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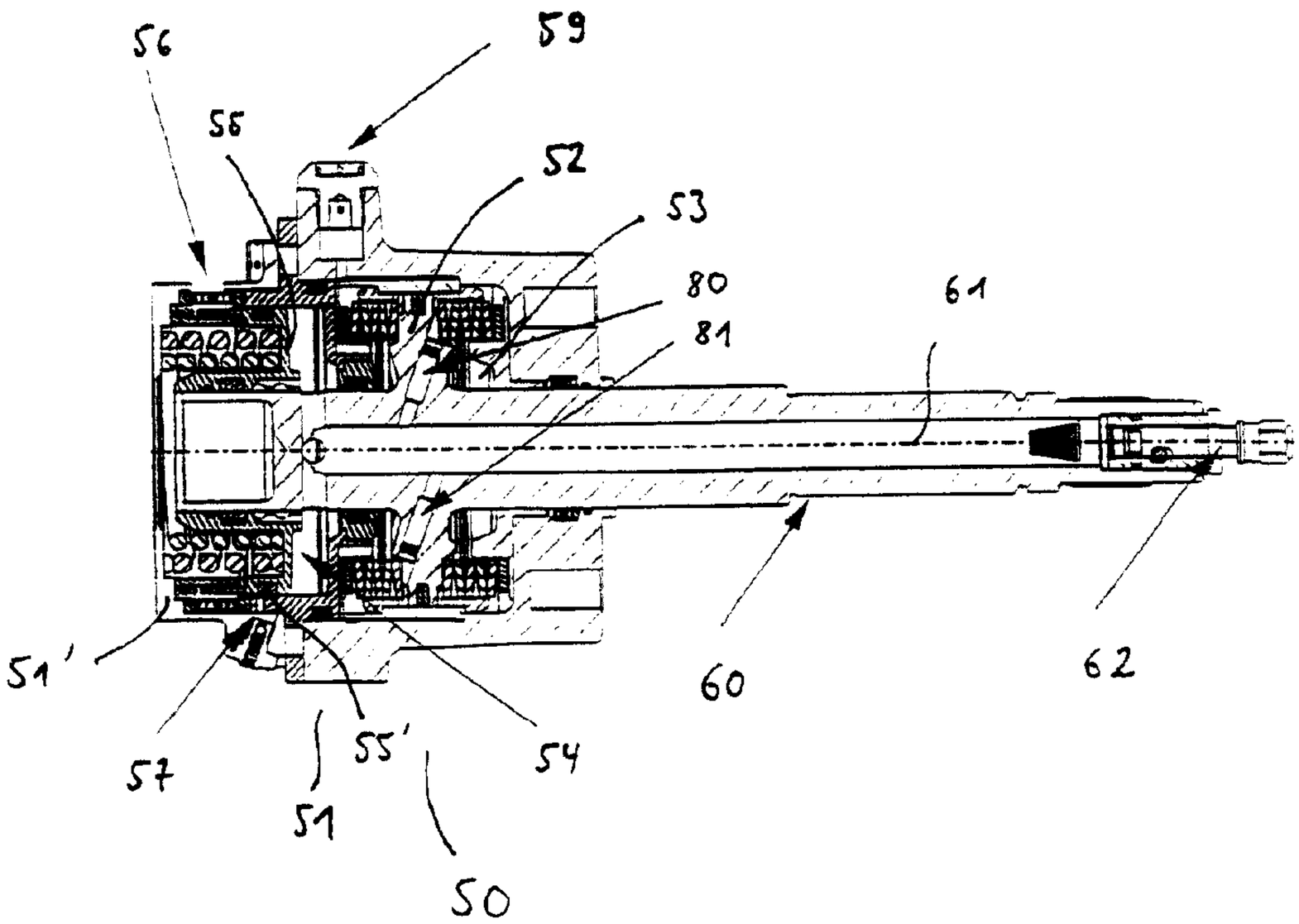
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(54) Titre : TRAIN D'ATTERRISSAGE AVEC AMORTISSEUR DE VIBRATIONS
(54) Title: AIRCRAFT LANDING GEAR WITH VIBRATION DAMPER



(57) Abrégé/Abstract:
The present invention relates to an aircraft landing gear with a landing gear housing and a connecting rod accommodated therein, having a first and a second steering arm, the first steering arm of which being directly or indirectly connected with the landing gear housing and the second steering arm directly or indirectly with the connecting rod, and with a vibration damper which has a housing and a damping element, the damping element being movable in a fluid-filled area, preferably an oil-filled area of the vibration damper in such a way that the movement of the damping element is damped by the fluid, and the first or the second steering arm being indirectly or directly connected with the housing and the other steering arm directly or indirectly with the damping element, and with a fluid reservoir, preferably an oil reservoir, which is connected with the fluid-filled area, the fluid reservoir being integrated in the housing of the vibration damper.

Abstract

The present invention relates to an aircraft landing gear with a landing gear housing and a connecting rod accommodated therein, having a first and a second steering arm, the first steering arm of which being directly or indirectly connected with the landing gear housing and the second steering arm directly or indirectly with the connecting rod, and with a vibration damper which has a housing and a damping element, the damping element being movable in a fluid-filled area, preferably an oil-filled area of the vibration damper in such a way that the movement of the damping element is damped by the fluid, and the first or the second steering arm being indirectly or directly connected with the housing and the other steering arm directly or indirectly with the damping element, and with a fluid reservoir, preferably an oil reservoir, which is connected with the fluid-filled area, the fluid reservoir being integrated in the housing of the vibration damper.

Aircraft Landing Gear With Vibration Damper

The invention relates to an aircraft landing gear having a landing gear housing and a connecting rod accommodated therein, with a first and a second steering arm, the first steering arm of which being indirectly or directly connected with the landing gear housing and the second steering arm being connected indirectly or directly with the connecting rod, and with a vibration damper which has a housing and a damping element, the damping element being movably arranged in a fluid-filled area, preferably an oil-filled area, of the vibration damper, in such a way that the movement of the damping element is damped by the fluid and wherein the first or the second steering arm is directly or indirectly connected with the housing and the other steering arm is indirectly or directly connected with the damping element, and with a fluid reservoir, preferably an oil reservoir, which is connected with the fluid-filled area.

