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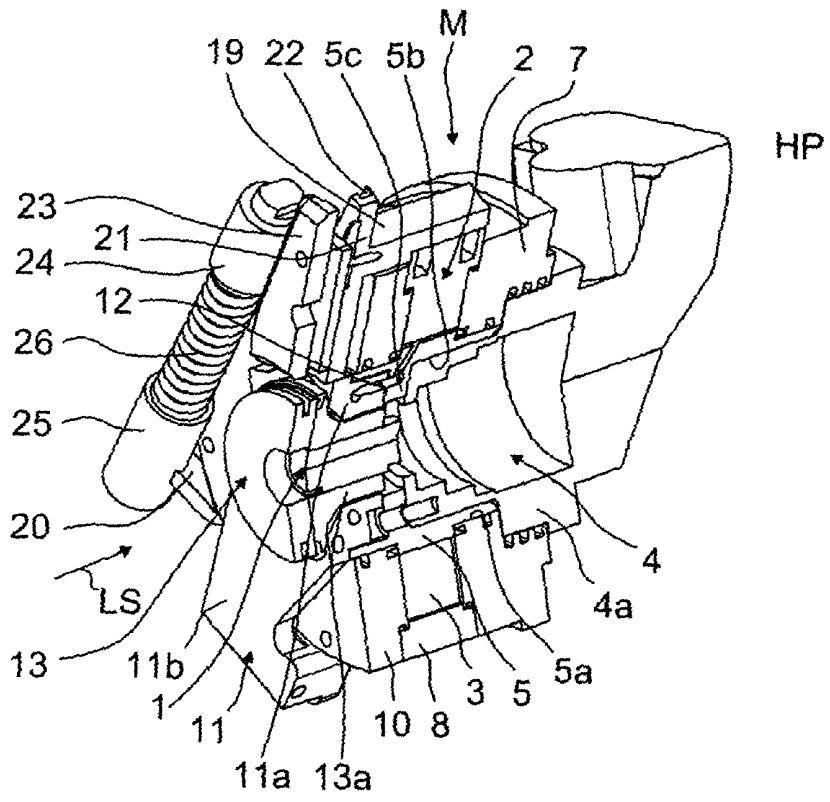
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[Continued on next page]

(54) **Title:** TRANSFORMER UNIT



(57) **Abstract:** The invention relates to a transformer unit, particularly for sawing, wherein the transformer unit (M) comprises a first machine element (1), particularly a shaft, performing a continuous rotational movement during the use of the transformer unit, and a second machine element (2) performing a limited alternating rotational motion on a part of the transformer unit, particularly a wing torsion device driven by pressurized medium. The transforming unit (M) is arranged to be coupled to an arrangement to supply driving energy for the transformer unit (M), such as a hydraulic pump unit. The first and second machine element (1, 2) of the transformer unit are preferably coupled to a device performing the same work. The device is used for performing first and second partial work performances, wherein in connection with a flanged chain saw it is operated in such a way that the first machine element (1) is arranged to rotate the chain saw during the sawing performance, and the second machine element (2) is arranged to feed the flange for the chain saw, or the like, during the sawing performance and to return the flange for the saw chain to the initial position of sawing during the sawing performance.

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Transformer unit

The invention relates to a transformer unit, particularly for sawing. The transformer unit comprises a first machine element performing a continuous rotational motion during the operation of the transformer unit, particularly a shaft, and a second machine element performing a limited alternating rotational motion on a part of the transformer unit. The transformer unit is arranged to be coupled to an arrangement to supply driving energy for the transformer unit, such as a hydraulic pump unit. The first and second machine element of the transformer unit are preferably coupled to a device performing the same work and being arranged to perform first and second partial work performances, particularly a flanged chain saw, in such a way that the first machine element is arranged to rotate the saw chain during the sawing performance, and the second machine element is arranged to feed the flange or the like for the saw chain during the sawing performance and to return the flange of the saw chain to the starting point of the sawing after the sawing performance.

As to the prior art, reference is made to the publication WO 98/53666 disclosing a sawing unit, in which the second machine element performing the second partial work performance consists of the combination of a toothed rack in a cylinder-piston mechanism operated by a pressurized medium, fixed to the cylinder-piston mechanism and arranged to be movable in its longitudinal direction, and a toothed rim fixed at the end of the sawing unit, in connection with the flange of the saw chain and in cooperation with the rack. The sawing unit is functional as such, and it provides an even moment and a steady speed during the sawing performance. However, the sawing unit presented in said publication WO 98/53666 is, primarily due to its overall principle of operation, massive and bulky in its outer dimensions, wherein it is difficult to place, for example, in connection with the harvester head of a forest machine. On the other hand, the construction of the sawing unit is relatively complex, wherein it has a high price.

