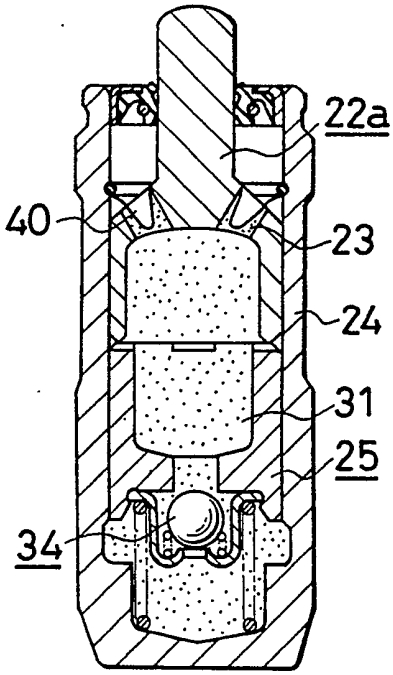


FIG. 12(E)

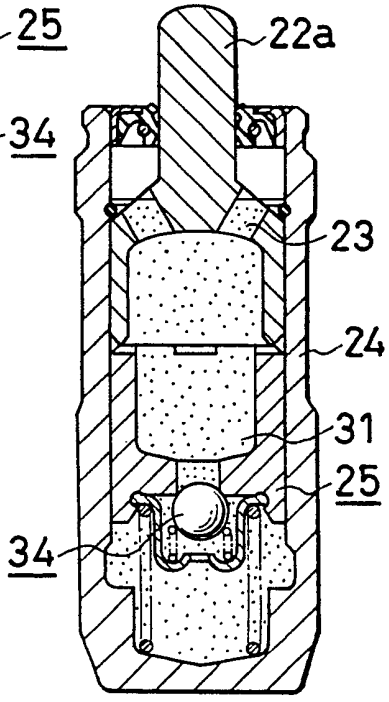


FIG. 13

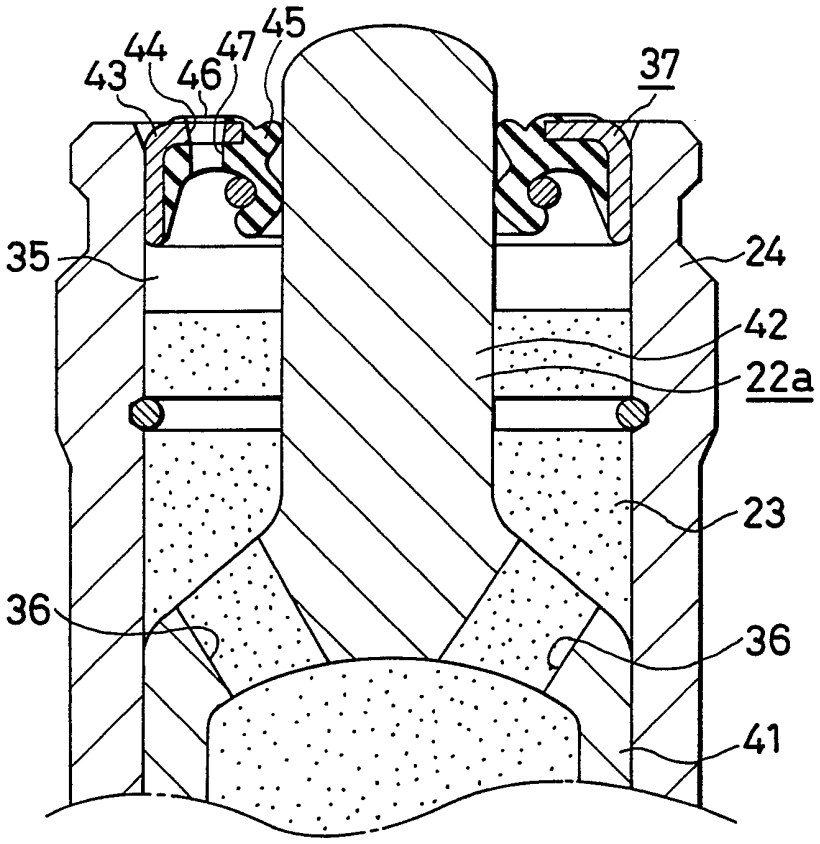


FIG. 14

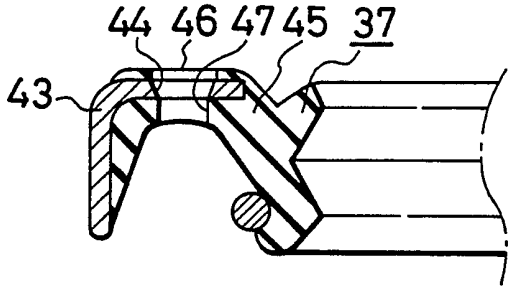


FIG. 15

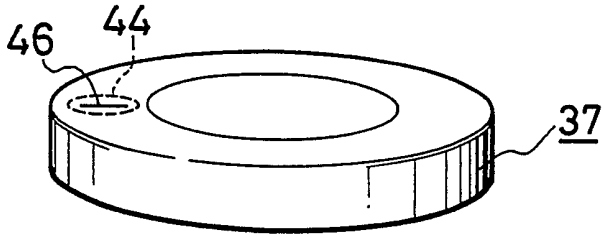


FIG. 16(A)

