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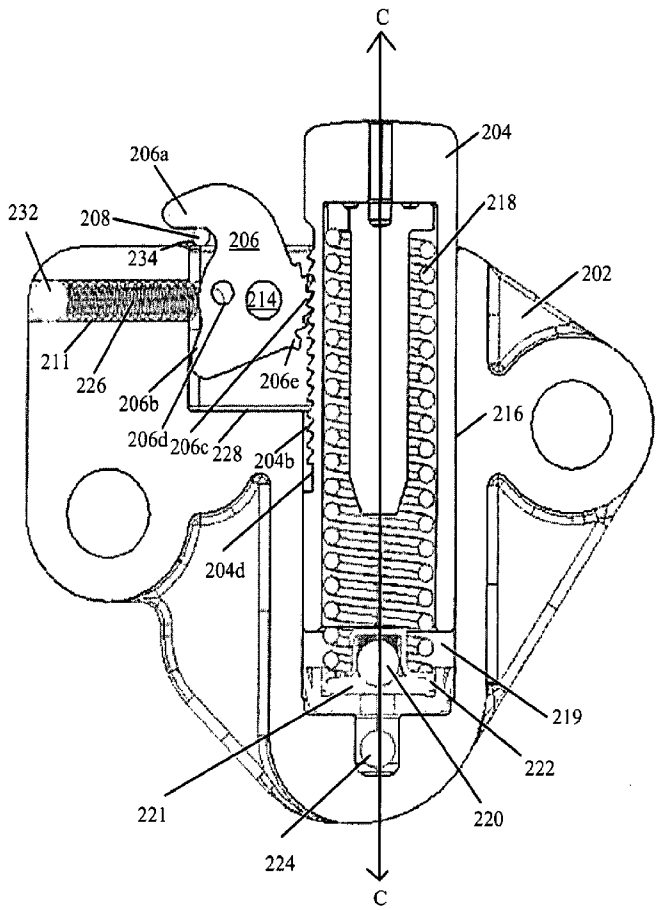
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(54) Title: RATCHETING TENSIONER WITH A SLIDING AND PIVOTING PAWL



(57) Abstract: A tensioner with a piston is slidably received with a bore (216) of the housing and has a plurality of grooves (204b) formed on its outer circumference. A piston spring (226) biases the piston (204) in an outward direction from the bore. A pawl (206) is received by a cutout in the housing and is pivotally and slidably attached to the housing by a pin (208). The pawl has a first protruding shoulder (206a), a second shoulder (206b), a teeth portion (206c), and a hole (211) defined between the first protruding shoulder and the second shoulder. The pawl is biased toward the grooves formed on the outer circumference of the piston by a spring.

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RATCHETING TENSIONER WITH A SLIDING AND PIVOTING PAWL

REFERENCE TO RELATED APPLICATIONS

This application claims one or more inventions which were disclosed in Provisional Application Number 60/746,659, filed May 8, 2006, entitled "RATCHETING TENSIONER WITH A SLIDING AND PIVOTING PAWL". The benefit under 35 USC §119(e) of the United States provisional application is hereby claimed, and the aforementioned application is hereby incorporated herein by reference.

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The invention pertains to the field of tensioners. More particularly, the invention pertains to tensioners with a sliding and pivoting pawl.

DESCRIPTION OF RELATED ART

In chain and belt tensioners, pistons are urged from their housings by a spring or a spring plus hydraulic pressure. Check valves are added to tensioners between the pressurized fluid source and the fluid chamber formed between the housing and the piston to prevent backflow of the hydraulic fluid out of the fluid chamber. The rate of leakage between the piston to the bore clearance allows the retraction of the piston as makeup fluid subsides or ceases. As the rate of leakage increases, the restriction or retraction of the piston lessens and as the rate of leakage decreases, the restriction or retraction of the piston increases. When chain load spikes or a loss of fluid pressure is present, retraction of the plunger occurs and if the retraction of the plunger is excessive, loss of chain control or other undesirable effects occur. Therefore, limiting the amount of piston retraction is desirable.

A ratchet device that is used to limit the piston retraction must allow the plunger to retract and reduce chain load when fluid pressure is reduced during engine shutdown, but

not so much as to leave the chain uncontrolled during engine restart. The retraction of the piston is limited by the amount of backlash added to the ratchet.

Figure 1 shows a pivoting pawl ratchet tensioner 10 of U.S. Patent No. 4,874,352. The tensioner includes a tensioner housing 9 with a bore for receiving a hollow piston 3 with a rack 13 along its outer circumference and a pivoting ratchet pawl 12 biased towards the rack 13 by spring 11. The bore creates a fluid chamber 17 with the hollow piston 3. Passages 7, 8 in the housing 9 connect the fluid chamber 17 with a pressurized source of fluid. A check valve, including the check ball 15, seat 5, and retainer 14 is provided between the pressurized source and the fluid chamber 17, allowing fluid into the chamber 17 only. The piston is biased outward toward chain 1 to contact shoe 2 by spring 4. When the pawl teeth are intermeshing with the rack teeth 13 of the piston 3 and moving from one tooth to the next, the pawl 12 rotates against spring 11. One of the problems with the tensioner of U.S. Patent No. 4,874,352 is that the piston 3 rotates and ratchets with the rack 13 along the outer circumference of the piston 3 up until all of the teeth on the pawl 12 no longer mesh with piston's rack 13. In other words, the piston 3 can completely exit the housing 9, since a stop mechanism is not present.

Prior art Figure 2 shows a tensioner from U.S. Patent No. 6,244,981 that uses a ratchet device. The tensioner includes a housing 36 with a bore 34 for slidably receiving a hollow piston 24 that creates a fluid chamber with the bore 34. A passage in the housing connects the fluid chamber with a pressurized source of fluid. A check valve (not shown) is provided between the pressurized source and the fluid chamber, allowing fluid into the chamber only. The piston 24 is biased by a spring 28 in a protruding direction. The piston 24 contains a series of grooves 26 on its outer surface that are engaged by a pair of pawls 30, 32, located opposite each other in vertical slots in the bore 34. The pawls 30, 32, which have flats that aid in providing backlash, are held in place by circlips 22. One of the two pawls 30, 32 is located higher up on the bore 34 than the other. As the piston 24 extends it engages one of the pawls 30, 32, and then the other, providing limited retraction of the piston 24.

Figures 3a and 3b show a prior art tensioner from U.S. Patent No. 5,967,921. The tensioner 50 maintains tension on chain 57 wrapped around sprockets 54, 56 by pushing

on a pivoting 51 tensioner arm 53. The tensioner 50 includes a housing 68 with a bore 72 for receiving a sleeve 64. The sleeve is fixedly attached to the bore in the housing. A hollow piston 55 is slidably received in the sleeve 64, creating a fluid chamber 74 with the sleeve 64. A check valve 60 comprising a valve member 62 biased by a valve spring 59 against a valve support member 58 and a seal member 61 connects the fluid chamber with a pressurized source of fluid through passage 81, and allows fluid into the fluid chamber only. The piston 55 is biased by spring 73 in a protruding direction from the housing 68. The piston 55 has a series of grooves 82 on its outer surface that are engaged by a clip 83 to prevent the piston 55 from retracting too far when the engine is stopped. The clip 83 is attached to the sleeve 64 or housing 68. A vent disk 79 may be present at the end of the fluid chamber, closest to the tip 63 of the piston 55, for the passage of air out of the tensioner.

Figure 4 shows a cartridge type tensioner from U.S. Patent No. 6,685,587. The tensioner has a cylinder or body 91 that slidably receives a piston 92 in a bore 93 of the cylinder 91. The cylinder has a head 94 and thread 95 for attaching to the engine block. The piston 92 is biased outward from the cylinder 91 by spring 96 and fluid. The fluid enters the bore 93 from a passage 108 attached to a source and moves through a check valve 99 to the bore. In order to prevent the uncontrolled reentry of the piston 92 into the cylinder 91, during a partial emptying of the bore 93 of fluid, the piston has at least one longitudinal rack 97 in which a toothed pad 98, biased by a spring 102, engages, passing through an aperture 109 of the cylinder. The toothed pad 98 is guided by a pad base 100 and slides in a corresponding seat 101 in the cylinder adjacent to the aperture 109.

SUMMARY OF THE INVENTION

A tensioner with a piston is slidably received within a bore of the housing and has a plurality of grooves formed on its outer circumference. A fluid chamber is formed between the piston and the bore of the housing. A check valve is present in the fluid chamber to allow fluid from a source into the chamber only. A piston spring biases the piston in an outward direction from the bore. A rotating sliding pawl is received by a cutout in the housing and is pivotally and slidably attached to the housing by a through pin in a pair of mating slots. The pawl has a first protruding shoulder, a second shoulder, a

teeth portion, and a hole defined between the first protruding shoulder and the second shoulder. The pawl is biased toward the grooves formed on the outer circumference of the piston by a spring received by a first hole in the housing adjacent to the cutout of the housing. The first end of the spring abuts with the plugged end of the first hole of the housing and the second end of the spring abuts with the rotating sliding pawl.

When hydraulic fluid pressure is absent or inadequate in the fluid chamber, and slack in the chain has decreased, the piston is biased inwards towards the housing by the chain. The shoulders of the grooves on the outer circumference of the piston apply a vertical force inwards towards the housing on the shoulders of the teeth of the pawl, rotating the pawl until the second protruding shoulder contacts the housing, preventing the piston from moving further inwards towards the housing.