The aim of the present invention is to eliminate, particularly by the application intended for sawing work, the problems of prior art sawing

units. In other words, the solution of the present invention provides all the advantages of the prior art sawing unit, *i.e.* an even moment and a constant speed of the saw flange, but the solution is considerably lighter in its weight and smaller in its outer dimensions as well as more reliable for use as a transformer unit, particularly in sawing functions. Furthermore, it makes accessory functions possible without modifying the dimensions.

To achieve these aims, the transformer unit of the invention is primarily characterized in that the second machine element is a wing torsion device operated by a pressurized medium.

In this invention, the wing torsion device refers to a machine element which is operated by a pressurized medium and which comprises an at least partly annular space for the pressurized medium, wherein the outer surface of the inner rim of the annular space for the pressurized medium is provided with at least one protruding radial wing and, in a corresponding manner, at least one inwards directed radial wing is fixed to the inner surface of the outer rim of the annular space for the pressurized medium, wherein either the inner rim or the outer rim is arranged to rotate in relation to the other rim when pressurized medium is supplied between the wings in the space for the pressurized medium.

According to a particularly advantageous embodiment of the transformer unit, the wing torsion device forming the second machine element is at least partly arranged to surround the first machine element, particularly a shaft, preferably so that an annular space for pressurized medium is formed around the first machine element. This solution makes it possible to achieve a very compact transfer unit.

The appended other dependent claims present some preferred embodiments of the transformer unit according to the invention.

The following description illustrates the transformer unit according to the invention in more detail, wherein reference is made to the

appended drawings which show an advantageous application of the transformer unit according to the invention. In the drawings,

Fig. 1 shows a perspective cross-sectional view of the transformer unit when assembled,

Fig. 2 shows an exploded view of the transformer unit from the direction of Fig. 1, also in a cross-section, and

Fig. 3 shows a system for spraying an additive in a schematic view.

The transformer unit application shown in Figs. 1 and 2 is intended for use in sawing work to be performed with the harvester head of a forest machine. The detailed structure of the harvester head and the operations to be carried out therewith are disclosed, for example, in several patent publications in the field of forest machinery. The transformer unit M is placed between a flanged chain saw LS (direction of mounting shown) and the frame of the harvester head HP.

The transformer unit M comprises two machine element 1, 2 for performing two partial work performances during the actual sawing performance. Thus, the first machine element 1 is a shaft which is fitted to carry out the first partial work performance, *i.e.* to rotate the saw chain of the flanged chain saw and to receive its driving energy from a hydraulic engine 4, to which the shaft is coupled. The second machine element 2 is a wing torsion device which is operated by a pressurized medium and is fitted to carry out the second partial work performance, *i.e.* to feed the flange, or the like, for the saw chain in the sawing direction during the sawing performance and, after the sawing performance, to return the flange of the saw chain to the initial position for sawing. The second machine element 2 is arranged to receive its driving energy from the harvester head. These operations are arranged, in a way known as such, to operate in a controlled manner during the overall operational sequence of the harvester head.

As can be seen from Figs. 1 and 2, the wing torsion device forming the second machine element 2 is arranged to surround the first machine element 1, *i.e.* the shaft, wherein a circular, annular space 3 for pressurized medium is formed around the first machine element 3 to accommodate the wing torsion device used as the second machine element 2. In this case, the inner surface of the annular space 3 for pressurized medium is arranged to be immobilized in relation to the mounting of the transformer unit M, *i.e.* the frame HP of the harvester head, and the outer surface of the annular space 3 for pressurized medium is, in turn, arranged to rotate in relation to the inner surface during the limited alternating rotation of the second machine element 2.

The hydraulic motor 4 driving the first machine element 1, *i.e.* the shaft, is arranged to be immobilized in connection with the transformer unit M during its operation, wherein its frame 4a forms the mounting for the transformer unit. A sleeve shaft 5 is placed around the first machine element 1, *i.e.* the shaft, and is fixed to the frame 4a of the hydraulic engine 4 in a stationary manner. Furthermore, the outer surface 5a of the sleeve shaft 5 (the inner surface of the space 3 for pressurized medium) is provided, in the application of Figs. 1 and 2, with two integrated wings 6a, 6b protruding from the outer surface 5a in the radial direction and belonging to the wing torsion device forming the second machine element 2. Said wings 6a, 6b are placed on the outer surface 5a of the sleeve shaft 5, at an angular distance of 180° from each other in the direction of the rim of the sleeve shaft 5.