An aircraft landing gear of this type is known, for example, from US 5,224,668. The object of the vibration damper is to dampen vibrations or oscillations occurring in the landing gear during rolling, starting and landing, in particular during the braking process.

In the aircraft landing gear known from US 5,224,668, the housing of the damper is securely connected (screwed) with a steering arm of the aircraft landing gear, whereas the shaft having a damping element is connected with the other steering arm via a bearing. Since one steering arm is connected with the landing gear housing and one steering arm with the connecting rod/wheel axle, a vibrating motion of the connecting rod/wheel unit about the connecting rod axis on the damper produces a linear movement between shaft or damping element and the damper housing. In the previously known solution, the piston serving

as damping element divides an oil chamber in the damper housing into two chambers which are interconnected via one or more choke bores. Oil between these chambers is displaced via the choke(s) by a linear movement of the piston. This oil movement thereby absorbs the vibrating motion of the connecting rod assembly. To prevent cavitation and equalize temperature fluctuations or leakages, an oil reservoir supplies the respective low-pressure chamber of the oil reservoir with oil via check valves. In the solution disclosed in US 5,224,668, the oil reservoir sits, in the form of a separate container, on top of the vibration damper and is attached there in such a way that it is in fluid connection with the chambers of the oil reservoir.

A disadvantage of this previously known solution is that the oil reservoir is exposed to damage or even separation of the damper due to impacting parts, for example, by broken stones, birds or rubber parts of burst tires. A further disadvantage is found in that hydraulic and/or electric lines must be led over additional steering arms, so-called slave links, instead of over steering arms due to the complex design of the vibration damper.

The object of the present invention is to further develop an aircraft landing gear of the aforementioned type in such a way that the probability of damage or even separation of the oil reservoir is reduced and thus the reliability of the vibration damper increased.

Proceeding from an aircraft landing gear having the features of the preamble of claim 1, this object is solved in that the fluid reservoir is integrated in the housing of the vibration damper. Preferably, the fluid reservoir is integrated in the housing cover. As a result, a very compact construction of the damper is produced and the reservoir is protected against damage or separation due to broken stones, birds, tire parts which have

split off or other parts flying about. Furthermore, this compact construction enables hydraulic and/or electric lines, for example, the brake supply, to be led over the vibration damper so that, in a preferred embodiment of the invention, slave links can be omitted. Accordingly, in a preferred embodiment of the invention, it is provided that hydraulic and/or electric lines are led via the vibration damper. For this purpose, corresponding guides or carriers can be provided.

In a further embodiment of the invention, a shaft is provided with which one of the steering arms is connected. Preferably, the shaft serves as a steering arm bolt on which the steering arm is pivotally mounted.

The damping element can be configured as a piston which is movable in the fluid-filled reservoir.

In a further embodiment of the invention, it is provided that the damping element or piston is connected with the shaft or is a component of the shaft. It is especially advantageous if the shaft is designed as a hollow shaft and if the hollow of the shaft is connected with the fluid reservoir. Thus, the reservoir can be filled via the hollow of the shaft which can have a fill-up valve in its end region.

Furthermore, it is especially advantageous if the hollow of the shaft is connected with the fluid-filled area.

In a preferred embodiment of the invention, the hollow of the shaft can be connected both with the fluid-filled area in which the damping element is situated and with the fluid reservoir. Thus, in this embodiment of the invention, the hydraulic connection between the fluid-filled area and the fluid reservoir is led via the shaft or its hollow.

Furthermore, it can be provided that the piston or shaft divides the fluid-filled area into two or more chambers which are connected to one another by one or more choke bores. The choke bores cause the fluid, in particular the oil, to undergo a resistance when passing through the bores, as a result of which the movement of the damping element or the piston is damped relative to the housing of the vibration damper.

It can thereby be provided that the hollow of the shaft is fluid-connected with at least one of the chambers, preferably with both chambers. It is especially advantageous if check valves are placed in the connecting lines between the hollow of the shaft and the chambers. With a check valve (anticavitation valve) each of this type per damping chamber, it is attained that short and symmetrically equally arranged connecting paths are present between fluid reservoir and the two damping chambers. The affect of line losses on the cavitation behaviour is thereby reduced.

Furthermore, it can be provided that a wall of the fluid reservoir is formed by a movable, spring-loaded piston which exerts pressure on the fluid present in the reservoir. The piston is pushed by one or more springs against the reservoir and thereby produces a prestress pressure in the fluid. Furthermore, it can be provided that a viewing window is situated in the housing of the vibration damper, the piston being arranged relative to the viewing window in such a manner that the position of the piston can be seen through the viewing window. As a result, the fill levels of the reservoir can be read from the outside with reference to the position of the piston. In a preferred embodiment of the invention, a glass ring clamped between two sealing rings protects the reservoir piston, sealing rings and springs against contamination. In a further embodiment of the invention, it is provided that an

overflow bore is provided in a wall of the fluid reservoir, said overflow bore being separated, in a first piston position, from the reservoir by a piston seal and, in a second piston position, is connected with the fluid reservoir when there is excess fluid. This bore allows e.g. oil to flow out of the reservoir when there is too much oil in the damper and, as a result, the piston seal "passes over" the overflow bore, i.e. releases it, so that oil can flow out of the reservoir.

Further details and advantages of the invention are described in greater detail with reference to an example of an embodiment illustrated in the drawings, showing:

Figure 1: a side view of an aircraft landing gear according to the prior art,

Figure 2: a perspective representation of the vibration damper according to the invention with steering arms arranged thereon,

Figure 3: a side view of an aircraft landing gear according to the invention,

Figure 4: a perspective view of the vibration damper according to the invention,

Figure 5: a view according to Figure 4 in an enlarged representation, and

Figure 6: a longitudinal section through the vibration damper according to the invention.