When hydraulic fluid pressure is present or adequate in the fluid chamber, and slack in the chain has increased, the piston is biased outwards from the housing and as a result of the design and mesh of the pawl teeth and piston grooves, applies a vertical force outwards from the housing and a horizontal force towards the pawl relative to a centerline of the piston. The vertical force causes the pawl to rotate until the first protruding shoulder contacts the housing stopping further rotation. The horizontal force causes the pawl to slide perpendicular to the centerline of the piston against the spring to disengage the teeth of the pawl from the grooves on the piston, allowing further outwards movement of the piston from the housing.

The housing also has a pair of slots and a pair of second holes. The pair of slots receive the through pin, pivotally and slidably attaching the rotating sliding pawl to the housing. The pair of second holes are partially aligned with the hole of the pawl defined between the first protruding shoulder and the second shoulder. The front second hole receives an external pin, catching the hole of the pawl, sliding the pawl and the pawl teeth away from the piston bore until the pin can engage the rear second hole, locking the pawl away from the piston bore, for component assembly or piston resetting purposes.

Ejection of the piston from the bore of the housing is prevented when the pawl rotates, such that the first protruding shoulder contacts the housing and the teeth portion

closest to the second shoulder engage a shoulder in a stop groove on the outer circumference of the piston.

The tensioner is placed in a shipping or assembly position when an external pin is received between the first protruding shoulder and the housing, for locking the pawl into position.

BRIEF DESCRIPTION OF THE DRAWING

Fig. 1 shows a prior art tensioner.

Fig. 2 shows another prior art tensioner.

Fig. 3a shows a prior art tensioner.

Fig. 3b shows a close-up of the tensioner of Figure 3a.

Fig. 4 shows another prior art hydraulic tensioner.

Fig. 5 shows an exterior view of the tensioner of the present invention, pinned for shipping and/or assembly.

Fig. 6 shows a section through the center of the piston in Figure 5.

Fig. 7 shows a sectional view of the tensioner of the present invention with the pawl pivoted and slid away from the piston, pinned in the disengaged state.

Fig. 8 shows an exterior view of the tensioner position shown in Figure 7.

Fig. 9 shows a sectional view of the tensioner of the present invention with the pawl having pivoted for providing backlash and ratcheting against a spring.

Fig. 10 shows a sectional view of the tensioner of the present invention with the pawl ratcheted to the end of the piston's stroke.

Fig. 11 shows another sectional view of the tensioner of the present invention with the pawl ratcheted to the end of the piston's stroke.

Fig. 12 shows a schematic of the housing without the piston or the pawl present.

Fig. 13 shows a close-up of the meshing between the teeth of the pawl and the grooves on the piston and the forces applied when hydraulic fluid pressure is present.

Fig. 14 shows a close-up of the meshing between the teeth of the pawl and the grooves on the piston and the force applies when hydraulic fluid pressure is not adequate or present.

DETAILED DESCRIPTION OF THE INVENTION

Figures 5 through 13 show the tensioner of the present invention. The tensioner includes a housing 202 having a cutout 228 for receiving a rotating, sliding pawl 206 and a bore 216 for slidably receiving a hollow piston 204 that creates a fluid chamber 219 with the bore 216. A passage 224 in the housing 202 connects the fluid chamber 219 with a pressurized source of fluid. A check valve 221 comprising a check ball 220 and a seat 222, allows fluid into the fluid chamber 219 only. The piston 204 is biased by a piston spring 218 in a protruding direction from the housing 202 toward a chain or belt (not shown). The piston 204 contains a series of grooves 204b around or across, at least a portion of the outer circumference of the piston 204 for ratcheting with the rotating, sliding pawl 206. At least one of the grooves acts as a stop 204d, to help prevent the ejection of the piston 204 from the housing 202.

The rotating, sliding pawl 206 is rotatably attached to the housing by a pin 214. The pawl 206 has a first protruding shoulder 206a, a second shoulder 206b, a teeth portion 206c, with a stop tooth 206e, and a pawl hole 206d between the first protruding shoulder 206a and the second shoulder 206b. The teeth of the teeth portion 206c are preferably wedge-shaped. The stop tooth 206e of the pawl 206 only engages the shoulder 204e of the stop groove 204d of the piston 204. The rotating, sliding pawl 206 is biased toward the grooves 204b on the outer circumference of the piston 204 by spring 226 received in a first hole 211 adjacent to the cutout 228 of the housing 202. Within the hole 211 of the housing 202 is a press fit ball 232 in which the inner end of the spring 226 abuts against. The opposite end of the spring 226 abuts against the pawl 206.

The housing 202 also contains a pair of aligned slots 212 for receiving a through pin 214, which pivotally connects the pawl to the housing and a pair of second holes 210a, 210b that are aligned and may receive an external pin 208. The external pin preferably has a tapered end. The pair of second holes 210a, 210b are partially aligned with a pawl hole 206d defined by the pawl 206 in between the first protruding shoulder 206a and the second shoulder 206b.

Figures 5 and 6 show the tensioner pinned for shipping or assembly to the engine. In this position, a pin 208 is placed between a stop 234 of the housing 202 and the first protruding shoulder 206a of the rotating pawl 206. By placing the pin 208 between the first protruding shoulder 206a and the stop 234 of the housing 202, the pawl 206 cannot rotate or slide away from the grooves 204b on the outer circumference of the piston 204. The teeth 206c of the pawl 206 are locked into contact with the grooves 204b on the outer circumference of the piston 204 by the contact of the second protruding shoulder 206b against the wall of the cutout 228 and the pin 208 between the shoulder 206a and the stop 234 of the housing 202. The intermeshing of the teeth 206c of the pawl and grooves 204b on the piston, hold the piston in place relative to the housing 202.

Figures 7, 8, and 12 show the tensioner in a position in which the pawl 206 is pinned in a disengaged state and is pivoted away from the piston 204. The tensioner may be placed in this position during assembly of the tensioner, allowing the piston 204 to be placed in the housing 202 after the pawl 206 has already been assembled and pivotally attached to the housing 202. In this position, a pin 208 is placed in the front second hole 210a of the housing 202 and the tapered end of the pin catches pawl hole 206d, sliding the pawl 206 against spring 226, moving the pawl teeth 206c away from the piston 204 and its outer grooves 204b and locking the pawl in this position with the pin 208 engaging the rear second hole 210b.

When sufficient hydraulic fluid pressure is present in the chamber 219, the teeth 206c of the pawl 206 ratchet with the grooves 204b on the outer circumference of the piston 204, and do not impede the movement of the piston 204 outwards from the housing 202. Referring to Figures 9 and 13, as the piston 204 is biased outwards from the housing 202, the grooves 204b meshed or ratcheted with the teeth portion 206c apply a force,

shown by arrow 242, in a direction outwards from the housing 202 on the ramp portion 246a of the teeth of the pawl 206, causing the pawl 206 to rotate the first protruding shoulder 206a towards the housing 202. Once the first protruding shoulder 206a contacts the housing 202, the force of the outwards movement of the piston 204 becomes horizontal or perpendicular to the piston's centerline C, shown by arrow 244 and is applied to the ramps 246a of the teeth on the pawl, since the pawl 206 cannot rotate any further in the direction of arrow 242 and the horizontal force 244 is greater than the spring force of the spring 226, and the pawl 206 slides in a perpendicular direction away from the piston's centerline C or in the direction shown by arrow 244. The horizontal force 244 is just great enough so that the teeth portion 206c of the pawl 206 may disengage or no longer mesh with the grooves 204b on the piston 204, allowing the piston 204 to move outwards from the housing 202 at least one groove worth. The spring 226 then biases the pawl teeth portion 206c of the pawl 206 back into contact with the grooves 204b on the piston 204, completing the ratcheting of one piston groove with one pawl tooth. The spring force of the spring 226 insures remeshing of the teeth 206c and the grooves 204b after fast ratcheting, based on mass, acceleration and inertia, yet at the same time does not inhibit the outward movement of the piston 204.

During engine start, stop, or during an oil pump failure/malfunction, when hydraulic fluid pressure is not present or adequate in the chamber 219 and spring 218 cannot handle tension spikes from the decreased slack in the chain, the pawl 206 meshes with and prevents the piston 204 from moving inwards towards the housing 202. Referring to Figure 14, the piston 204 is biased inwards toward the housing 202 by a force, shown by arrow 240, the pawl teeth 206c prevent the piston 204 from moving inwards towards the housing 202. The force shown by arrow 240, rotates the pawl so that the second protruding shoulder 206b contacts the housing. The teeth 206c of the pawl mesh with the grooves 204b on the piston 204, such that the shoulder 204c of the groove 204b contacts the shoulder 246b of the tooth of the pawl 206 preventing inwards movement towards the housing.

Figures 10 and 11 show the tensioner ratcheted to the end of the piston's stroke. In this position, the pawl 206 has rotated so that the first protruding shoulder 206a is in contact with the housing 202 and the bottom shoulder of the stop tooth 206e engages with

a shoulder of the stop groove 204d on the outer circumference of the piston 204. The pawl 206 does not slide away from the piston 204, against spring 226, due to the lack of a force 244. Force 244 does not exist since any further protruding movement of the piston 204 from the housing 202 is prevented by the first protruding shoulder 206a of the pawl 206 contacting the housing 202 and the engagement of the stop tooth 206e with the shoulder 204e of the stop groove 204d of the piston, preventing the piston 204 from ejecting from the bore 216 of the housing 202.