Further with reference to Figs. 1 and 2, between the frame 4a of the hydraulic engine 4 and the wings 6a, 6b of the sleeve shaft 5, a first end part 7 is placed to limit said annular space 3 for pressurized medium in the first axial direction (mounting direction of the frame of the harvester head HP in Figs. 1 and 2) and to surround the first end of the sleeve shaft 5 which is fixed to the frame of the hydraulic engine 4. At the wings 6a, 6b of the sleeve shaft 5, an annular frame part 8 is placed to surround the wings 6a, 6b. On the inner surface 8a of the frame part 8, in the application shown in Figs. 1 and 2, there are two movable wings 9a, 9b placed at angular distances of 180° in the direction of the rim of the inner surface and fixed to said inner surface 8a to

extend in radial direction towards the outer surface 5a of the sleeve shaft 5, to which their innermost end is arranged to be sealed in the radial direction. A corresponding arrangement, with respect to the sealing, is also provided between the inner surface 8a of the frame part 8 and the ends of the wings 6a, 6b. Furthermore, in connection with the second end of the sleeve shaft 5, there is a second end part 10 limiting the annular space 3 for pressurized medium in the second axial direction (mounting direction of the flanged chain saw LS in Figs. 1 and 2) and surrounding the second end of the sleeve shaft 5.

Consequently, the first 7 and second 10 end parts as well as the annular frame part 8 therebetween, connected with *e.g.* bolts through holes R1–R3 in the axial direction, constitute the driving frame of the transformer unit M. The driving frame 7, 8, 10 performs a limited alternating rotational motion during the operation of the second machine element 2 consisting of the wing torsion device. In the sawing application of the transformer unit M, the flange of the saw chain is arranged to be connected to the driving frame. The space 3 for pressurized medium is rectangular, seen in the axial cross-section of the transformer unit M, and annular, seen in the direction perpendicular to the axial direction, and is limited by the first 7 and second 10 end parts as well as by the annular frame parts 8 together with that portion of the flange part 5 which is placed at the annular frame part 8 in the radial direction. Both the stationary 6a, 6b and the mobile 9a, 9b wings correspond, in their size and shape, to the rectangular cross-sectional shape of the space 3 for pressurized medium in the axial direction, wherein the side edges of the wings 6a, 6b, 9a and 9b are provided with sealings which seal the wings 6a, 6b, 9a and 9b at their side edges against the inner edges of the first 7 and second 10 end parts extending towards the space 3 for pressurized medium.

The wing torsion device which forms the second machine element 2 comprises, in the application of Figs. 1 and 2, two wings 6a, 6b; 9a, 9b both in the sleeve shaft 5 and in the annular frame part 8, wherein the wing torsion device is divided, with respect to the space 3 for pressurized medium, into four partial volumes 3a–3d for pressurized medium (cf. Fig. 3), of which the first one 3a and the second one 3b are

arranged to carry out the first stage of the second partial work performance (the volumes of the first 3a and second 3b partial volumes for pressurized medium are increased, and the volumes of the third 3c and fourth 3d ones are decreased), partially to feed the chain saw flange at the sawing stage in the sawing application, and of which the third 3c and fourth 3d ones are arranged to carry out the second stage of the second partial work performance (the volumes of the first 3a and second 3b partial volumes for pressurized medium are decreased, and the volumes of the third 3c and fourth 3d ones are increased), partially the movement of returning the flange in the sawing application.

The second end part 10 is formed to be annular in such a way that the stream of preferably hydraulic pressurized medium into the space 3 for pressurized medium in the wing torsion device, required to drive the wing torsion device forming the second machine element 2, is arranged to take place from the side of the second end part 10, through the second end of the sleeve shaft 5. Thus, the inner surface 5b of the sleeve shaft 5, the middle section of the sleeve shaft, is provided with a radial flange 5c, whose that radial front surface which faces the second end part 10 is connected to the front surface of the sleeve-like section 11a of the annular unit 11 for feeding pressurized medium to drive the wing torsion device, wherein the sleeve-like section of the feeding unit 11 is placed in the inner hole of the sleeve shaft, via the second end of the sleeve shaft 5. The sleeve shaft 5, the internal flange 5c of the sleeve shaft, and the feeding unit 11 are equipped with channelling parts which, combined in the transformer unit M, constitute a channel system 12 for feeding pressurized medium into the wing torsion device forming the second machine element 2, and for discharging it from the wing torsion device. In connection with the feeding unit 11, there is fixed a by-pass manifold for pressurized medium, provided with connections for pressurized medium to couple the channel system 12 with the hydraulic system of the forest machine. As can be seen from Figs. 1 and 2, through an internal hole 11c in the sleeve-like section 11 of said feeding unit, a driving wheel 13 or the like, equipped with a mounting sleeve 13a, is coupled to the shaft operating as the first machine element 1 and is intended, particularly in the sawing applica-

tion of the transformer unit M, to drive the saw chain rotating around the flange.

