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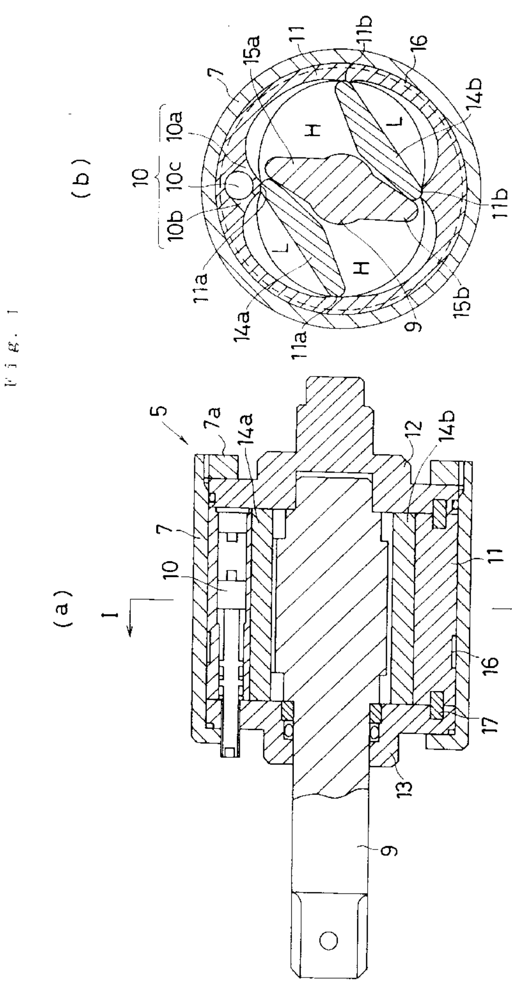
(54) **An impulse torque generator for a hydraulic power wrench.**

(57) Objective of the invention is to provide an impulse torque generator for hydraulic impulse torque wrench having a high energy efficiency, and low temperature increase of the hydraulic oil. The impulse generator comprising a liner (11,21,31,41), driven by a rotor, having inner cavity and at least four, or two pairs (2n) of seal surfaces around its inner surface, a main shaft (9) having at least two (n) projections on its surface mounted coaxially within the liner (11,21,31,41) and at least two (n) driving blades (14a, 14b, 24a, 24b, 34a, 34b, 44a, 44b) generating impulse torque on the main shaft abutting the projections of the main shaft (9).
(n is an integer greater than or equal to 2)



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FIELD OF THE INVENTION

The invention relates to a hydraulic impulse torque generator for a power driven torque wrench.

PRIOR ARTS

Power driven wrenches have been developed and are widely used because the noise and the vibration during the operation are rather small.

Figure 21 indicates an example of this type of hydraulic impulse wrench which comprises a main valve 2 to start and to stop the supply of compressed air and a direction switch valve 3 for selecting the direction of the revolution and a rotor 4 which is driven by compressed air supplied through the valves 2, 3. An impulse torque generator 5 which converts the rotational output torque into an impulse torque is mounted inside a front case 6 projected from the main body of the hydraulic impulse torque wrench 1. The impulse torque generator 5 comprises a liner 8 disposed inside a liner case 7, a main valve 2, a main shaft 9 having one or more slots on its surface coaxially mounted within the liner 8, and blades B disposed along the slots of the main shaft 9 being radially urged outwardly by springs S to contact the inner surface of the liner 8 thereby forming a seal between the liner 8 and the main shaft 9. The liner 8 has an output adjusting mechanism 10 for adjusting the strength of impact torque.

An impact torque is generated on the main shaft 9 when the blades B reach to the seal points inside the liner 8 while the rotor 4 drives the liner 8 rotating.

In the impact torque wrench of the prior art, a frictional resistance between the blades B and the surface of the inner surface of the liner 8 causes a comparatively large energy loss because the blades B disposed in the slots of the main shaft 9 are always urged radially by the spring S to contact the inner surface of the liner 8 and the frictional heat causes a viscosity change of the hydraulic oil filled in the liner 8 consequently the output of the wrench fluctuates.