Accordingly, it is to be understood that the embodiments of the invention herein described are merely illustrative of the application of the principles of the invention. Reference herein to details of the illustrated embodiments is not intended to limit the scope of the claims, which themselves recite those features regarded as essential to the invention.

What is claimed is:

1. A tensioner for tensioning a chain comprising:

a housing having a bore;

a piston slidably received within the bore having a plurality of grooves each comprising a groove shoulder and a groove ramp, formed along at least a portion of an outer circumference of the piston, the piston forming a fluid chamber with the bore;

a piston spring biasing the piston in an outward direction from the bore; and

a rotating, sliding pawl received by a cutout in the housing and pivotally and slidably attached to the housing by a through pin, the pawl having a first protruding shoulder, a second shoulder, a teeth portion comprising a plurality of teeth each having a tooth shoulder and a tooth ramp, and a pawl hole defined between the first protruding shoulder and the second shoulder, the pawl being biased toward the grooves on the outer circumference of the piston by a spring;

wherein when hydraulic fluid pressure is absent or inadequate in the fluid chamber, and slack in the chain has decreased, the piston is biased inwards towards the housing by the chain and the groove shoulders apply a vertical force inwards towards the housing on the teeth shoulders of the pawl, rotating the pawl until the second protruding shoulder contacts the housing, such that the piston is prevented from moving further inwards towards the housing.

2. The tensioner of claim 1, further comprising a check valve in the fluid chamber.

3. The tensioner of claim 1, wherein the spring biasing the pawl into engagement with the grooves on the outer circumference of the piston has a first end received by a first

hole defined by the housing, adjacent to the cutout of the housing, and a second end abutting against the rotating, sliding pawl.

4. The tensioner of claim 1, wherein the housing further comprises a pair of slots and a pair of second holes, both defined by the housing, the pair of slots receiving the through pin pivotally attaching the rotating sliding pawl to the housing, and the pair of second holes being partially aligned with the pawl hole, defined between the first protruding shoulder and the second shoulder of the pawl.

5. The tensioner of claim 4, wherein the pair of second holes receive an external pin, catching the hole of the pawl, sliding the pawl and the pawl teeth away from outer grooves on the outer circumference of the piston.

6. The tensioner of claim 1, wherein when hydraulic fluid pressure is present or adequate in the fluid chamber, and slack in the chain has increased, the piston is biased outwards from the housing and applies a vertical force outwards from the housing and a horizontal force towards the pawl relative to a centerline of the piston on the tooth ramp, such that the vertical force rotates the pawl until the first protruding shoulder contacts the housing and the horizontal force slides the pawl perpendicular to the centerline of the piston against the spring to disengage the teeth of the pawl from the grooves on the piston, allowing outwards movement of the piston from the housing.

7. The tensioner of claim 1, wherein at least one of the grooves on the outer circumference of the piston is a stop groove.

8. The tensioner of claim 7, wherein ejection of the piston from the bore of the housing is prevented by the engagement of a tooth of the tooth portion of the pawl with a shoulder of the stop groove on the outer circumference of the piston.

9. The tensioner of claim 1, further comprising an external pin received between the first protruding shoulder and a stop on the housing for locking the tensioner in a shipping position.

10. The tensioner of claim 1, wherein backlash of the tensioner is a combination of a distance of rotation between the first protruding shoulder and the housing and a distance of rotation between the second shoulder and the housing.

11. A tensioner for tensioning a chain comprising:

a housing having a bore;

a piston slidably received within the bore having a plurality of grooves each comprising a groove shoulder and a groove ramp, formed along at least a portion of an outer circumference of the piston, the piston forming a fluid chamber with the bore;

a piston spring biasing the piston in an outward direction from the bore; and

a rotating, sliding pawl received by a cutout in the housing and pivotally and slidably attached to the housing by a through pin, the pawl having a first protruding shoulder, a second shoulder, a teeth portion comprising a plurality of teeth each having a tooth shoulder and a tooth ramp, and a pawl hole defined between the first protruding shoulder and the second shoulder, the pawl being biased toward the grooves on the outer circumference of the piston by a spring;

wherein when hydraulic fluid pressure is absent or inadequate in the fluid chamber, and slack in the chain has decreased, the piston is biased inwards towards the housing by the chain and the groove shoulders apply a vertical force inwards towards the housing on the teeth shoulders of the pawl, rotating the pawl until the second protruding shoulder contacts the housing, such that the piston is prevented from moving further inwards towards the housing;

wherein when hydraulic fluid pressure is present or adequate in the fluid chamber, and slack in the chain has increased, the piston is biased outwards from the housing and applies a vertical force outwards from the housing and a horizontal force towards the pawl relative to

a centerline of the piston on the tooth ramp, such that the vertical force rotates the pawl until the first protruding shoulder contacts the housing and the horizontal force slides the pawl perpendicular to the centerline of the piston against the spring to disengage the teeth of the pawl from the grooves on the piston, allowing outwards movement of the piston from the housing.

12. The tensioner of claim 11, further comprising a check valve in the fluid chamber.

13. The tensioner of claim 11, wherein the spring biasing the pawl into engagement with the grooves on the outer circumference of the piston has a first end received by a first hole defined by the housing, adjacent to the cutout of the housing, and a second end abutting against the rotating, sliding pawl.

14. The tensioner of claim 11, wherein the housing further comprises a pair of slots and a pair of second holes, both defined by the housing, the pair of slots receiving the through pin pivotally attaching the rotating sliding pawl to the housing, and the pair of second holes being partially aligned with the pawl hole, defined between the first protruding shoulder and the second shoulder of the pawl.

15. The tensioner of claim 14, wherein the pair of second holes receive an external pin, catching the hole of the pawl, sliding the pawl and the pawl teeth away from outer grooves on the outer circumference of the piston.

16. The tensioner of claim 11, wherein at least one of the grooves on the outer circumference of the piston is a stop groove.

17. The tensioner of claim 16, wherein ejection of the piston from the bore of the housing is prevented by the engagement of a tooth of the tooth portion of the pawl with a shoulder of the stop groove on the outer circumference of the piston.

18. The tensioner of claim 11, further comprising an external pin received between the first protruding shoulder and a stop on the housing for locking the tensioner in a shipping position.

19. The tensioner of claim 11, wherein backlash of the tensioner is a combination of a distance of rotation between the first protruding shoulder and the housing and a distance of rotation between the second shoulder and the housing.