The sleeve shaft 5 is connected to the frame 4a of the hydraulic engine 4 at the internal radial flange 5c of the sleeve shaft 5 in such a way that the flange 5c is provided with an axial perforation R4, through which a bolted joint is made in the threaded perforation R5 on the front surface of the frame 4a of the hydraulic engine 4, via a perforation R4 in the flange 5c (Fig. 2).

Particularly with reference to Fig. 3, at least one of the partial volumes for pressurized medium, *e.g.* volume 3c, is arranged to operate during the volume change in said volume 3c for pressurized medium, preferably as a source of energy for an auxiliary work performance LT related to the work to be performed by the transformer unit M, to be implemented by pressurized medium. Such an auxiliary work performance may, particularly in a sawing application of the transformer unit M to be used in connection with a forest machine, be lubrication of the saw chain and/or the spraying of a tree stump treatment agent. The partial volume of pressurized medium to be used in such an auxiliary work performance (*e.g.* 3c) is a partial volume of pressurized medium with a volume which is decreased during the first stage of the second partial work performance, wherein the pressurized medium discharged from the partial volume 3c of pressurized medium is led along a feeding line 16a to drive a means 14, *e.g.* an injection piston, transferring a medium (*e.g.* chain oil or tree stump treatment agent) into the target. The injection piston is spring-loaded (spring 14a) in such a way that it is returned to the initial position after the injection 14c via a throttle 14b during the second stage of the second partial work performance, wherein the pressurized medium returns to the partial volume 3c for pressurized medium in the transformer unit M, partially during the return movement of the flange in the sawing application. The volume for spraying a medium in an injection piston is arranged to be filled from a medium storage 15 in connection with the transformer unit M along a line 15b equipped with a unidirectional valve 15a during said second stage. As shown in Fig. 3, the means 14 is coupled by means of a supplementary line 16b and a unidirectional valve 17, whose

conducting direction is towards the means 14, to a pressurized medium tank 18, wherein it is secured that there is a sufficient quantity of pressurized medium in the partial volume 3c for pressurized medium. From the other partial volume 4d for pressurized medium, having a volume which is reduced during the first stage of the second partial work performance, the pressurized medium is led via the valve 19 to the pressurized medium tank 18. During the first stage of the second partial work performance, pressurized medium is led in the same way via the valve 19 into the partial volumes 3a, 3b for pressurized medium with increasing volumes. It is obvious that also the other partial volume 3d for pressurized medium, with a volume reducing during the first stage of the second partial work performance, can be used by a combination of devices 14 to 17 accomplished in a corresponding manner. The positions of the valve 19 during the first stage II/1 and the second stage II/2 of its second partial work performance are marked in the blocks of the valve 19. In the sawing application, the storage 15 of the medium to be used in the supplementary work performance is placed in connection with the harvester head HP, and an annular channel system 27 is formed between the first end part 7 and the frame 4a of the hydraulic engine 4 (Fig. 2), extending through the driving frame 7, 8 and 10, all the way to the means 14 in connection with the flange.

Two lugs 19, 20 are fixed to the driving frame 7, 8 and 10, onto the outer surface of its annular frame part 8. To the first one 19 is connected the frame 21 of the holder of the flange, provided with a slide bar 22 or the like for the holder 23 of the flange. To the holder 23 of the flange is connected a first end lug 24 for a clamp for the saw chain. To the second lug 20 is connected a second end lug 25 for the clamp for the saw chain. Thus, the spring set 26 intended for clamping the saw chain is placed between the first 24 and the second 25 end lugs.

Claims:

1. A transformer unit, particularly for sawing, wherein the transformer unit comprises a first machine element (1) performing a continuous rotational motion during the operation of the transformer unit, particularly a shaft, and a second machine element (2) performing a limited alternating rotational motion on a part of the transformer unit, wherein the transformer unit (M) is arranged to be coupled to an arrangement to supply driving energy for the transformer unit (M), such as a hydraulic pump unit, and wherein the first and the second machine element (1, 2) of the transformer unit (M) are preferably coupled to a device performing the same work and being arranged to perform first and second partial work performances, particularly a flanged chain saw, in such a way that the first machine element (1) is arranged to rotate the chain saw during the sawing performance and the second machine element (2) is arranged to feed the flange or the like in the chain saw during the sawing performance and to return the flange of the chain saw to the starting point of the sawing after the sawing performance, **characterized** in that the second machine element (2) is a wing torsion device operated by pressurized medium.