Figure 1 shows an aircraft landing gear according to the prior art in a schematic side view. The landing gear consists of the

landing gear housing 10 in which the connecting rod 20 is accommodated. The steering arm 30 is in a swivel connection with the landing gear housing 10 and steering arm 40 is in a swivel connection with the connecting rod 20. Both steering arms 30, 40 are connected with the vibration damper 13 on whose upper side the oil reservoir 11 is located. The housing of the damper 13 is securely connected (screwed) with the upper steering arm 30, while the shaft of the damper 13 is connected with the lower steering arm 40 via a bearing. A vibrating motion of the connecting rod/wheel unit about the connecting rod axis produces a linear movement between shaft and damper housing on the damper 13. In the manner known from US 5,224,668, the shaft divides the oil reservoir of the damper 13 into two chambers in the damper housing, said chambers being connected with one another via the choke bores. The aforementioned linear movement between shaft and housing of the damper 13 causes the oil to be displaced between the chambers via the choke. This oil movement dampens the vibrating motion of the connecting rod assembly. The oil reservoir 13 supplies the respective low-pressure chamber via check valves, in particular to prevent leakages and cavitation and to equalize fluctuations in temperature.

As can be seen in Figure 1, the oil reservoir 11 is situated in an exposed position and is therefore exposed to damages which could lead to a destruction of the oil damper 11 and result therein that the damping properties of the damper 13 are lost.

It can also be seen in Figure 1 that so-called slave links 12 are connected with the landing gear housing 10 and the connecting rod 20, said slave links 12 being swivel-mounted on the landing gear housing 10 and on the connecting rod 20 and also pivotally interconnected. The slave links 12 serve to guide lines, for example, of electric or hydraulic lines, as

required e.g. for the brake supply of the wheel shown in Figure 1.

Figure 2 shows a perspective view of the vibration damper 50 according to the invention with the steering arms 30, 40 arranged thereon. The vibration damper 50 has a housing 51 with which the upper steering arm 30 is screwed together. Furthermore, the damper 50 has a shaft 60 (see Figs. 5, 6) on which the lower steering arm 40 is swivel-mounted by means of a bearing. The shaft 60 has a piston which is housed so as to be axially movable in an oil reservoir formed in the housing 51 and the movement of which results in the displacement of the oil, as a result of which a damping effect is obtained.

Contrary to the arrangement according to Figure 1, the oil reservoir is not configured as a container placed on the vibration damper 50, but is integrated in the housing cover 51', as will be described in greater detail below. The air vents 59 are located on the upper side of the vibration damper 50. By integrating the oil reservoir in the housing 51 of the vibration damper 50, a very compact construction is produced which makes it possible to lead hydraulic and/or electric lines, in particular the brake supply, via the vibration damper, for which purpose the conducting line 58, shown in Figure 2, is provided. In a preferred embodiment of the invention, the slave links 12 shown in Figure 1 can thus be omitted.

The upper steering arm 30 according to Figure 2 is swivel-mounted on the landing gear housing 10 and the lower steering arm 40 is swivel-mounted on the connecting rod 20.

The upper steering arm 30 does not have to be situated directly on the landing gear housing 10 and the lower steering arm 40 not directly on the connecting rod 20. Rather, the invention also

provides for an indirect arrangement, such that, for example, the upper steering arm 30 is swivel-mounted on a component arranged on the landing gear housing 10 and, for example, the lower steering arm 40 is connected with the wheel axle.

Figure 3 shows a side view of the aircraft landing gear with the main landing gear strut with landing gear housing 10 and connecting rod 20 which is housed in the landing gear housing 10 so as to be axially movable. The upper steering arm 30 is swivel-mounted on the landing gear housing 10 and the lower steering arm 40 is swivel-mounted on the connecting rod 20. In their respectively other end region, both steering arms 30, 40 are connected with the vibration damper 50. A perspective view of the vibration damper 50 according to Figure 3 is shown in Figure 4.

Figure 5 shows an enlarged representation of this vibration damper 50. The vibration damper 50 consists essentialy of the damper housing 51 with housing cover 51' in which the oil reservoir is accommodated. The shaft 60, in whose end region the fill-up valve 62 is located, extends from the damper housing 51. The fill-up valve 62 serves to fill the oil reservoir via the shaft 60 configured as a hollow shaft.

The first (upper) steering arm 30 and the second (lower) steering arm 40 are placed on the shaft 60. The first steering arm 30 is screwed together with the housing 51, as can be seen for example in Fig. 2, whereas the second steering arm 40 is swivel-mounted on the shaft 60 via a bearing.

As can also be seen in Figure 5, the viewing window 56 through which the fill level of the oil reservoir can be read is located in the housing cover 51'.

The detailed design of the vibration damper 50 according to the invention can be found in Figure 6. As noted above, the shaft 60 extends out of the housing 51 of the vibration damper 50, said shaft being configured as a hollow shaft and having the hollow 61. The shaft 60 is closed in its end region by the fill-up valve 62. The oil reservoir 54 which is connected with the hollow 61 of the shaft 60 and can, accordingly, be filled via the fill-up valve 62 is located in the housing 51 or under the housing cover 51'. A wall of the oil reservoir 54 is formed by the piston 55 which is accommodated in the housing 51 or housing cover 51' so as to be axially movable. The latter is loaded by two springs which are supported on the housing cover 51' and exert a force on the piston 55 in direction of the oil reservoir 54, according to Fig. 6, a force which is exerted toward the right. As can be seen in Figure 6, the hollow 61 of the shaft 60 is connected with the oil reservoir 54 via two intersecting bores. The viewing window 56 through which the position of the piston 55 can be seen is located on the upper side of the housing cover 51', so that the fill level of the oil reservoir 54 can be read. The glass ring forming the viewing window 56, which is situated on the inside and is clamped between two sealing rings, protects the sealing rings of the reservoir piston 55, the piston itself and also the springs against contamination.

As can also be seen in Figure 6, the overflow bore 57 which is separated from the oil reservoir 54 by the piston seal 55' during normal operating conditions is situated in the wall of the housing 51 or the housing cover 51'. If there is too much oil in the oil-filled area of the vibration damper 50, the reservoir piston 55 is in a position which is shifted toward the left vis-à-vis Figure 6, so that a connection between oil reservoir 54 and overflow bore 57 is opened and oil can flow off accordingly until the piston seal 55' blocks a connection

between oil reservoir 54 and overflow bore 57. The piston seal 55' is configured as a seal that extends peripherally and seals the oil reservoir 54.