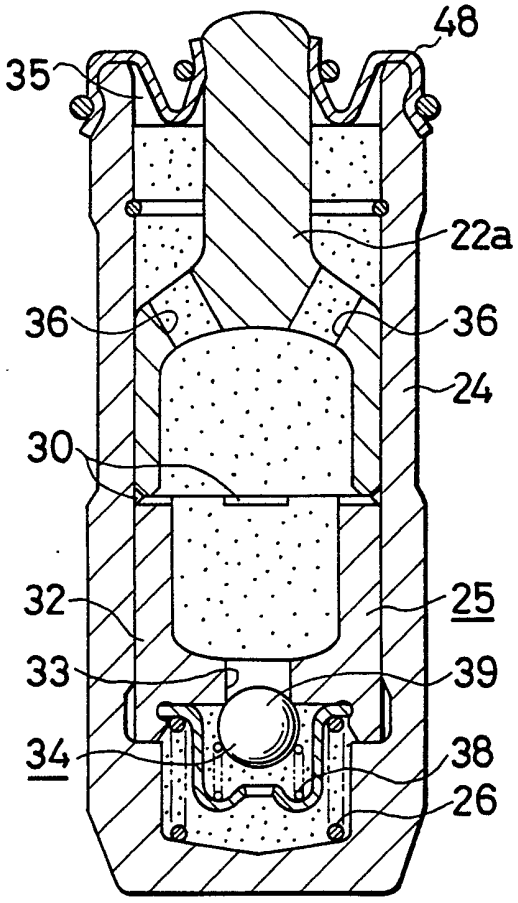


FIG. 16(B)

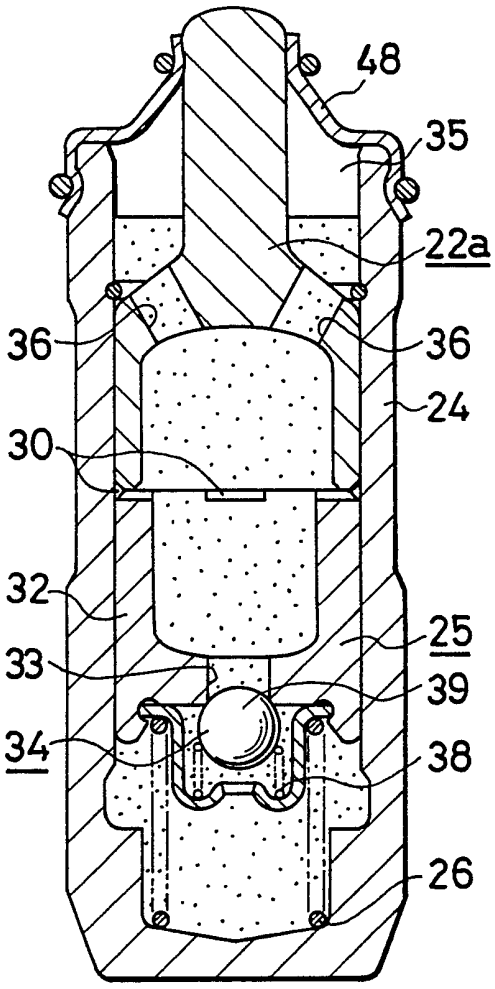
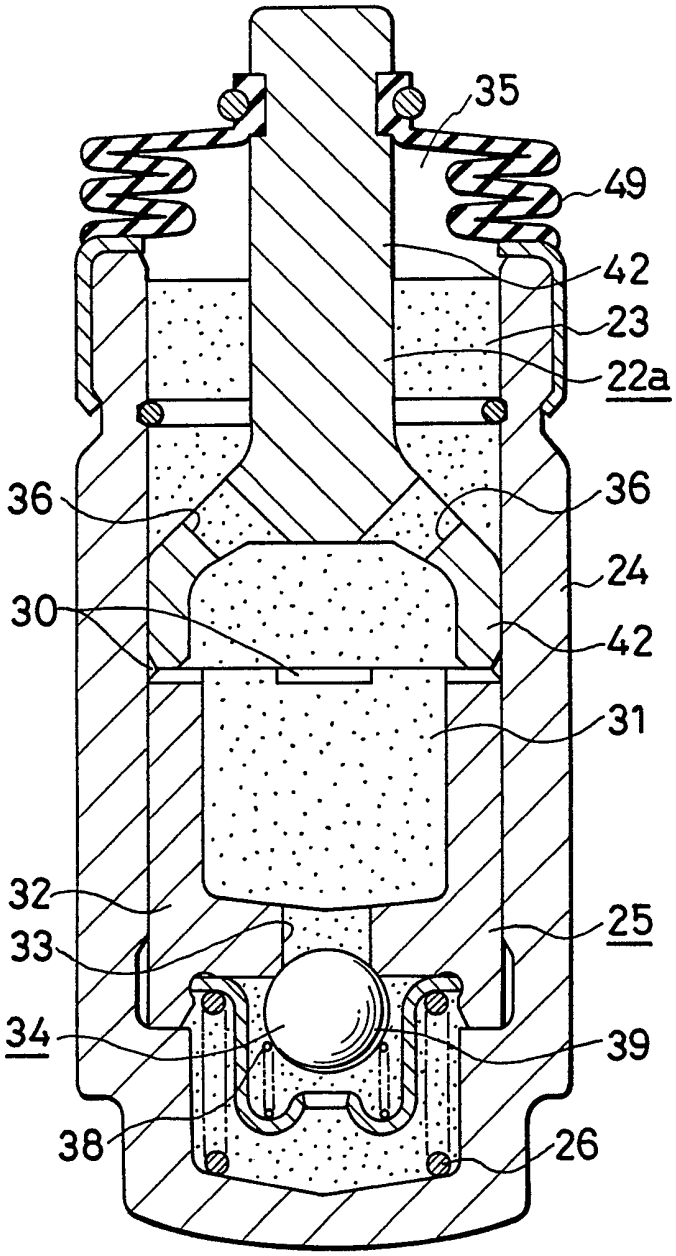