2. The transformer unit according to claim 1, **characterized** in that the wing torsion device forming the second machine element (2) is arranged at least partly to surround the first machine element (1), particularly a shaft.

3. The transformer unit according to claim 1, **characterized** in that an annular space (3) for pressurized medium is formed around the first machine element (1), in which space the wing torsion device used as the second machine element (2) is placed.

4. The transformer unit according to claim 1 or 3, **characterized** in that the inner surface of the annular space (3) for pressurized medium is arranged to be immovable with respect to the mounting of the transformer unit (M), and the outer surface of the annular space (3) for pressurized medium is arranged to rotate around the limited alternating rotation of the second machine element (2), or *vice versa*.

5. The transformer unit according to any of the claims 1 to 4, **characterized** in that the frame (4a) of the hydraulic engine (4) or the like for driving the first machine element (1), operating in the mounting of the transformer unit (M), is arranged in connection with the transformer unit (M) to be immovable during its operation, wherein a sleeve shaft (5) is placed around the first machine element (1), connected in the frame (4a) of the hydraulic engine (4) in a stationary manner, and that to the outer surface (5a) of the sleeve shaft (5) is connected at least one stationary wing (6a, 6b) protruding from the outer surface in the radial direction and belonging to the wing torsion device forming the second machine element (2).

6. The transformer unit according to any of the claims 1 to 5, **characterized** in that between the frame (4a) of the hydraulic engine (4) and at least one wing (6a) of the sleeve shaft (5) a first end part (7) is placed to limit the annular space (3) for pressurized medium in a first axial direction and to surround the first end of the sleeve shaft (5) which is fixed to the frame (4a) of the hydraulic engine (4), that by said at least one wing (6a, 6b) of the sleeve shaft (5) an annular frame part (8) is placed on whose inner surface (8a) there is at least one movable wing (9a, 9b) belonging to the wing torsion device forming the second machine element (2), and that in connection with the second end of the sleeve shaft (5) a second end part (10) is placed to limit the annular space for pressurized medium in a second axial direction and to surround the second end of the sleeve shaft (5), wherein the first (7) and second (10) end parts as well as the annular frame part (8) therebetween constitute the element of the transformer unit (M) which makes a limited alternating rotational motion, *i.e.* a driving frame which is turned during the use of the wing torsion device, to which, particularly in a sawing application of the transformer unit (M), a flange is arranged to be connected.

7. The transformer unit according to claim 1 or 6, **characterized** in that the second end part (10) is formed to be annular in such a way that the stream of the pressurized medium, required for driving the wing torsion device, into the wing torsion device, is arranged to flow

from the side of the second end part (10), through the second end of the sleeve shaft (5).

8. The transformer unit according to any of the claims 1, 6 or 7, **characterized** in that the inner surface of the sleeve shaft (5) is provided with a radial flange (5c) to whose radial front surface facing the second end part (10) is connected an annular unit (11) for feeding pressurized medium driving the wing torsion device, wherein the sleeve shaft (5), the flange (5c) inside the sleeve shaft (5) and the feeding unit (11) are equipped with a channel system (12) for feeding pressurized medium into the wing torsion device and for discharging it from the wing torsion device.

9. The transformer unit according to any of the claims 1 or 6 to 8, **characterized** in that to the first machine element (1) is coupled, via an internal hole (11c) in said feeding unit (11), a driving wheel (13) or the like which is equipped with a mounting sleeve (13a) and which is, particularly in the sawing application of the transformer unit, intended to drive the saw chain rotating around the flange.

10. The transformer unit according to claim 1 or 6, **characterized** in that the wing torsion device comprises two wings (6a, 6b; 9a, 9b) both in the sleeve part (5) and in the annular frame part (8), wherein the wing torsion device is divided, with respect to the space for pressurized medium, into four partial volumes (3a–3d) for pressurized medium, of which the first (3a) and the second (3b) volumes are arranged to perform the first stage of the second partial work performance, particularly in the sawing application, the feeding of the flange, and of which the third (3c) and the fourth (3d) volumes are arranged to perform the second stage of the second partial work performance, particularly in the sawing application, the movement of returning the flange.