As can also be seen in Figure 6, the shaft 60 is widened in the area of the oil area 53, as a result of which a rotating piston 52 is formed which is moved back and forth in the oil area 53 according to the vibrations that occur. A design with several pistons is also feasible. The piston-shaped section 52 of the shaft 60 adjoins the corresponding wall of the housing 51 via seals. The piston 52 divides the oil area 53 into chambers which are connected to one another by choke bores provided in the piston 52. When the piston moves in the oil area 53, oil is moved through the choke bores located in the piston 52 due to the enlargement or reduction of the chambers and, as a result, a damping is produced. As can also be seen in Figure 6, springs are provided which move the shaft 60 or the piston 52 attached to it in one piece are moved into the centred neutral position.

Each of the chambers is connected with the hollow 61 of the shaft 60 and thus also with the oil reservoir 54 via a connecting line 80, 81. Check valves are provided in the connecting lines 80, 81, the respective low-pressure chamber being supplied with oil from the oil reservoir 54 via said check valves to prevent cavitation, compensate leakages and prevent fluctuations in temperature. The connecting line 80 connects the oil reservoir 54 with the chamber shown on the right in Fig. 6 and the connecting line 81 connects the oil reservoir 54 with the chamber shown on the left in Fig. 6. At least one anticavitation valve (check valve) each per damping chamber is arranged in the shaft 60. This produces short and symmetrically similar connecting paths between reservoir 54 and the two chambers. As a result, the affect of line losses on the cavitation behaviour is reduced.

As can be seen in Figure 6, on the whole, a very compact arrangement is produced which makes it possible to lead hydraulic or electric lines, e.g. the brake supply, via the vibration damper 50, as shown for example in Figure 3. The corresponding line 58 is shown in Figure 2.

Due to the arrangement of the oil reservoir 54 in the housing 51 or in the housing cover 51', one obtains not only a compact construction but the danger of damages or even the separation of the oil reservoir from the damper is greatly reduced in comparison to the solution known from the prior art.

We Claim:

1. Aircraft landing gear with a landing gear housing (10) and a connecting rod (20) accommodated therein, having a first (30) and a second steering arm (40), the first steering arm (30) of which being directly or indirectly connected with the landing gear housing (10) and the second steering arm (40) directly or indirectly with the connecting rod (20), and with a vibration damper (50) which has a housing (51) and a damping element, the damping element being movable in a fluid-filled area (53), preferably an oil-filled area, of the vibration damper (50) in such a way that the movement of the damping element is damped by the fluid, and the first (30) or the second steering arm being indirectly or directly connected with the housing (51) and the other steering arm (40) directly or indirectly with the damping element, and with a fluid reservoir (54), preferably an oil reservoir, which is connected with the fluid-filled area (53), characterized in that the fluid reservoir (54) is integrated in the housing (51) of the vibration damper (50).

2. Aircraft landing gear according to claim 1, characterized in that the fluid reservoir (54) is integrated in the cover (51') of the housing (51) of the vibration damper (50).

3. Aircraft landing gear according to claim 1 or 2, characterized in that electric and/or hydraulic lines are led via the vibration damper (50).

4. Aircraft landing gear according to any one of the preceding claims, characterized in that a shaft (60) is provided with which one of the steering arms (40) is connected.

5. Aircraft landing gear according to claim 4, characterized in that the damping element is designed as a piston (52) which is connected with the shaft or is a component of the shaft (60).

6. Aircraft landing gear according to claim 4 or 5, characterized in that the shaft (60) is designed as a hollow shaft and that the hollow (61) of the shaft (60) is connected with the fluid reservoir (54).

7. Aircraft landing gear according to any one of the claims 4 to 6, characterized in that the shaft (60) is designed as a hollow shaft and that the hollow (61) of the shaft (60) is connected with the fluid-filled area (53).

8. Aircraft landing gear according to any one of the preceding claims, characterized in that the damping element divides the fluid-filled area (53) into two or more chambers which are connected to one another by one or more choke bores.

9. Aircraft landing gear according to any one of the claims 4 to 7 and claim 8, characterized in that the shaft (60) is designed as a hollow shaft and that the hollow (61) of the shaft (60) is connected with the chambers.

10. Aircraft landing gear according to claim 9, characterized in that check valves are arranged between the hollow (61) of the shaft (60) and the chambers in the connecting lines (80, 81).

11. Aircraft landing gear according to any one of the preceding claims, characterized in that a wall of the fluid reservoir (54) is formed by a movable, spring-loaded piston (55) which exerts pressure on the fluid located in the fluid

reservoir (54).

12. Aircraft landing gear according to claim 11, characterized in that a viewing window (56) is arranged in the housing (51) of the vibration damper (50) and that the piston (55) is arranged relative to the viewing window (56) in such a manner that the piston position can be seen through the viewing window (56).

13. Aircraft landing gear according to claim 11 or 12, characterized in that an overflow bore (57) is provided in a wall of the fluid reservoir (54), said overflow bore (57) being separated from the fluid reservoir (54) by a piston seal (55') in a first position of the piston and connected with the fluid reservoir (54) when there is excess fluid in a second position of the piston.