FIG. 17



DAMPER APPARATUS FOR AN AUTOTENSIONER

FIELD OF THE INVENTION

The present invention relates to an autotensioner damper apparatus which is fitted to an autotensioner used to produce an appropriate tension in a belt such as an automotive engine timing belt or a belt for driving auxiliary equipment such as an alternator or compressor (referred to hereunder simply as a belt), so as to suppress vibration in the belt.

DESCRIPTION OF THE PRIOR ART

Drive units such as shown in FIG. 1 which use a belt 1 are widely used for driving the cam shaft of OHC or DOHC engines in synchronous timing with the crank shaft. The drive unit of FIG. 1 comprises a drive pulley 2 driven by the engine crank shaft, a follower pulley 3 fixed to an end of the cam shaft, guide pulleys or follower pulleys 4 for guiding the belt 1 or driving auxiliary equipment such as a water pump, and a pulley 5 for producing an appropriate tension in the belt 1.

The pulley 5 is pivotally mounted on a rocking or pivotable member 7 which pivots about a pivot shaft 6. The end of a bracket 8 which is fixed to the rocking member 7 is fitted with a spring 9 which acts so that the pulley 5 is resiliently pressed against the belt 1, thus keeping the tension of the belt 1 constant irrespective of vibration in the belt due to the engine operation, or dimensional changes in the belt 1 due for example to temperature changes.

In addition to the function of tensioning the belt 1

however, a belt control function is also required in the autotensioner. With the cam shaft drive unit shown in FIG. 1, there is tendency for the belt 1 to vibrate at some location between the pulleys 2 and 5 swinging in a direction perpendicular to the direction of travel. If such vibration is permitted the amplitude of vibration increases (vibration growth) so that the belt produces abnormal vibrations in the drive components, or in the case of a toothed belt, there is the possibility of so called "tooth skipping".

In view of these problems, a damper apparatus has heretofore been fitted to the autotensioner as disclosed for example in Japanese Patent First Publication KOKAI Nos. S58-65357 and S63-18075, so that the belt 1 is controlled by the damper apparatus. The pulley in these autotensioners, however, displaces slowly in any direction so as not to follow the belt as it is slackening. Consequently, the tension of belt may be temporarily lower.

To more reliably prevent slackening of the belt 1 the pulley 5 is made to quickly follow the belt 1 at the time of slackening, and to retain the belt without retracting when under tension. Such belt control autotensioners are also disclosed for example in Japanese Patent First Publication KOKAI Nos. S63-167163, H2-72252, H2-80839, H3-24346, and Japanese Utility Model First Publication KOKAI Nos. H2-16846, H2-98243, H4-39349. These autotensioners have however, some problems as follows; One-way clutch is insufficient in durability due to fretting abrasion (No. S63-167163). Internal structures are so complicated to need difficult and costive production processes (No. H2-72252, H2-80839, H3-24346, H2-16846, H2-98243).

In addition, Japanese Patent First Publication No. S63-167163 discloses an autotensioner having a one-way clutch between the viscous damper and the swinging member.

Japanese Patent First Publication No. H2-80839 and Japanese Utility Model First Publication No. H2-16846 disclose a ratchet mechanism in the damper apparatus.

Japanese Patent First Publication No. H2-72252, Japanese Patent First Publication No. H3-24346 and Japanese Utility Model Publication No. H2-98243 discloses a one-way damper apparatus with a check valve.

Japanese Utility Model First Publication No. H4-39349 discloses a damper apparatus having a slope surface for the viscous liquid to easily flow in one direction only.

Japanese Patent First Publication KOKAI No. S62-274143 and Utility Model First Publication KOKAI No. S60-52458 disclose an autotensioner structure comprising a rocking member and a damper apparatus separated from the rocking member, each mounted to the front face of the engine cylinder block.

The properties in some autotensioners may, however, be subject to secular change due to abrasion in components, and the pulley may not follow well due to effects of viscous liquid resistance even when the belt is slackening (No. H2-72252, No. H3-24346, No. H2-98243, No. H4-39349).

And, some autotensioners need larger installation spaces, and are insufficient in following rapid decrease in belt tension (No. S62-274143 and No. S60-52458).