11. The transformer unit according to claim 1 or 10, **characterized** in that at least one of the volumes (3c) for pressurized medium is arranged to operate during the volume change of said volume (3c) for pressurized medium, preferably as a source of energy for a supplementary work performance related to work performed by the trans-

former unit (M) and to be implemented by the pressurized medium, particularly in a supplementary work performance (LT) in connection with the sawing application of the transformer unit (M), performing the transfer of a medium, such as the lubrication of the saw chain and/or the injection of a tree stump treatment agent.

12. The transformer unit according to claim 1, 10 or 11, **characterized** in that said at least one volume (3c) for pressurized medium is a partial volume for pressurized medium which is decreased during the first stage of the second partial work performance, wherein the pressurized medium is arranged to be led by using a means (14), such as an injection piston, for transforming the medium to the target.

13. The transformer unit according to claim 6, **characterized** in that two lugs (19, 20) are connected to the driving frame (7, 8, 10), onto its outer surface, wherein to the first one (19) is connected the frame (21) of a holder for the flange, provided with a slide bar (22) or the like for the holder (23) of the flange, wherein the first end lug (24) is connected to the holder (23) of the flange and the second end lug (25) of the tensioner for the chain is connected to the second lug (20), wherein the spring set (26) intended for tensioning the chain is placed between the first (24) and second (25) end lugs.

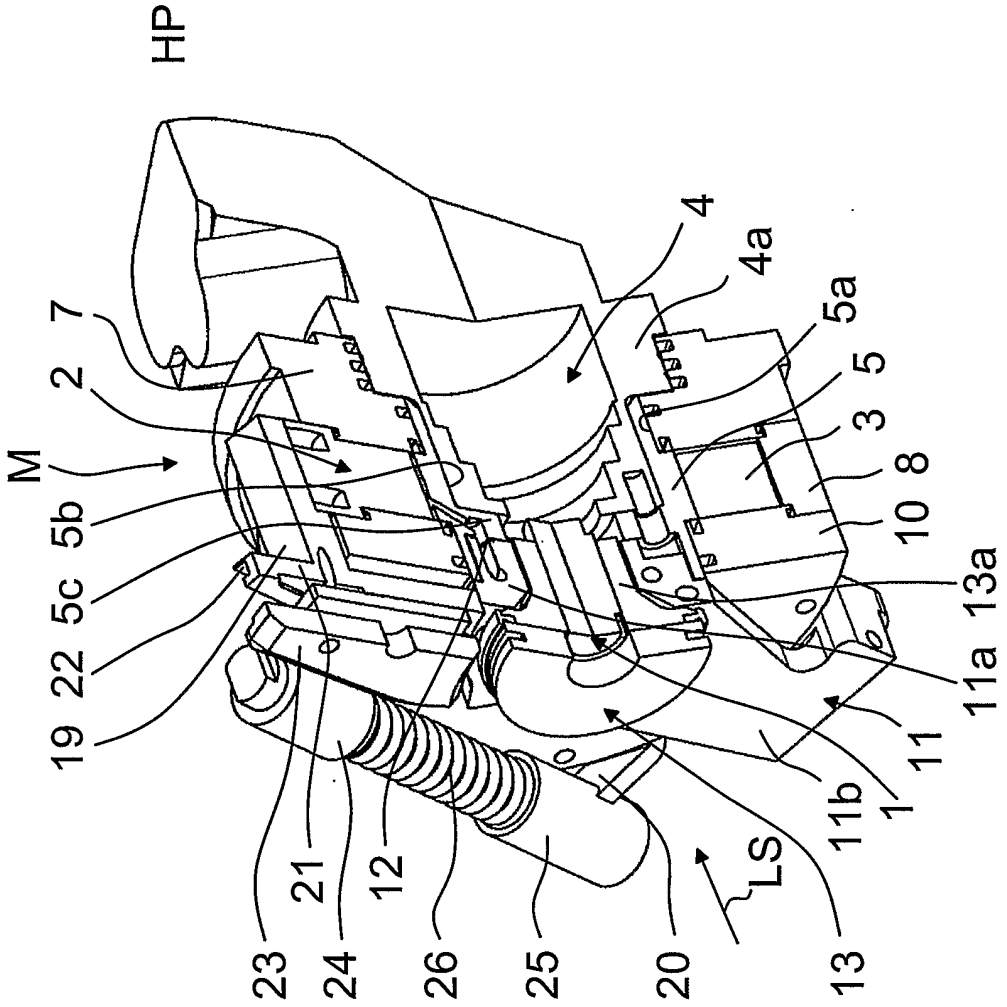
14. The transformer unit according to claim 8, **characterized** in that the sleeve shaft (5) is connected to the frame (4a) of the hydraulic engine (4) or the like, by the radial flange (5c) inside the sleeve shaft (5), in such a way that the flange (5c) is provided with an axial perforation (R4), through which the threaded perforation (R5) on the front surface of the frame (4a) for the hydraulic engine (4) or the like is provided with a bolted joint via the perforation in the flange (5c).