Fig. 1

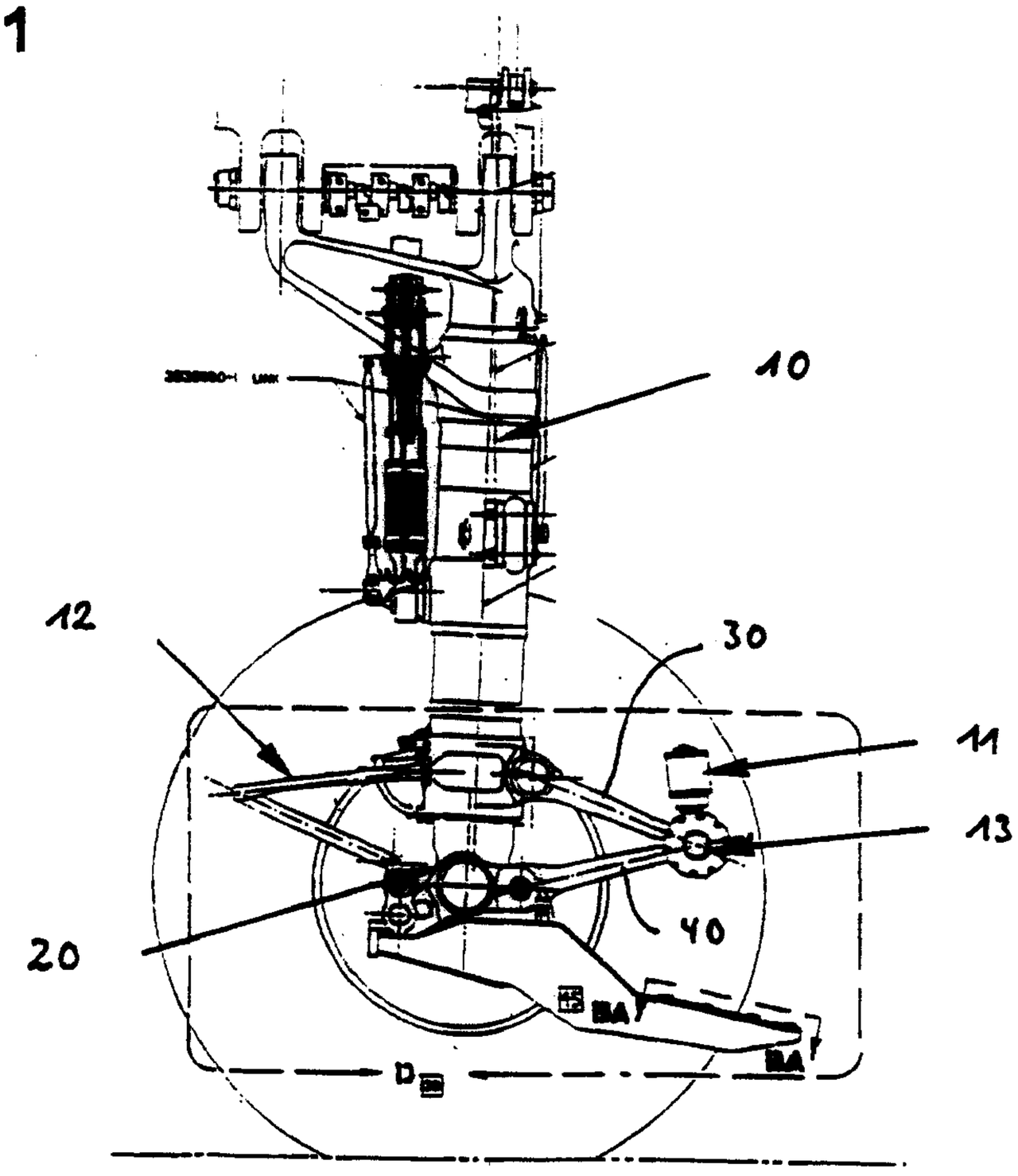


Fig. 2

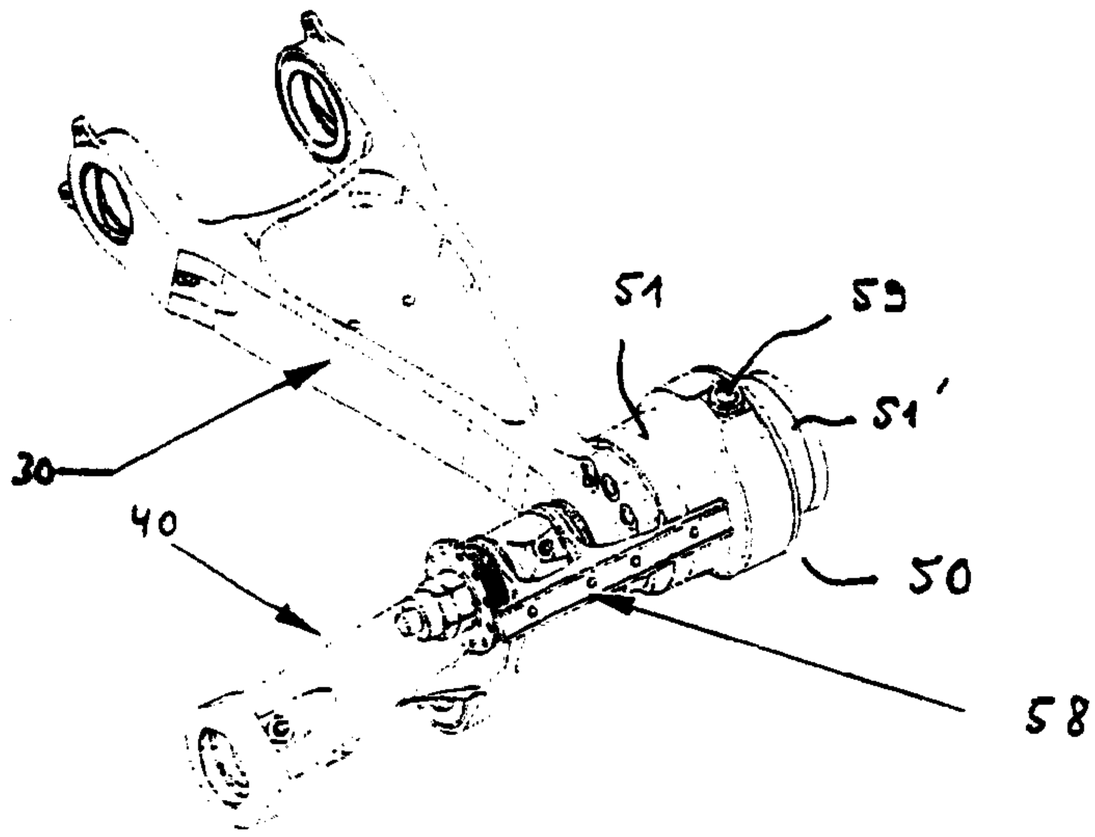