SUMMARY OF THE INVENTION

The present invention provides an autotensioner for use in applying a tension to a moving belt, comprising: a base member having a projection, a rocking member rockingly mounted to the base member through a first axle and having an arm, a pulley rotatably mounted to the rocking member through a second axle for applying the tension to the moving belt, and a damper apparatus provided between the projection of the base member and the arm of the rocking member, the damper apparatus comprising; a cylinder having upper and lower chambers and a lower section with a bottom, a piston fitted into the cylinder so as to move within a stroke with uppermost and lowermost ends and having an upper section formed with a push member, a spring member provided between the lower section of the cylinder and the piston, and placed under compression so as to push the piston up, the lower chamber in the cylinder defined by the cylinder bottom and the piston, the upper chamber in the cylinder formed over the piston, a viscous fluid contained in the lower and upper chambers in the cylinder, a leakage path for communicating the lower chamber with the upper chamber so as to apply a resistance to the viscous fluid flowing from the lower chamber to the upper chamber, and a release path for communicating the lower chamber with the upper chamber and having a check valve which is opened when the viscous fluid flows from the upper chamber to the lower chamber and is closed when the viscous fluid flows from the lower chamber to the upper chamber, the push member comprising a lower body and an upper protrusion, the lower body being hollow and dividing the upper chamber into an inner space within the lower body and an

outer space outside the lower body separated from the inner space, the inner space having an upper vent passage provided adjacent the upper protrusion to be communicated with the outer space, and the release path provided through the piston for communicating the lower chamber with the inner space, whereby the viscous fluid has a liquid surface kept in the outer space above the upper vent passage even when the push member is raised to the uppermost end of its stroke.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front elevational view showing one example of a use of a conventional autotensioner;

FIG. 2 is a front elevational view showing an example of an autotensioner related to the present invention;

FIG. 3 is a front elevational view of another example of an autotensioner related to the present invention;

FIG. 4 is a longitudinal cross sectional view of an autotensioner damper apparatus related to the present invention;

FIG. 5(A) and FIG. 5(B) are longitudinal cross sectional views illustrating another embodiment of a damper apparatus in a contracted condition and an extended condition;

FIG. 6 is a front elevational view showing an example of use of an autotensioner according to the present invention;

FIG. 7(A) to FIG. 7(E) are longitudinal cross sectional views of the damper apparatus of FIG. 4;

FIG. 8(A) to FIG. 8(F) are longitudinal cross sectional views of the damper apparatus of FIG. 5;

FIG. 9 is a cross sectional view of a lower portion of a damper apparatus illustrating a condition wherein air has entered

into a region below the piston;

FIG. 10 is a longitudinal cross sectional view of another embodiment of the present invention in a contracted condition;

FIG. 11 is a longitudinal cross sectional view illustrating an extended condition of the embodiment of FIG. 10;

FIG. 12(A) to FIG. 12(E) are longitudinal cross sectional views illustrating successive stages from the contracted to the extended condition;

FIG. 13 is a cross sectional view of an upper portion of another embodiment of the present invention;

FIG. 14 is a cross sectional view showing a part of a seal ring of FIG. 13;

FIG. 15 is a perspective view of the seal ring of FIG. 13;

FIG. 16(A), and FIG. 16(B) are longitudinal cross sectional views illustrating another embodiment of the present invention in a contracted condition and an extended condition; and

FIG. 17 is a longitudinal cross sectional view of another embodiment of the present invention in a contracted condition.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The autotensioner of the present invention as shown in FIG. 2 comprises a rocking or pivotable member 12 having a base end pivotally mounted on a fixed shaft 11 which is provided on a fixed or base member 10, and a pivot shaft or axle 13 which is aligned in parallel with the fixed shaft 11 provided on a tip end thereof. A pulley 5 is supported on the pivot shaft 13 so as to rotate freely therearound, and a belt 1 to which a tension is applied is wrapped around a portion of the pulley 5. A coil

spring 14 has a coil portion 15 for applying a resilient force to the rocking member 12 in a direction so as to press the pulley 5 against the belt 1. The coil portion 15 is arranged around the fixed shaft 11. The coil spring 14 also has a pair of engagement portions 16a, 16b on the ends of the coil spring 14 which are respectively engaged with the fixed or base member 10 and the rocking member 12, so that the force is applied to the rocking member 12 in the abovementioned direction.

Moreover, a damper apparatus 19 having a cylinder 20 with a base end and a plunger or push member 22 with a tip end is provided between a fixed side arm or projection 17 on the fixed or base member 10 and a rocking side arm 18 on the rocking member 12. With the construction shown in the FIG. 2, the base end of the cylinder 20 is fixed in an end portion of the fixed side arm 17, and the tip end of the plunger 22 is abutted against a lower face of a bearing block 21 fixed to an end portion of the rocking side arm 18.

With the autotensioner shown in FIG. 3, the fixed member 10 as in the construction of FIG. 2 has been omitted. In this case the damper apparatus 19 is supported in the tip end of the rocking side arm 18, with a portion at the bottom end of the damper apparatus 19 protruding from the lower face of the rocking side arm 18 so as to abut against a protrusion (not shown in the figure) formed on a fixed portion such as the front face of the engine cylinder block. In addition, the engaging end 16a of the coil spring 14 is connected to this fixed portion.