Fig. 1

PRIOR ART

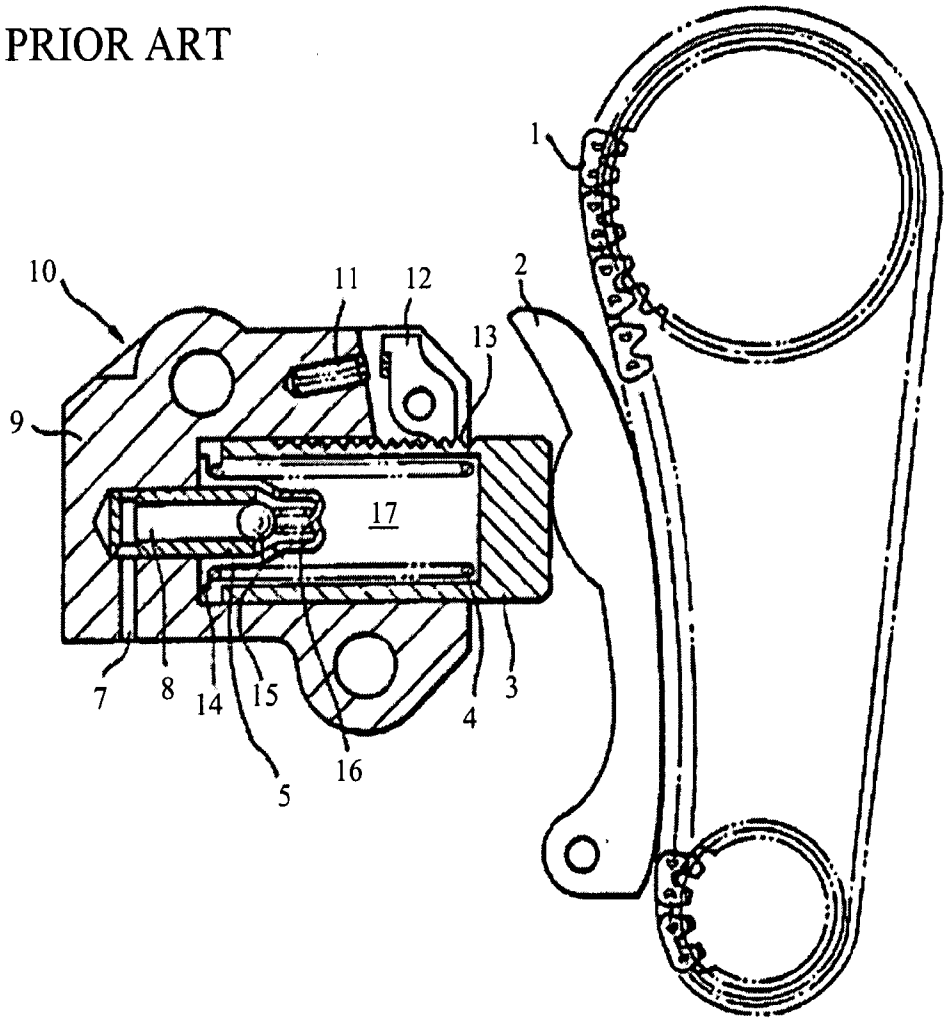


Fig. 2

PRIOR ART

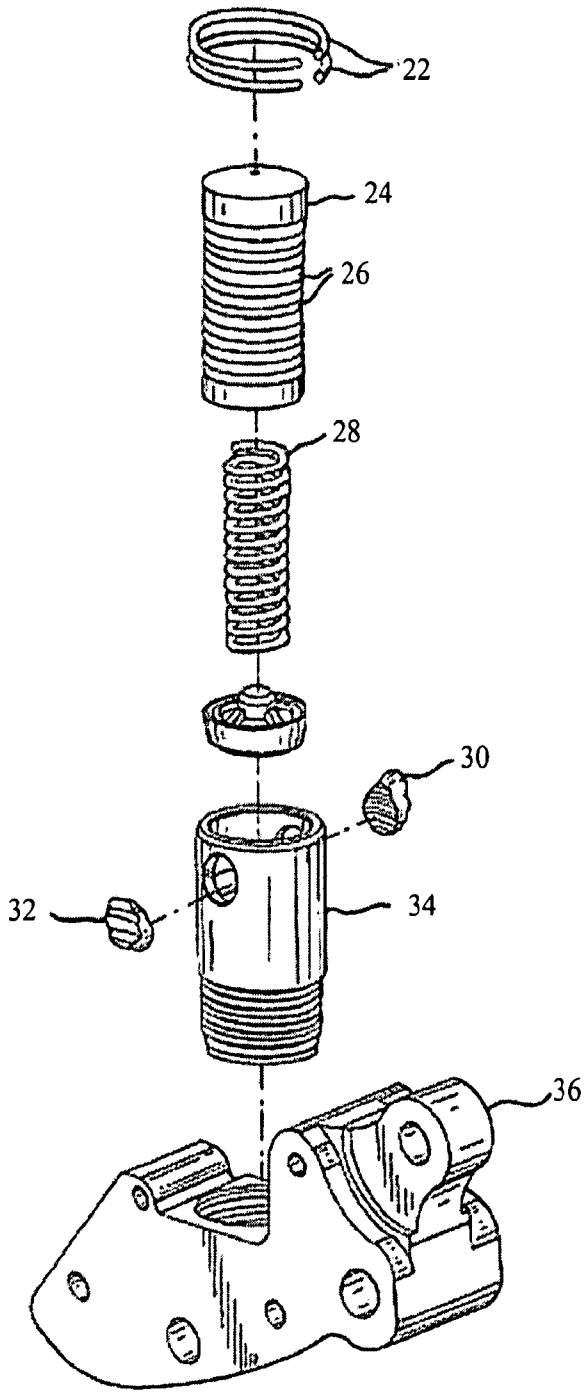


Fig. 3a

PRIOR ART

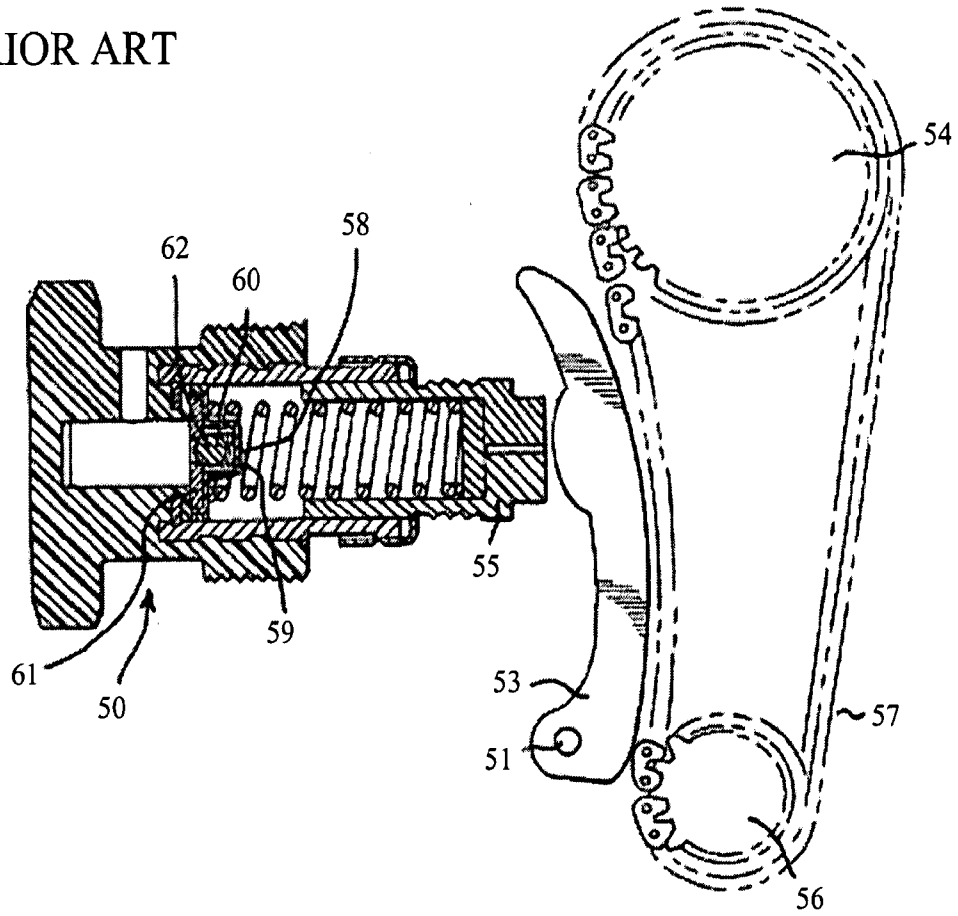


Fig. 3b
PRIOR ART

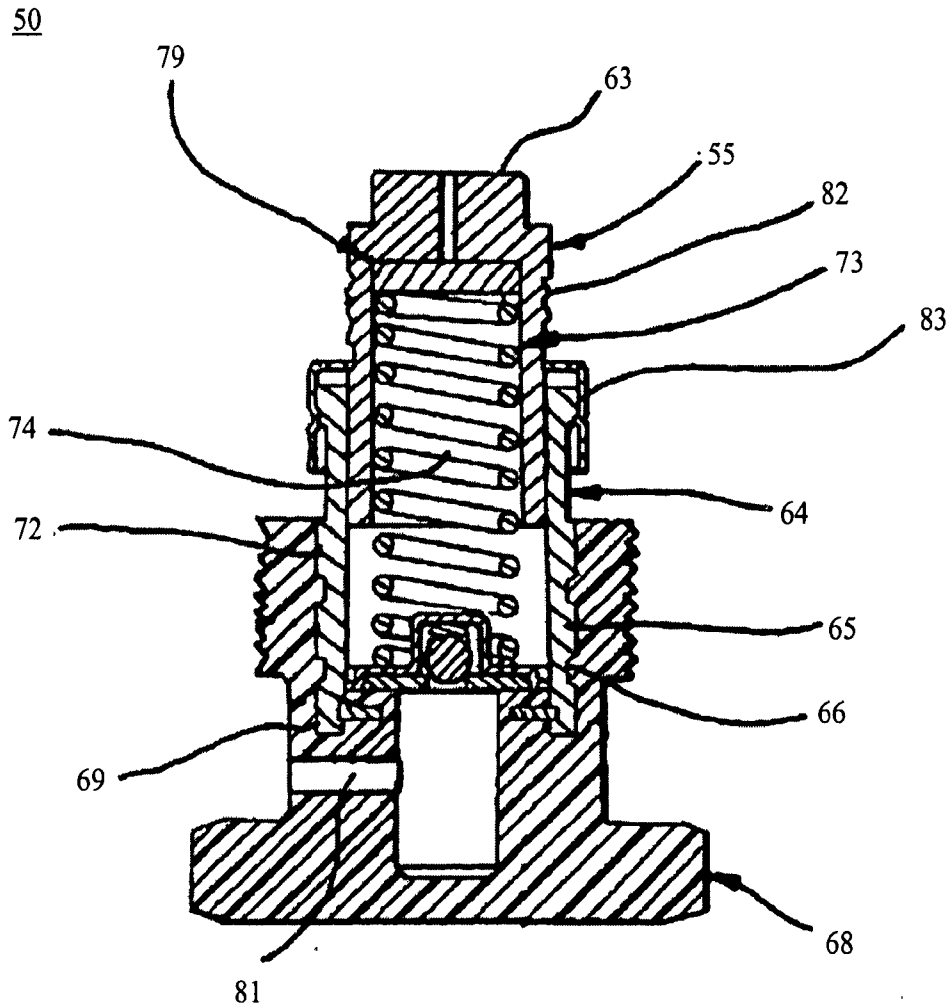


Fig. 4

PRIOR ART

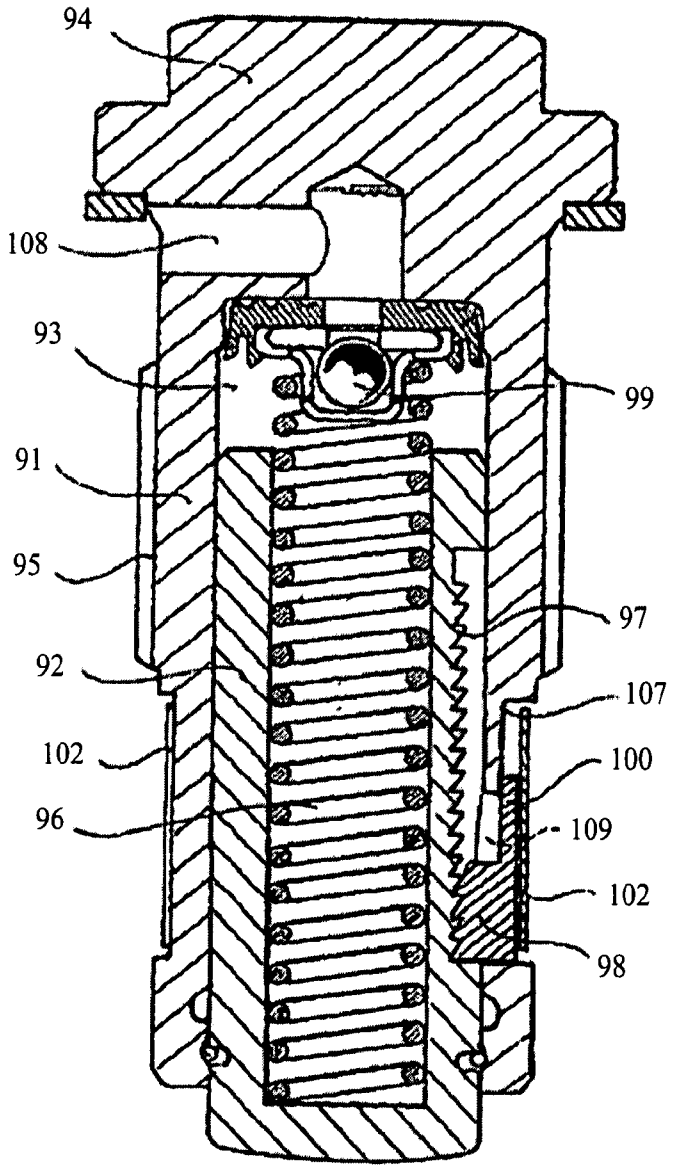


Fig. 5