Fig. 3

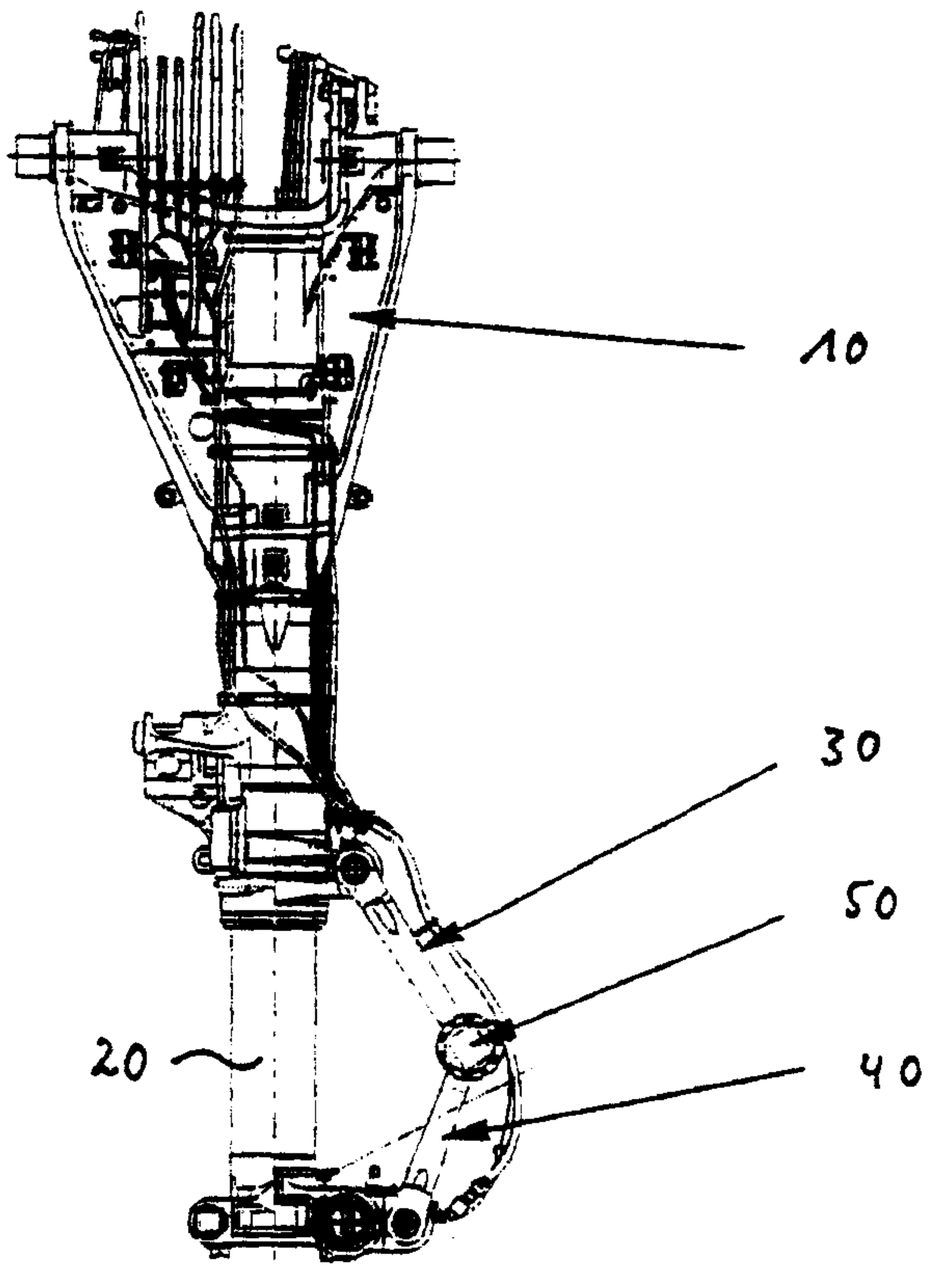


Fig. 4

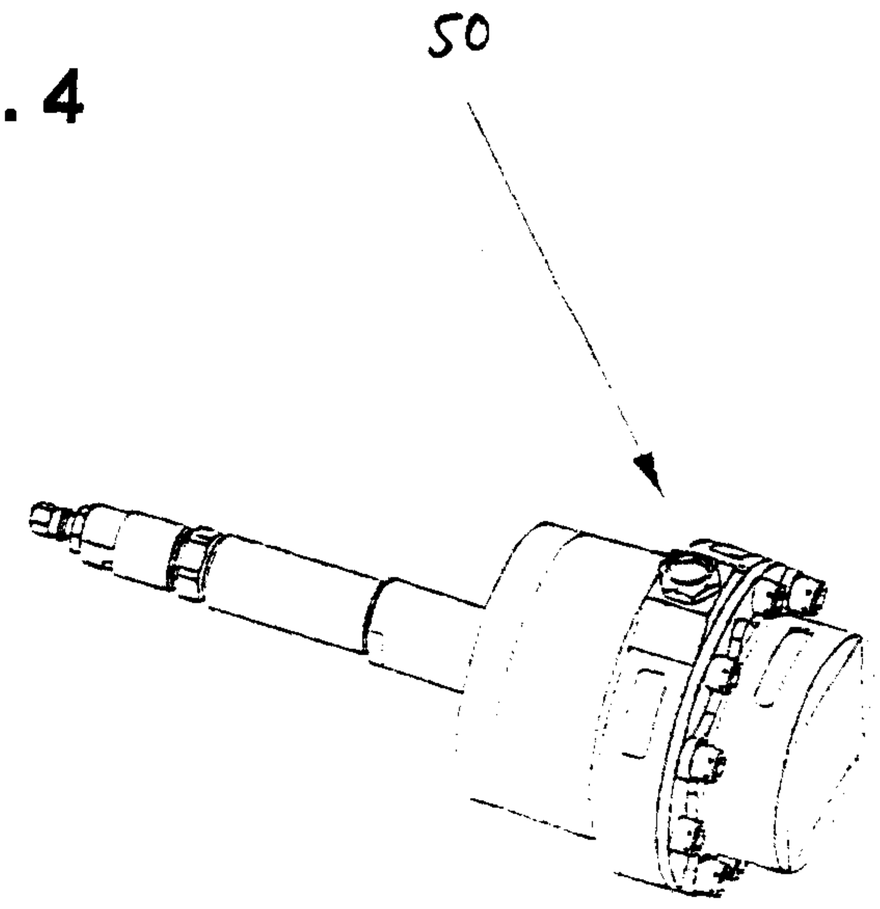