The damper apparatus 19 for either of the above arrangements of autotensioner is constructed as shown in FIG. 4 or FIG. 5(A),

5(B). With these constructions, a cylindrical tube member 24 (referred to as "cylinder" hereinafter) containing a viscous liquid 23 such as silicone oil, has an open upper end and a closed lower end with bottom. A piston 25 is fitted inside a lower half of the cylinder 24 so as to move freely up and down therein. There is a plunger or push member 22 above the piston 25.

A very small gap is provided between an outer peripheral face of the piston 25 and an inner peripheral face of the cylinder 24, so that the viscous liquid 23 can flow slowly between the regions above and below the piston 25 by way of this small gap.

A compression spring 26 is provided between a lower face of the piston 25 and an upper face of the base of the cylinder 24 to urge the piston 25 in an upward direction.

In addition, the plunger 22 has a base or lower body 28 which is fitted inside an upper half of the cylinder 24 so as to move freely in an upward and downward direction, with a seal 29 provided between the inner peripheral face of the cylinder 24 and an outer peripheral face of the base or lower body 28 to give a fluid tight seal therebetween.

A plurality of cut-outs 30 are formed in an upper end face of the piston 25 whereby an inner space 31 existing inside a region of abutment of the base or lower body 28 and the piston 25 is communicated with the beforementioned small gap.

The piston 25 also comprises a partition wall 32 with a central portion thereof formed with a through hole 33 which provides a passage communicating between the upper and lower

sides of the piston 25. A check valve 34 is provided on a lower side of the partition wall 32 for open/closing the through hole 33. The check valve 34 comprises a ball 39 which is urged by a spring 38 to resiliently press against the lower end opening of the through hole 33, and functions so as to open only when the piston 25 is displaced in an upward direction by the resilient force of the compression spring 26.

With the first embodiment of damper apparatus 19 shown in FIG. 4, the outer diameter of an end portion or protrusion 27 of the plunger 22 is made a certain amount smaller than the inner diameter of the cylinder 24, and a lower half portion of an upper space 35 formed between an outer peripheral face of the end portion 27 and an upper inner peripheral face of the cylinder 24 is also filled with viscous liquid 23. In addition, through holes 36 are provided in the portion between the base 28 and the end portion 27, so that the viscous liquid 23 can freely flow therethrough between the upper space 35 and the inner space 31.

A seal ring 37 is provided between the upper inner peripheral face of the cylinder 24 and the outer peripheral face of the end portion 27 to cover the upper end opening of the upper space 35.

On the other hand, with the embodiment of damper apparatus 19 shown in FIG. 5(A) and FIG. 5 (B), wherein FIG. 5(A) shows the contracted condition of the damper apparatus 19, while FIG. 5(B) shows the extended condition, the end portion 27a has a relatively large diameter, so that the internal volume of the end portion 27a is made large. Instead, the through holes 36 of FIG. 4 for communicating between the interior and exterior of the

plunger 22 are omitted.

When the damper apparatus 19 of FIGs. 5(A) and 5(B) is assembled in the autotensioner as shown in FIG. 3, the cylinder 24 protrudes from the lower face of the rocking side arm 18, so that the lower end face of the cylinder 24 can abut against an upper face of a protrusion formed on a fixed portion such as the front face of the engine cylinder block.

The autotensioner incorporating the damper apparatus 19 constructed as above and assembled in the previously described manner is fitted to an engine as shown in FIG. 6, so as to produce an appropriate tension force in a cam shaft drive belt 1. In using the autotensioner as shown in FIG. 6, the rocking member 12 is swung by the resilient force of the coil spring 14 so that the pulley 5 which is rotatably mounted on the pivot shaft 13 at the tip end of the rocking member 12 is resiliently pressed against the belt 1. The rocking member 12 is restricted in rocking by the pressing of the pulley 5 against the belt 1.

In this condition, the damper apparatus 19 provided between the rocking side arm 18 and the fixed side arm 17 (for the construction of FIG. 2) or between the rocking side arm 18 and the protrusion (not shown) formed on the fixed portion of for example the cylinder block (for the construction of FIG. 3), provides a support or tension condition between the rocking side arm 18 and the fixed side arm 17 (or the protrusion), which depends on the resilient force of the compression spring 26.

When the belt 1 slackens from this condition, the rocking member 12 swings under the resilient force of the coil spring 14 so that the pulley 5 follows the movement of the belt 1. At this

time, the displacement of the plunger 22 of the damper apparatus 19 is slightly delayed so that the tip end of the plunger 22 and the lower face of the bearing block 21 (for the construction of FIG. 2), or the lower face of the cylinder 24 and the upper face of the protrusion (for the construction of FIG. 3, not shown) separate from each other.

Therefore, when the belt 1 slackens, the rocking member 12 swings so that the pulley 5 follows the movement of the belt 1 with absolutely no resistance from the damper apparatus 19. The pulley 5 can thus quickly follows the movement of the belt 1 thereby avoiding a drop in tension of the belt 1. Meanwhile the overall length of the damper apparatus 19 is extended under the resilient force of the compression spring 26 with a slight lag behind the movement of the rocking member 12.