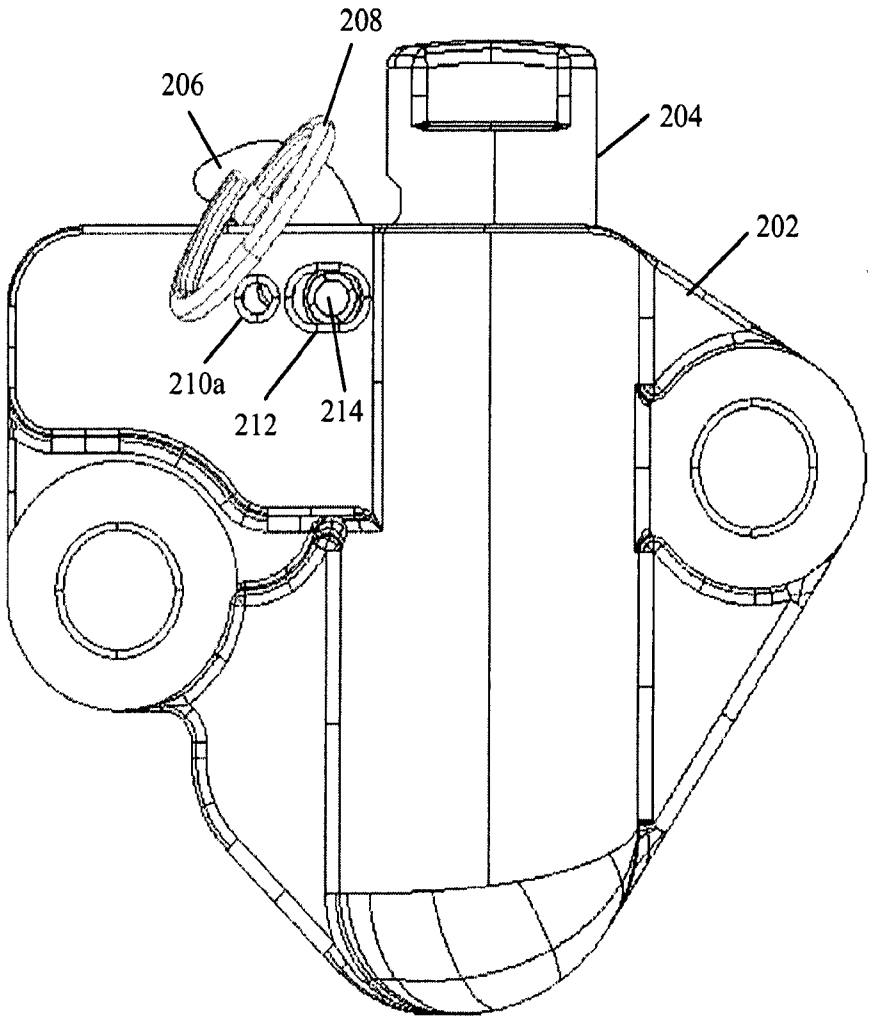


Fig. 6

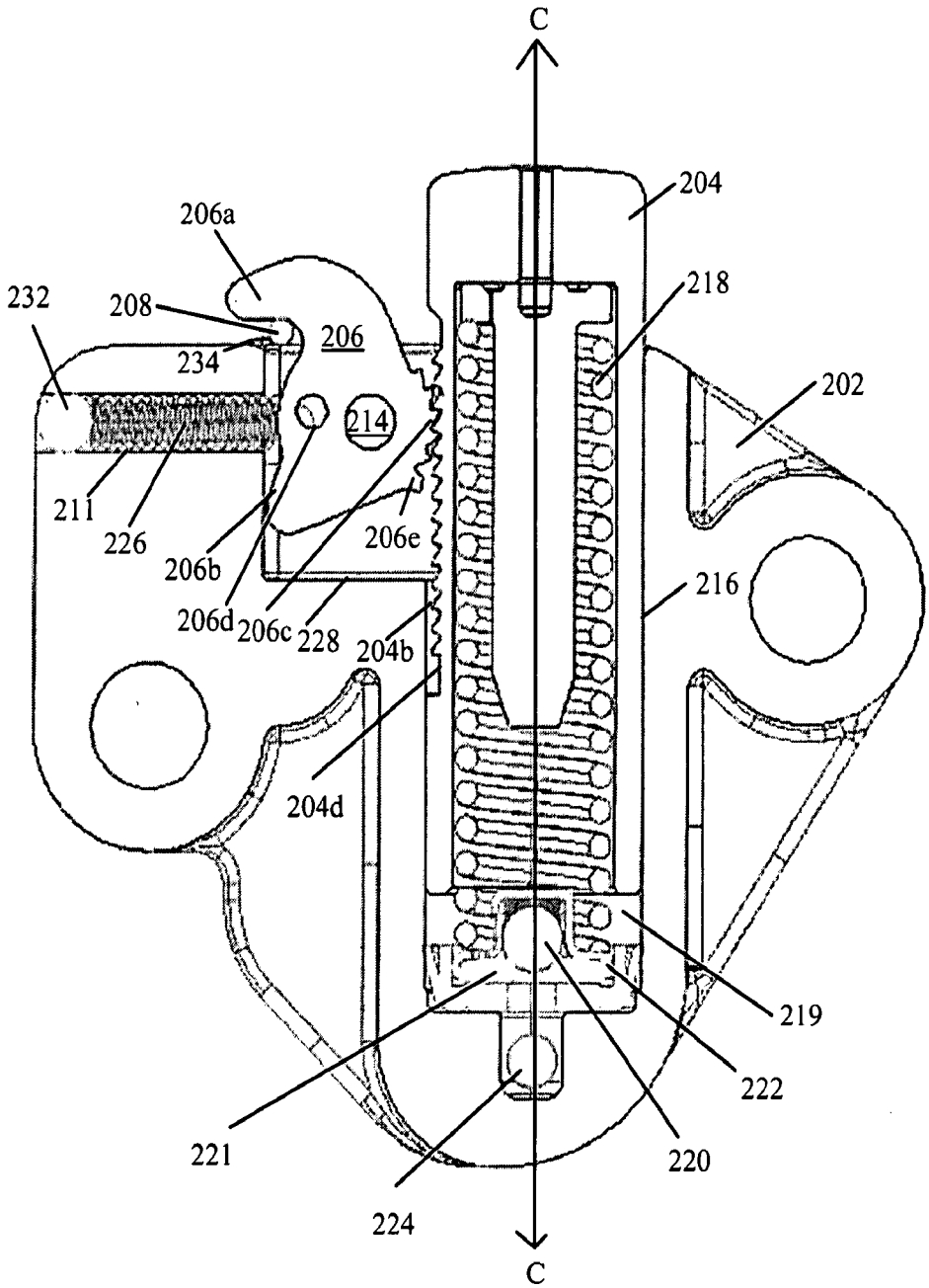

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232
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202
214
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206e
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204d
219
222
221
220
224
C