Fig. 5

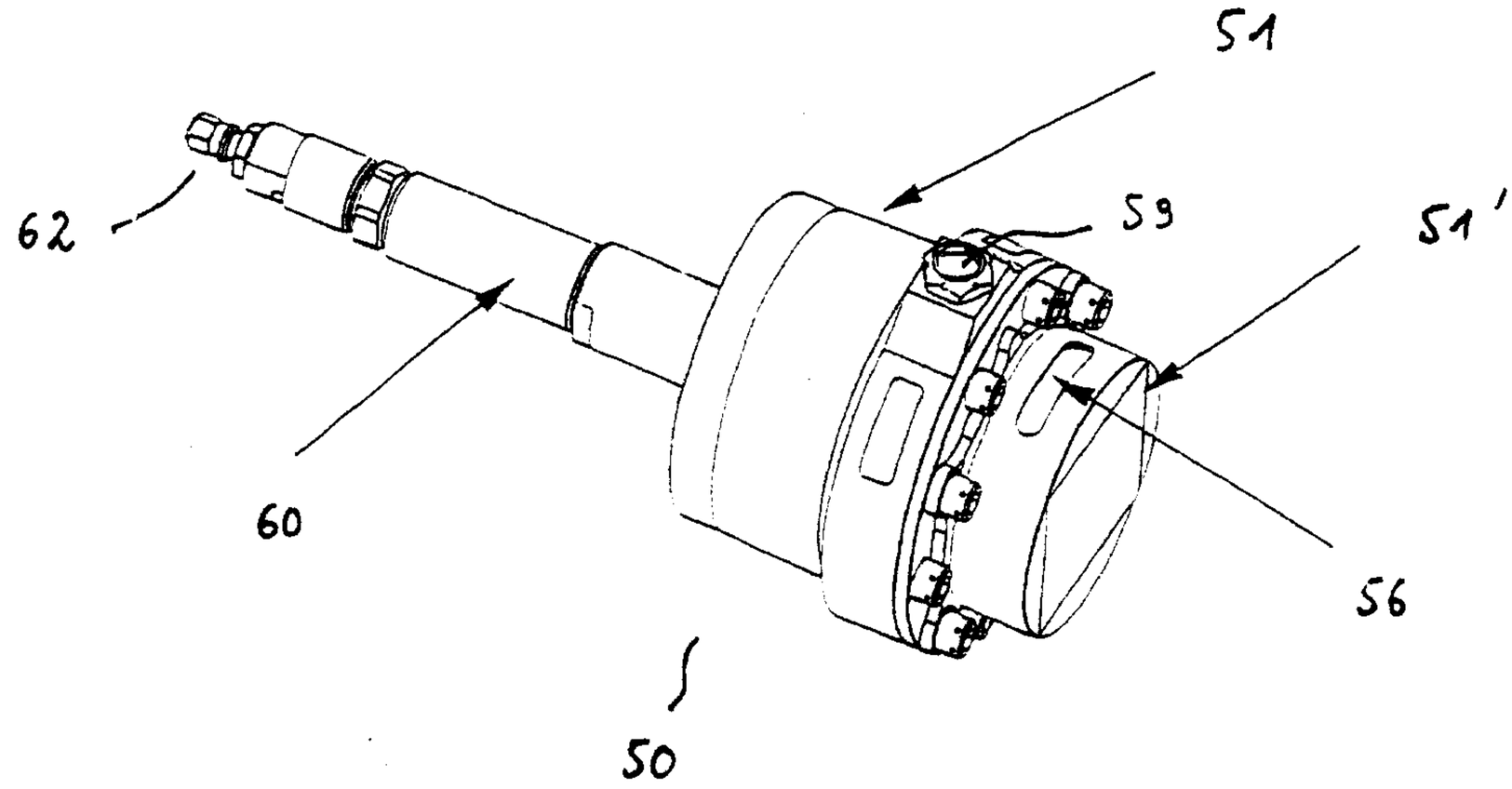
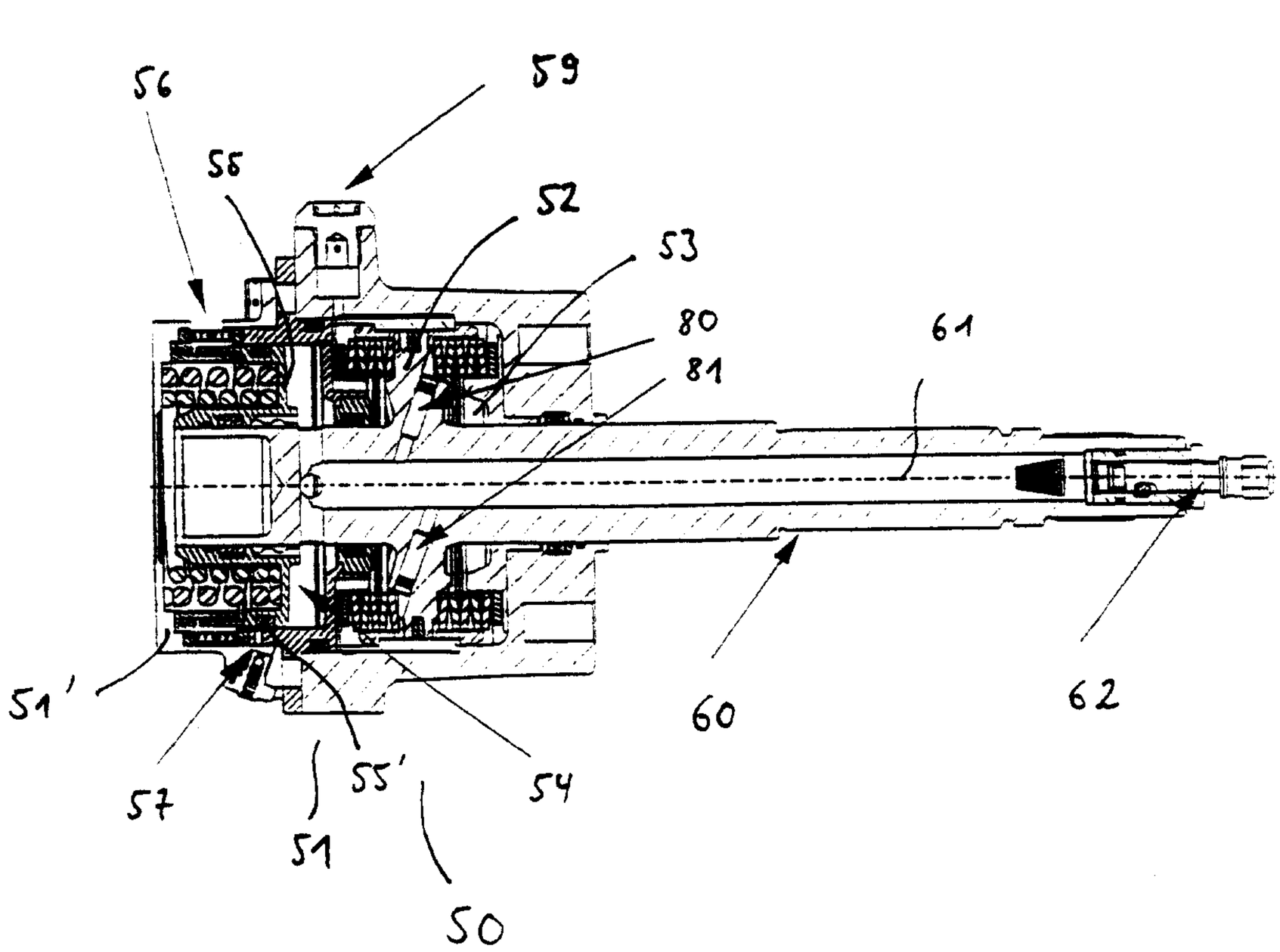