During extension of the damper apparatus 19 under the resilient force of the compression spring 26, the check valve 34 opens. That is to say, the ball 39 moves relatively downwards against the resilient force of the spring 38 thus opening the lower end opening of the through hole 33 formed in the partition wall 32. As a result, the viscous liquid 23 flows freely from the upper side of the partition wall 32 to the lower side, so that the piston 25 and the plunger 22 rise comparatively quickly. There is thus only a very short time delay before the damper apparatus 19 again provides a support or tension between the rocking side arm 18 and the fixed side arm 17 (or the protrusion).

On the other hand, when the tension in the belt 1 increases, the rocking member 12 tends to rock against the resilient force

of the coil spring 14. In this situation, the rocking side arm 18 presses the damper apparatus 19 in a compressive direction. Therefore, in this case the rocking of the rocking member 12 requires the plunger 22 and the piston 25 to be pressed against the resistance of the compression spring 26, into the cylinder 24.

At this time, since the check valve 34 remains closed, then for the piston 25 to move in a downward direction, the viscous liquid 23 in the region below the piston 25 must flow to the region above the piston 25 by way of the small gap between the inner peripheral face of the cylinder 24 and the outer peripheral face of the piston 25. However, due to the limitation on the amount of viscous liquid 23 that can flow by way of the small gap, the displacement of the piston 25 and the plunger 22 can only proceed slowly. As a result, the pulley 5 supported on the rocking member 12 can only move slowly so that the belt 1 is controlled or retained by the pulley 5 thus suppressing the growth of vibration in the belt 1.

With the autotensioner damper apparatus constructed as described above and fitted to an autotensioner in the above embodiments, when the tension of the belt 1 is quickly and considerably reduced from a high tension condition, there is the possibility of air entering into the region below the piston 25. If this occurs the performance of the damper apparatus 19 is reduced.

This phenomena of a sudden reduction in tension from a high tension condition of the belt 1 often occurs at the time of starting and stopping the engine. When this occurs the overall

length of the damper apparatus 19 is rapidly extended by the resilient force of the compression spring 26 from the compressed condition.

For example, with the damper apparatus 19 having the construction shown in FIG. 4, when the abovementioned phenomena occurs, then the damper apparatus 19 once compressed as shown in FIG. 7 (A) extends by way of the conditions of FIG. 7(B) to FIG. 7(D) to the condition shown in FIG. 7(E). When the damper apparatus 19 contracted shown in FIG. 7(A) extends, then at first as shown in FIG. 7(B), the check valve 34 opens, and the plunger 22 and piston 25 start to rise.

With the rise of the piston 25, the viscous liquid 23 in the upper space 35 flows into the inner space 31 by way of the through holes or upper vent passage 36. At this time however, as shown in FIG. 7(C), air 40 in the upper space 35 also enters into the inner space 31 by way of the through holes 36. If the piston 25 rises rapidly, then as shown in FIG. 7(D), the air 40 entering the inner space 31 from the through holes 36 passes through the inner space 31 and through the through hole 33 in the center of the partition wall 32, and reaches the region below the partition wall 32.

Then after the piston 25 stops rising and the check valve 34 closes, a portion of the air 40 which has passed into the region below the partition wall 32 remains there below the partition wall 32 as shown in FIG. 7(E), and FIG. 9.

Also with the damper apparatus 19 having the construction shown in FIGs. 5(A) and 5(B), during displacement from the contracted condition shown in FIG. 8(A) to the extended condition

shown in FIG. 8(F) by way of the conditions of FIG. 8(B) to FIG. 8(E), the air 40 enters into the region below the partition wall 32.

Since the air 40 which has entered in this way to the region below the partition wall 32 is a compressible fluid in contrast to the incompressible viscous liquid 23, it resiliently expands and contracts over the full length of travel of the damper apparatus 19 so that the performance of the damper apparatus 19 is deteriorated.

The autotensioner dampers of subsequent embodiments of the present invention are directed towards preventing air entering into the region below the piston 25, so as to prevent the resultant deterioration in performance as mentioned above.

The autotensioner damper apparatus according to the subsequent embodiments is installed in the autotensioner which comprises a fixed member, a fixed shaft provided on the fixed member, a rocking member with a base end supported on the fixed shaft so as to rotate freely thereabout, a pivot shaft aligned in parallel with the fixed shaft and provided on a tip end of the rocking member, a pulley supported on the pivot shaft so as to rotate freely therearound, and a tension spring for applying a resilient force to the rocking member in a direction so as to press the pulley against the belt. Specifically, the damper apparatus is provided between a fixed portion and a rocking side arm provided on the rocking member.

Such an autotensioner damper apparatus according to the these embodiments, as with the damper apparatus assembled in the autotensioner of the beforementioned embodiments, comprises a

cylindrical member or cylinder containing a viscous liquid, a piston fitted inside the cylinder so as to move freely in an axial direction, a spring provided between the piston and the cylinder for urging the piston in one direction, a plunger or push member which follows the displacement of the piston under the urging force of the spring so as to increasingly protrude from the cylinder, a passage connecting between opposite sides of the piston in an axial direction, and a check valve for opening/closing the passage. The check valve functions so as to only open the passage when the piston is displaced by the resilient force of the spring.