Fig. 7

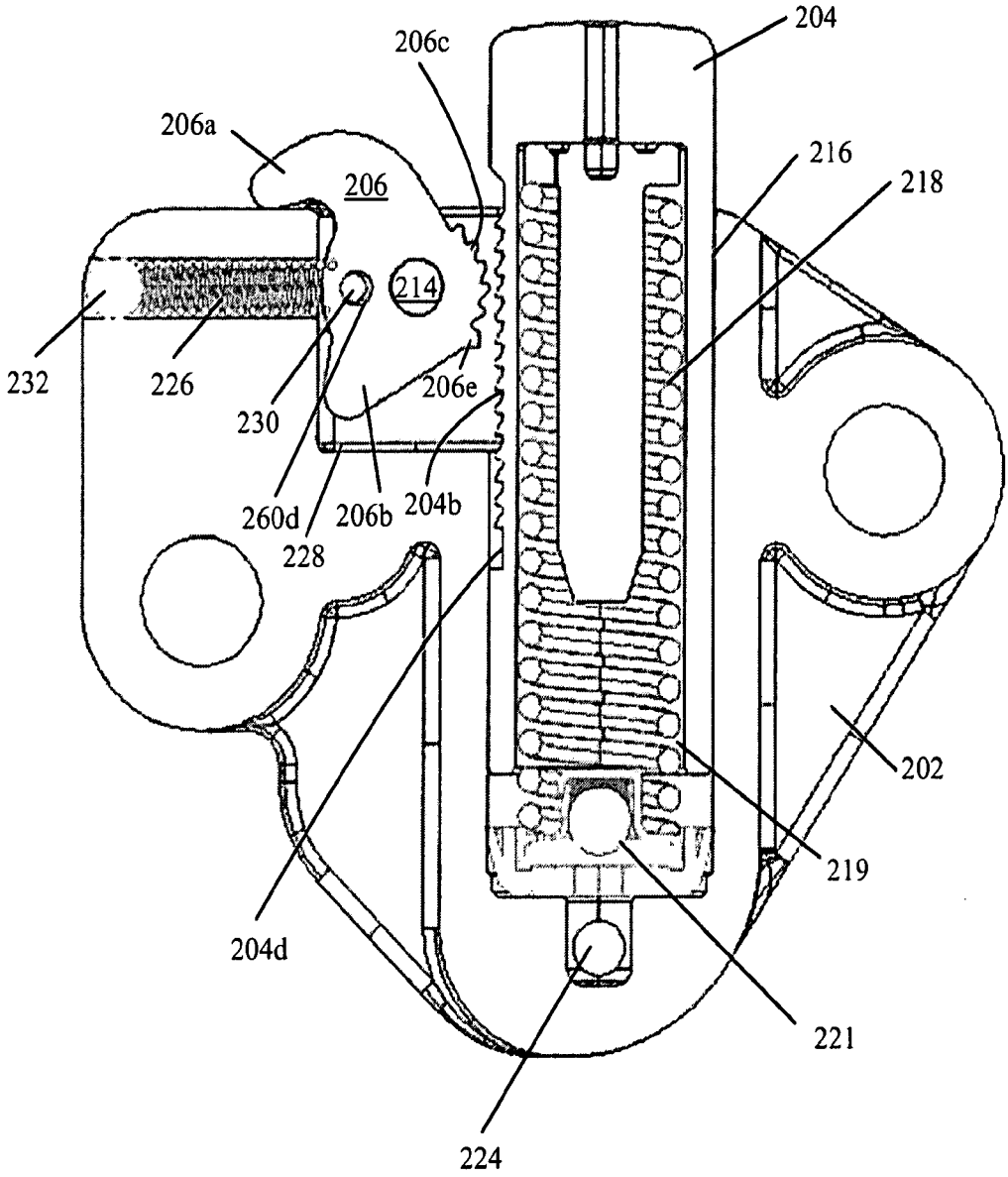

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206b
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Fig. 8

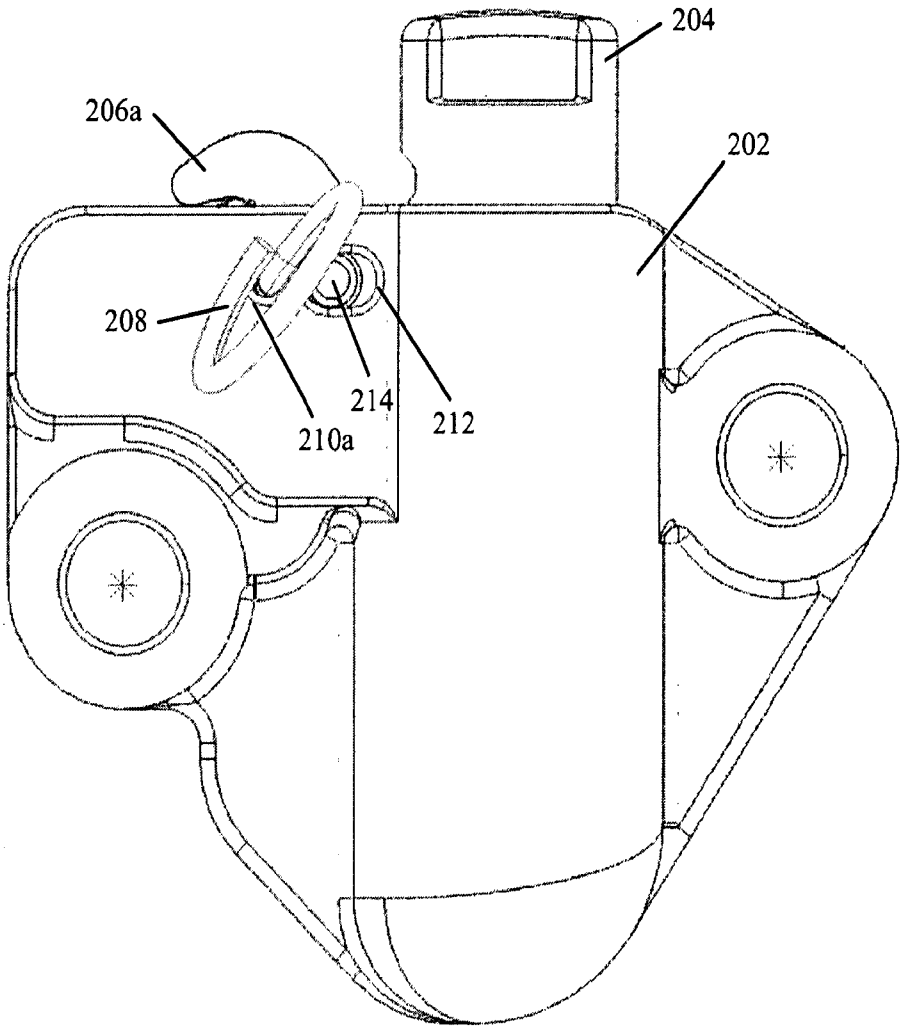


Fig. 9

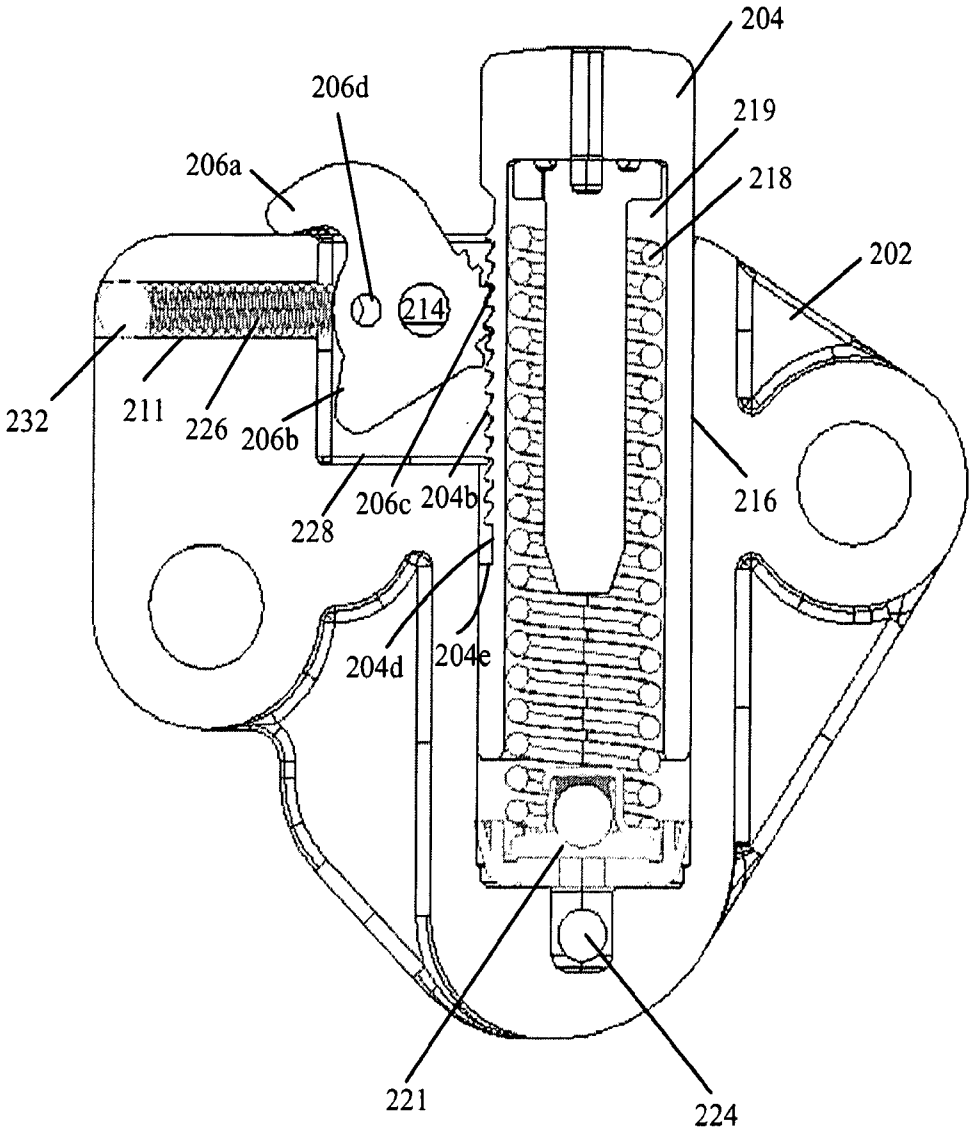

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206c
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Fig. 10