15. The transformer unit according to claim 12, **characterized** in that the injection piston used as the means (14) is spring-loaded (14a) in such a way that it returns to the initial position after the injection during the second stage of the second partial work performance, particularly the return motion of the flange in the sawing application, wherein the

injection medium volume of the injection piston is arranged to be filled from a medium storage (15) in connection with the transformer unit.

16. The transformer unit according to any of the claims 1, 5, 6 or 10, **characterized** in that said at least one wing (6a, 6b) of the sleeve shaft (5) is arranged to be pressed at its side surfaces against the side surfaces of the first (7) and second (10) end parts.

Fig. 1


HP
M
2
7
5b
5c
22
19
4
4a
5a
5
3
8
10
13a
11a
11
1
11b
LS
13
20
25
26
12
21
24
23

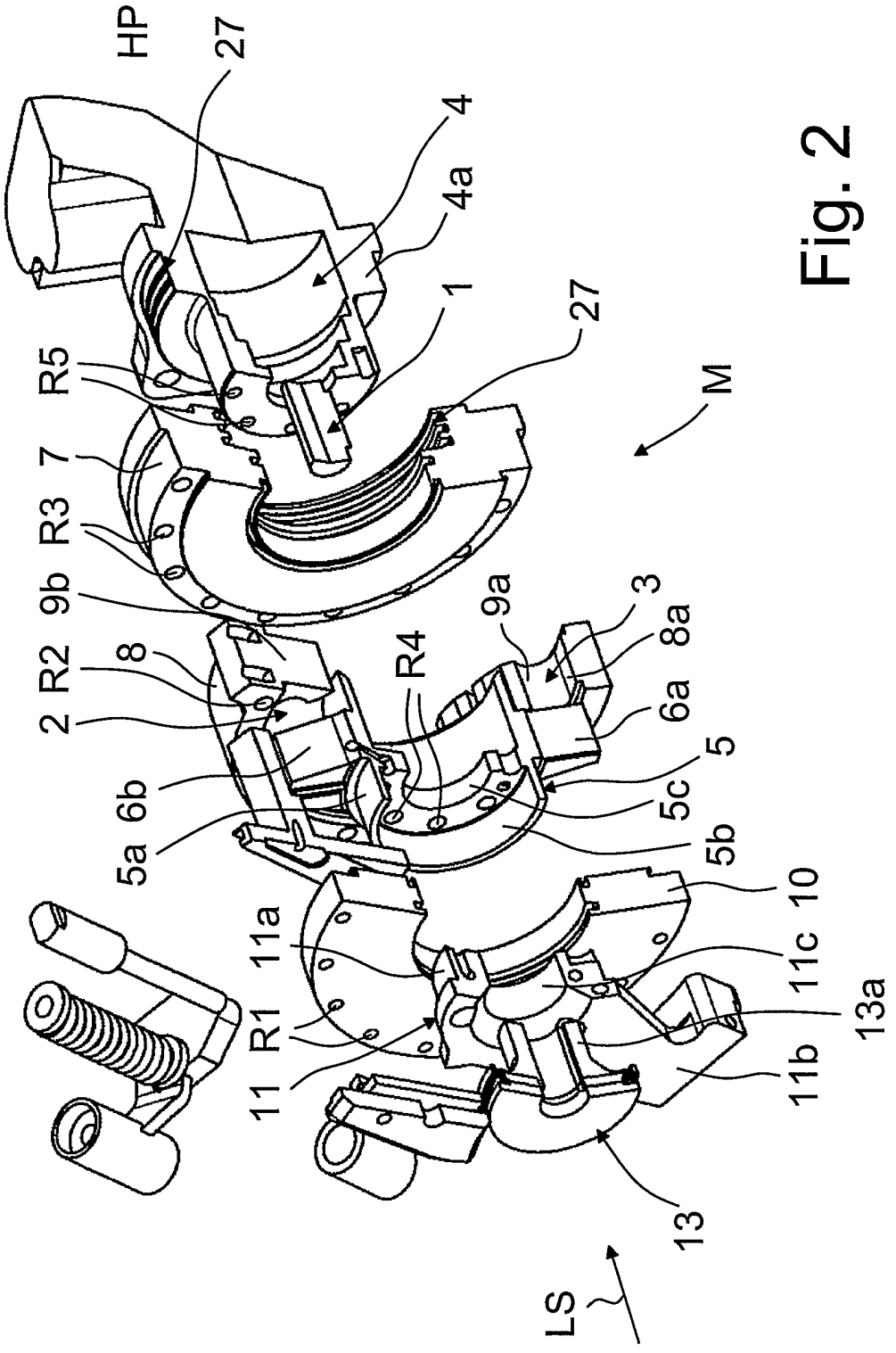

HP
27
4
4a
1
27