In particular, with the autotensioner damper apparatus of these embodiments, the cylinder is cylindrical in shape with an open upper end and a closed lower end, and the spring is a compression spring provided between the upper face of the bottom of the cylinder and the lower face of the piston. A lower half of the plunger is formed with a cylindrical portion which slides within the inner peripheral face of the cylinder, and an upper half is formed with a rod portion having an outer diameter a certain amount smaller than the inner diameter of the cylinder. A through hole for communicating between the interior and exterior of the cylindrical portion is provided in a portion between the cylindrical portion and the rod portion. In this damper apparatus, the quantity of viscous liquid contained inside the cylinder is controlled such that the liquid surface is always above the through hole, even in the situation wherein the plunger has been raised under the resilient force of the spring to the end of its travel.

When the autotensioner damper in these embodiments is installed into an autotensioner so as to control vibration in a belt, the operation at the time of controlling the displacement of the rocking member supporting the pulley is similar to that of the autotensioner dampers of the previous embodiments.

In particular, with the autotensioner damper of these embodiments, since the amount of viscous liquid is more than sufficient, then even if the damper apparatus is extended suddenly, there is little likelihood of the air above the viscous liquid passing into the interior of the plunger by way of the through hole. As a result, the air cannot enter into the region below the piston so that the reduction in performance of the damper due to air can be avoided.

Such an embodiment of the present invention is shown in FIG. 10. A cylindrical member or cylinder 24 having an open upper end and a closed lower end and containing a viscous liquid, is fitted with a piston 25 which slides freely in an upward and downward direction therein.

A compression spring 26 is provided between the lower face of the piston 25 and an upper face of the base of the cylinder 24 to thus apply a resilient force on the piston 25 in an upward direction.

A plunger 22a is provided on the upper side of the piston 25, so that the amount that the plunger 22a protrudes from the cylinder 24 increases as the piston 25 rises under the resilient force of the compression spring 26.

A through hole 33 is formed in a central portion of a

partition wall 32 of the piston 25 to provide a passage for communication between the regions above and below the piston 25.

A check valve 34 comprises a spring 38 and a ball 39 provided on a lower side portion of the partition wall 32. This check valve 34 opens only when the piston 25 is raised by the urging force of the spring 26.

A lower half of the plunger 22a is formed with a cylindrical portion 41 which slides on the inner peripheral face of the cylinder 24, and an upper half is formed with a rod portion 42 having an outer diameter a certain amount smaller than the inner diameter of the cylinder 24. The rod portion 42 is a solid body, different from the construction of the previous embodiments illustrated in FIG. 4.

Through holes 36 are provided in the portion between the cylindrical portion 41 and the rod portion 42, thus connecting the upper space 35 and the inner space 31.

The abovementioned construction resembles that of the autotensioner damper apparatus 19 of the previous embodiment illustrated in FIG. 4. However, in the case of the autotensioner damper of the present embodiment, the quantity of viscous liquid 23 contained in the cylinder 24 is greater. That is to say, with the damper of the present embodiment, the quantity of viscous liquid 23 is such that the liquid surface is always above the through holes 36, even in the situation as shown in FIG. 11 wherein the plunger 22a has been raised under the resilient force of the spring 26 to the end of its travel.

When the autotensioner damper according to the present embodiment constructed as above is fitted to an autotensioner as

illustrated in FIG. 2 and FIG. 3 so as to control vibration in a belt 1, the operation at the time of controlling the displacement of the rocking member 12 supporting the pulley 5 is similar to that of the autotensioner dampers of the previous embodiments.

In particular, with the autotensioner damper of the present embodiment, since the amount of viscous liquid 23 is more than sufficient, then even if the damper apparatus is extended suddenly from the contracted condition shown in FIG. 10 to the extended condition shown in FIG. 11, there is little likelihood of the air above the viscous liquid 23 passing into the interior of the plunger 22a by way of the through hole 36.

That is to say, when the belt tension changes suddenly with starting and stopping of the engine, and the overall length of the damper apparatus 19 is extended rapidly from the compressed condition by the resilient force of the spring 26, then the damper apparatus 19 once compressed as shown in FIG. 12 (A) extends by way of the conditions of FIG. 12(B) to FIG. 12(D) to the condition shown in FIG. 12(E).

With the damper apparatus 19 according to the present embodiment, the liquid surface of the viscous liquid 23 in the initial extension stages of FIG. 12(B) and FIG. 12(C), is sufficiently above the through holes 36. As a result, the air 40 does not enter into the through holes 36 during these stages.

In the final extension stage of FIG. 12(D), the level is close to the through holes 36 so that the air 40 could enter into the through holes 36. However, since immediately after this, the rising of the piston 25 is stopped, then, while the air 40 may pass into the inner space 31 it can not reach as far as the

through hole 33.

There is thus no possibility of the air 40 entering down as far as the region below the piston 25, so that the drop in performance of the damper device due to the air 40 is avoided.