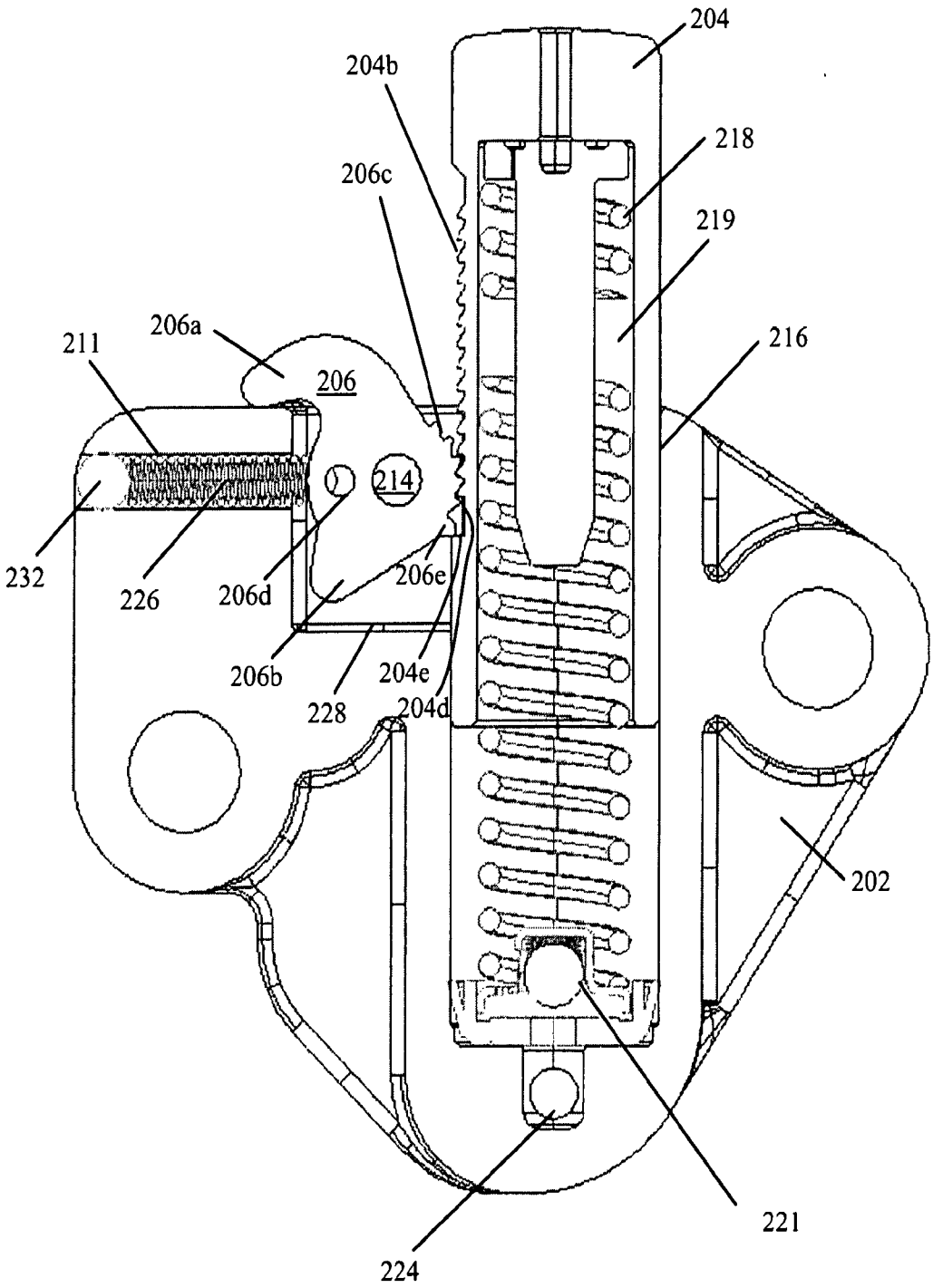

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Fig. 11

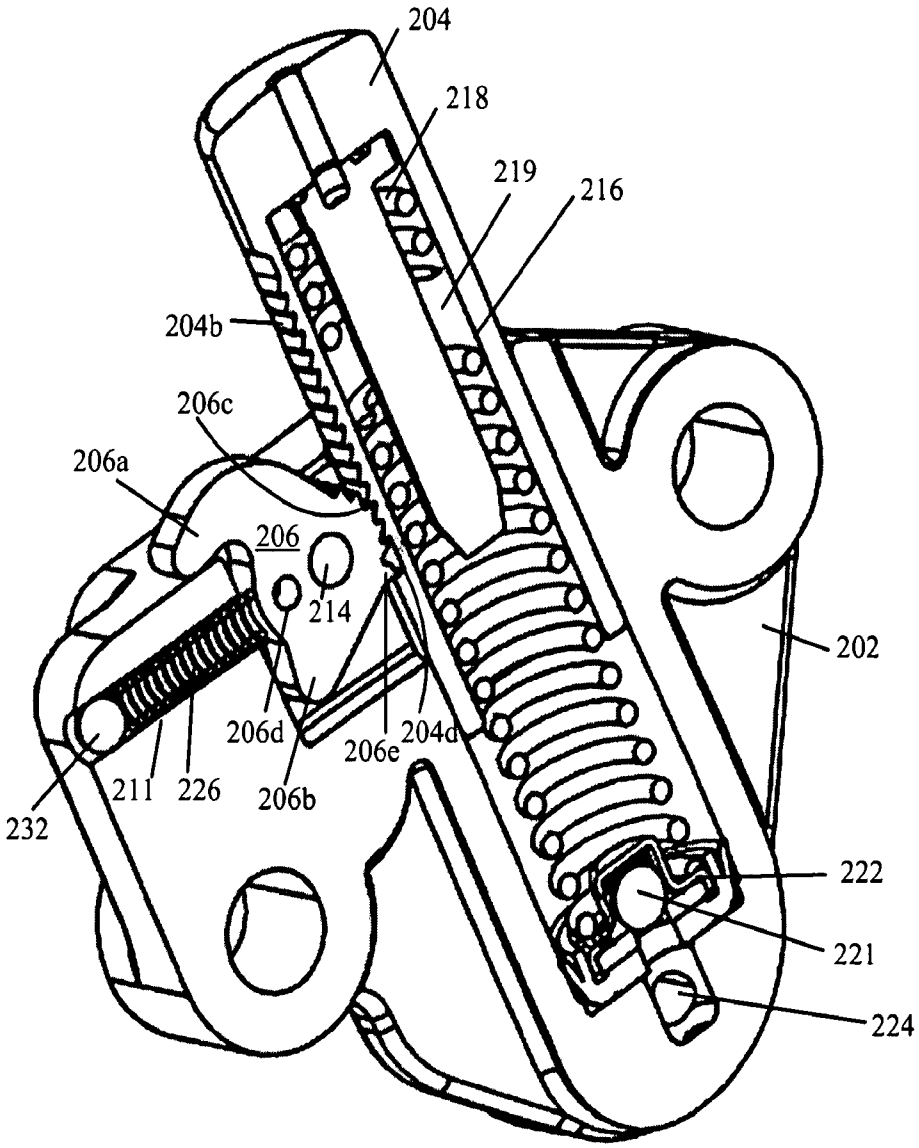
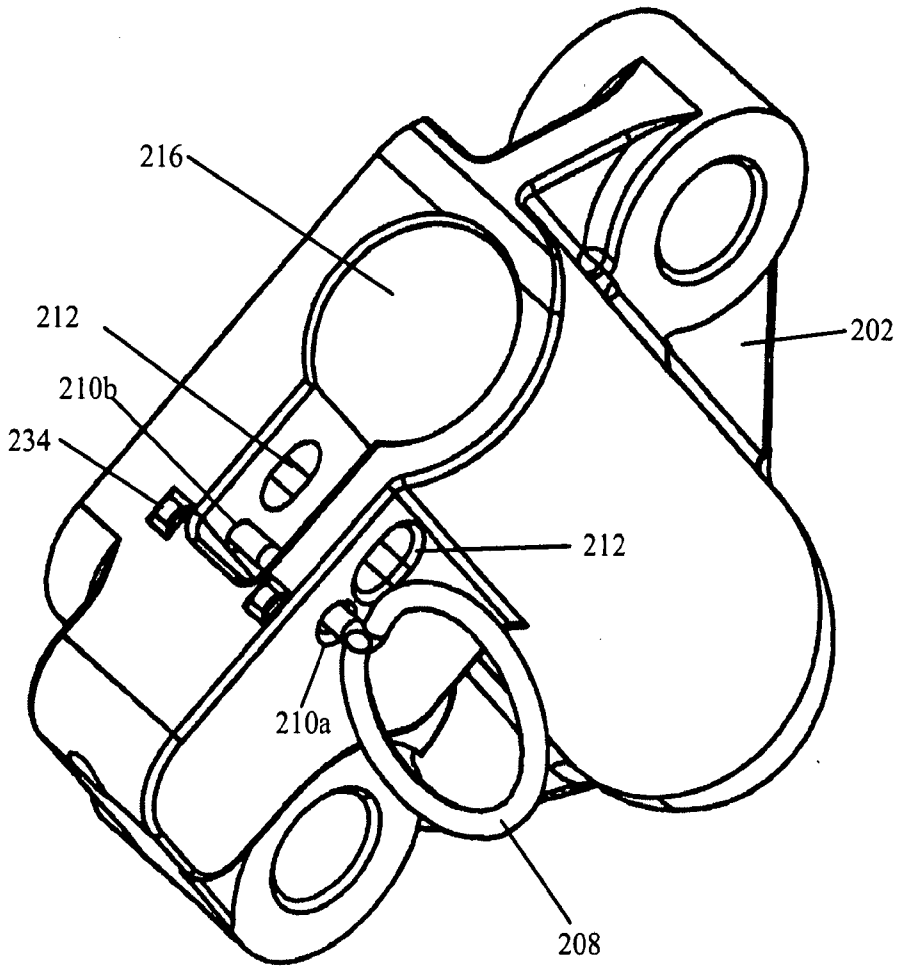