M
R5
7
R3
9b
2
R2
8
6b
5a
R4
9a
3
8a
6a
5
5c
5b
10
11c
13a
11b
11a
R1
11
13
LS

Fig. 2

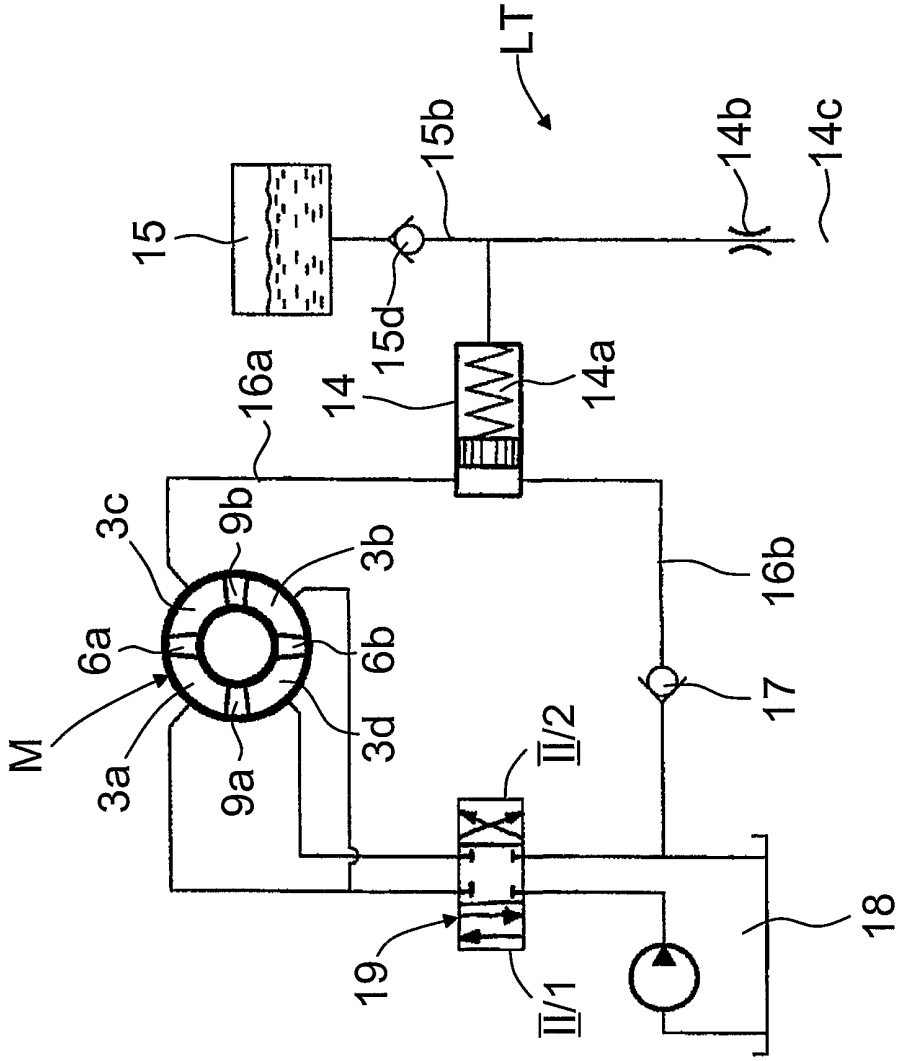

LT
15
15b
14b
14c
15d
14
14a
16a
16b
3c
9b
3b
6a
6b
M
3a
9a
3d
17
II/2
II/1
19
18

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 01/00646

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: A01G 23/08
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)

IPC7: A01G

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

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, 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.
Y	DE 3146695 A1 (HEINZ THUMM ÖLHYDRAULISCHE ANTRIEBE GMBH), 7 July 1983 (07.07.83), figures 1,2, abstract --	1-16
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7 November 2001	08 -11- 2001
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Eddy Leopold/MP Telephone No. +46 8 782 25 00

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