As follows is a description of another embodiment of the present invention with reference to FIG. 13 to FIG. 15. With this embodiment, the air is able to pass freely into and out of the upper air space 35 by way of a seal ring 37 which is insertingly fitted into the upper end opening of the cylinder 24, to cover the upper end opening of the upper space 35. To achieve this a small hole 44 is formed in a portion of the core 43 of the seal ring 37, and a slit 46 is made in the resilient material 45 of the seal ring 37 above the small hole 44, and a small hole 47 is made in the resilient material 45 below the small hole 44.

Consequently, when the pressure inside the upper space 35 changes due for example to changes in temperature, the air can flow into or out of the upper space 35 by way of the holes 44 and 47 and the slit 46 to thus alleviate any pressure change inside the upper air space 35. Since the slits 46 are normally closed, there is little possibility of dust and the like getting into the upper space 35.

FIG. 16(A) and FIG. 16(B) show another embodiment of the present invention. With this embodiment, a cover member 48 made from a resilient material such as rubber is provided between the outer peripheral face of the upper end of the cylinder 24 and the outer peripheral face of the upper end of the plunger 22a. The cover member 48 resiliently deforms with the rising of the plunger 22a between the conditions shown in FIG. 16(A), and FIG.

16(B), and reliably prevents the ingress of dust into the upper air space 35. Moreover, any pressure change inside the upper air space 35 is alleviated by resilient deformation of the cover member 48.

FIG. 17 shows another embodiment of the present invention. With this embodiment, a bellows 49 made from a resilient material such as rubber is provided between the outer peripheral face of the upper end of the cylinder 24 and the outer peripheral face of the upper end of the plunger 22a. The bellows 49 prevents the ingress of dust into the upper space 35. Moreover, any pressure change inside the upper space 35 is alleviated by resilient deformation of the bellows 49.

With the autotensioner dampers of the embodiments constructed and operated as described above, since air can be reliably prevented from entering into the region below the piston, then deterioration in damper performance due to air is avoided.

Accordingly, in the present invention, the autotensioner has a pulley which is improved in following the rapid change in tension in the belt.

What is Claimed is:

1. An autotensioner for use in applying a tension to a moving belt, comprising:

a base member having a projection,

a rocking member rockingly mounted to the base member through a first axle and having an arm,

a pulley rotatably mounted to the rocking member through a second axle for applying the tension to the moving belt, and

a damper apparatus provided between the projection of the base member and the arm of the rocking member,

the damper apparatus comprising;

a cylinder having upper and lower chambers and a lower section with a bottom,

a piston fitted into the cylinder so as to move within a stroke with uppermost and lowermost ends and having an upper section formed with a push member,

a spring member provided between the lower section of the cylinder and the piston, and placed under compression so as to push the piston up,

the lower chamber in the cylinder defined by the cylinder bottom and the piston,

the upper chamber in the cylinder formed over the piston,

a viscous fluid contained in the lower and upper chambers in the cylinder,

a leakage path for communicating the lower chamber with the upper chamber so as to apply a resistance to the viscous fluid flowing from the lower chamber to the upper chamber, and

a release path for communicating the lower chamber with the

upper chamber and having a check valve which is opened when the viscous fluid flows from the upper chamber to the lower chamber and is closed when the viscous fluid flows from the lower chamber to the upper chamber,

the push member comprising a lower body and an upper protrusion,

the lower body being hollow and dividing the upper chamber into an inner space within the lower body and an outer space outside the lower body separated from the inner space,

the inner space having an upper vent passage provided adjacent the upper protrusion to be communicated with the outer space, and

the release path provided through the piston for communicating the lower chamber with the inner space,

whereby the viscous fluid has a liquid surface kept in the outer space above the upper vent passage even when the push member is raised to the uppermost end of its stroke.

2. The autotensioner of Claim 1, wherein the inner space has a lower portion communicated with the outer space.

3. The autotensioner of Claim 1, wherein the leakage path is provided between the outer periphery of the piston and the inner periphery of the cylinder.

4. The auto tensioner of Claim 1, further comprising a biasing spring placed between the rocking member and the base member and adapted to apply an elastic force to the pulley so as to press the belt.

5. The autotensioner of Claim 4, wherein the inner space has a lower portion communicated with the outer space.

6. The autotensioner of Claim 4, wherein the leakage path is provided between the outer periphery of the piston and the inner periphery of the cylinder.

7. An autotensioner substantially as hereinbefore described with reference to the accompanying drawings.

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Examiner's report to the Comptroller under Section 17
(The Search report)

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29 September 1994

Databases (see below)
(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

(ii)

Documents considered relevant following a search in respect of Claims :-
1 to 7

Categories of documents

X: Document indicating lack of novelty or of inventive step.

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A: Document indicating technological background and/or state of the art.

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Category	Identity of document and relevant passages		Relevant to claim(s)
X	GB 2224095 A	(NTN) see particularly lines 8 to 20 of page 4 and lines 10 to 24 of page 5	1,2,3, 4,5,6
X	EP 0212119 A2	(TSUBAKIMOTO) see lines 1 to 20 of page 10, lines 33 of page 12 to line 14 of page 13, line 29 of page 23 to line 14 of page 24	1,2,3

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