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Fig. 12



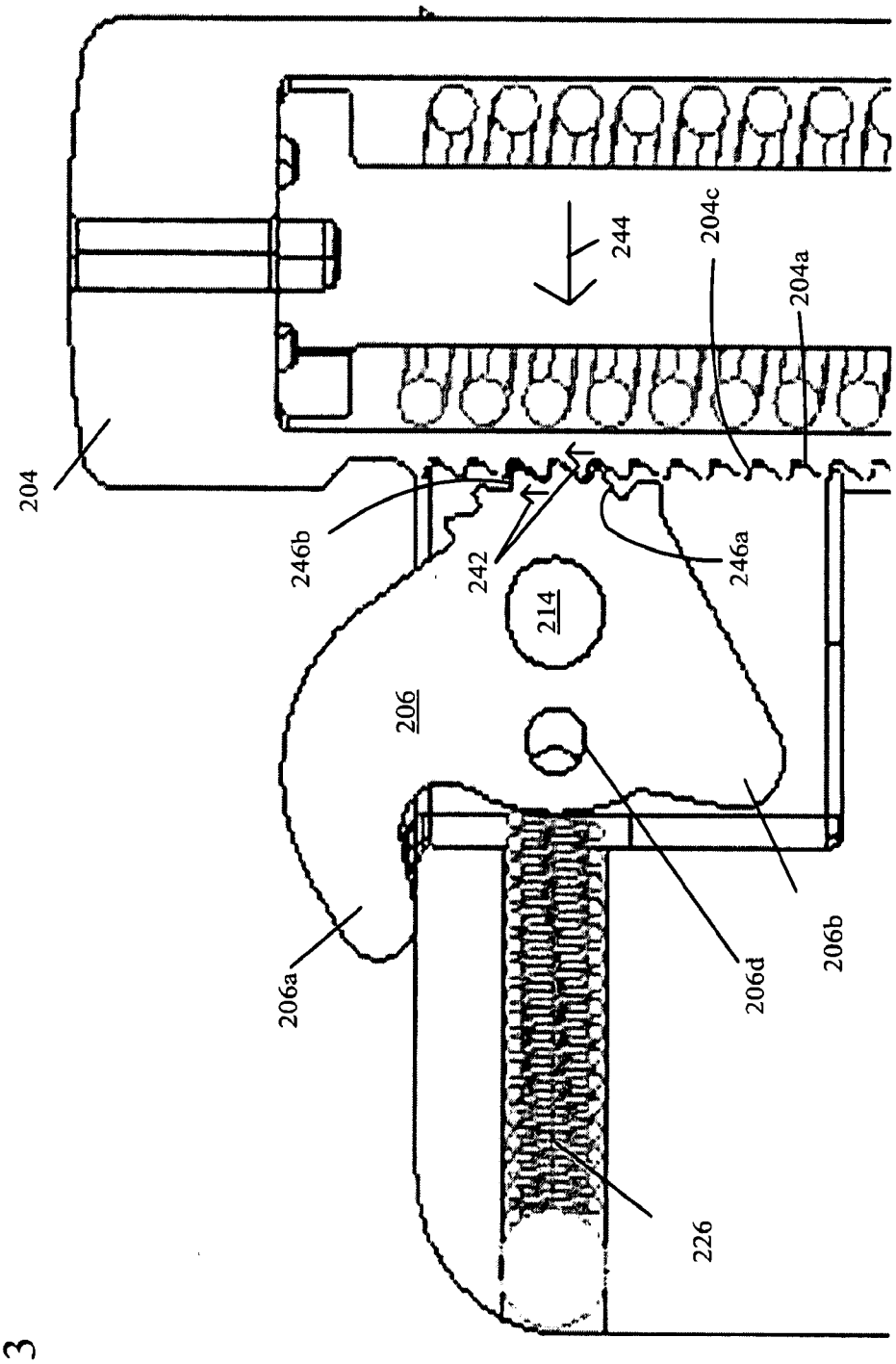


Fig. 13

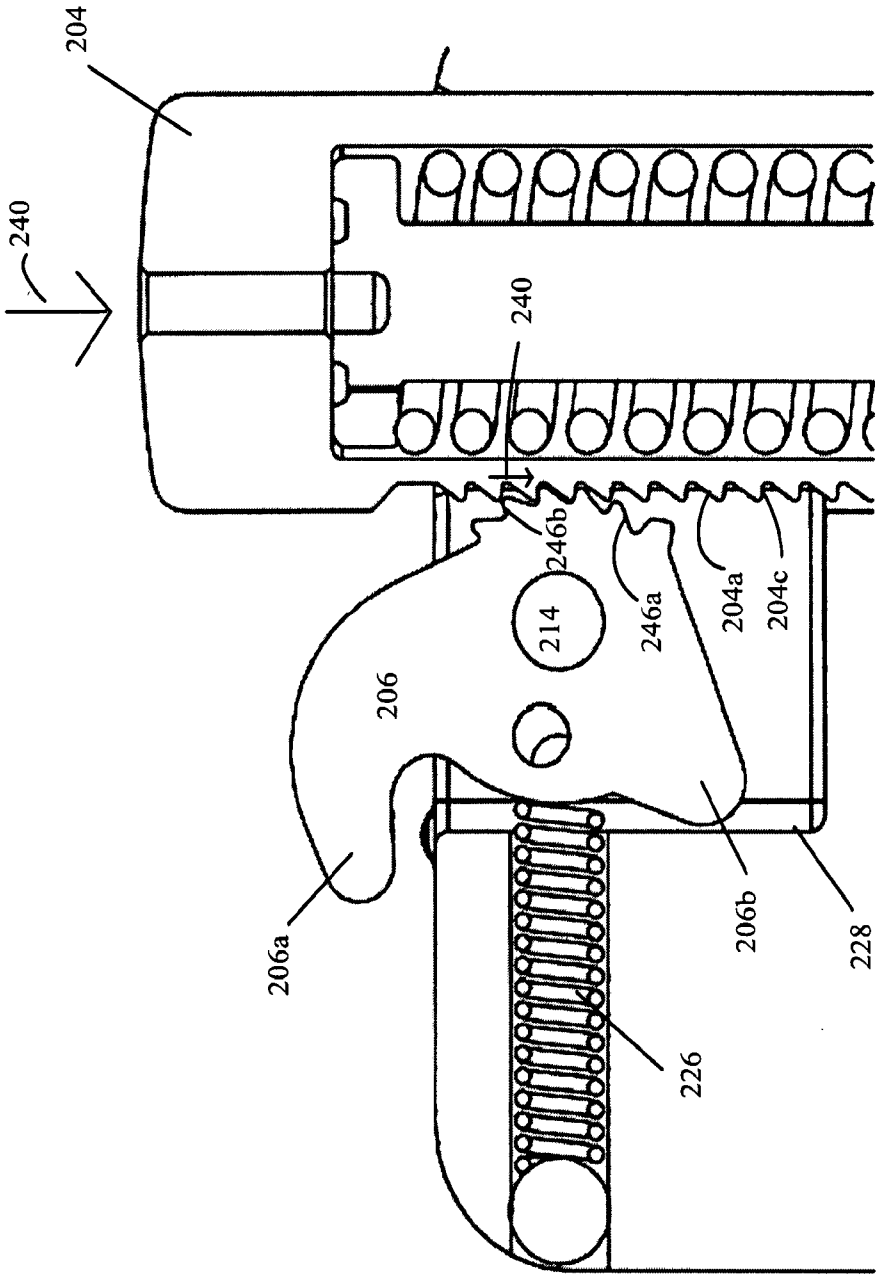


Fig. 14

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2007/066584

A. CLASSIFICATION OF SUBJECT MATTER
INV. F16H7/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F16H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 12 12 383 B (WIPPERMANN JR G M B H) 10 March 1966 (1966-03-10) the whole document	1-3, 6-13, 16-19
A	JP 62 013257 U (-) 27 January 1987 (1987-01-27)	1,11
A	JP 09 060696 A (DAIHATSU MOTOR CO LTD) 4 March 1997 (1997-03-04)	
A	US 2002/006840 A1 (KUROHATA JUNYA [JP]) 17 January 2002 (2002-01-17)	
A	JP 07 151196 A (NTN TOYO BEARING CO LTD) 13 June 1995 (1995-06-13)	

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 September 2007	21/09/2007

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Goeman, Frits

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2007/066584

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