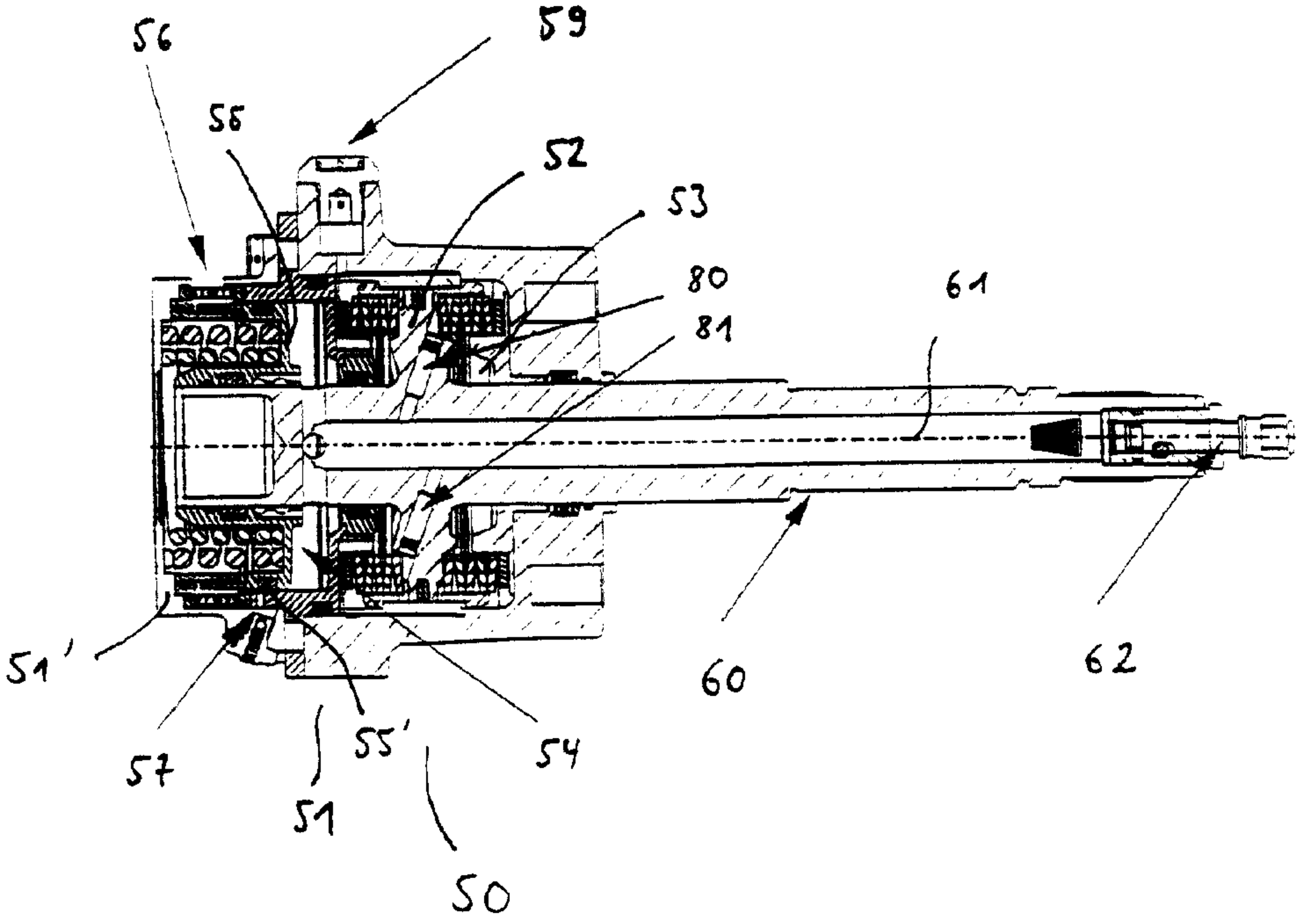


Fig. 6




56
59
56
52
53
80
81
61
51'
57
55'
54
60
62
51
50