A diameter of the main shaft 9 should be designed rather large to obtain a sufficient strength because there is provided the slots for mounting the blades on the main shaft 9 and holes for mounting the springs S and therefore it is difficult to manufacture a compact impulse torque wrench. In addition the structure of the tool becomes complex and further the durability of the tool is not sufficient because the springs S are likely damaged or destroyed.

SUMMARY OF THE INVENTION

An objective of this invention is to provide an impulse torque generator with less energy loss caused by the frictional resistance between the blades B and inner surface of the liner 8, a low temperature increase of the hydraulic oil by the frictional heat, and a simple structure and high durability by omitting the blades B being urged radially by the springs S.

The objective of this invention is accomplished by an impulse torque generator for a hydraulic power driven wrench comprising a liner, driven by a rotor, having inner cavity and at least four or at least two pairs (2n) of seal surfaces around its inner surface, a main shaft having at least two (n) projections on its surface mounted coaxially within the liner and at least two (n) driving blades with seal surfaces at both ends generating a impulse torque on the main shaft abutting the projections of the main shaft. (n is an integer greater than 2)

An invention of claim 2 is that the seal surface is so arranged symmetrically with respect the center of revolution at an angle of 360/n degree that n impacts are generated on the main shaft at each revolution of the liner.

An invention of claim 3 is that the seal surfaces are arranged symmetrically with respect to the center of revolution at an angle of 360/n degree and further a groove is disposed at the inner side of the liner cover and the side of the driving blades which contact with the liner thereby releasing the hydraulic oil pressure thereby generating one impulse at each revolution of the liner.

An invention of claim 4 is that an impulse generator of claim 1 wherein a pair of seal surface is arranged unsymmetrically thereby one impulse is generated on the main shaft at each one revolution of the liner.

An invention of claim 5 is that an impulse generator of claim 1 wherein the seal surface is arranged symmetrically at an angle of 360/n degree and guide grooves are eccentrically disposed on each an inner surface of the liner cover and pins disposed at the side of the driving blades being introduced into the guide grooves thereby generating one impulse on the main shaft at each revolution of the liner.

According to the invention of claim 1, as the liner is driven by the rotor and the seal surfaces and the seal surface at both ends of the driving blades meet each other, an impulse is generated on the main shaft of the machine therefore the springs of the conventional torque wrench have become unnecessary. Further in the invention of the application, high energy efficiency is accomplished, a steady output of the impulse is obtained with small temperature rise of the hydraulic oil. Also it becomes possible to provide an impulse torque wrench of compact and small size, with simple structure, and high durability.

According to the invention of claim 2, as the liner is driven by the rotor, then the n pairs of seal surfaces disposed inside the liner at an angle of 360/n degree and seal surface at both ends of the driving blades meet n times in one revolution of the liner therefore n impulses are generated at each one revolution of the liner.

According to the invention of claim 3, as the liner is driven by the rotor, then the n pairs of seal surfaces disposed inside the liner at an angle of 360/n degree and seal surfaces at both ends of the driving blades meet n times while one revolution of the liner but the high pressure of the hydraulic oil is released through the holes disposed at the driving blades therefore only one big impulse is generated at each one revolution of the liner.

According to the invention of claim 4, as the liner is driven by the rotor, then the n pairs of seal surfaces unsymmetrically disposed inside the liner at an angle of 360/n degree and the seal surfaces at both ends of the driving blades meet one time while one revolution of the liner therefore only one big impulse is generated at each one revolution of the liner.

According to the invention of claim 5, as the liner is driven by the rotor, then the n pairs of seal surfaces disposed inside the liner at an angle of 360/n degree and seal surfaces at both ends of the driving blades meet one time while one revolution of the liner by constraining the movement of the driving blades with the pins disposed at the end of the driving blades and guide grooves disposed on liner cover therefore only one impulse is generated at each one revolution of the liner.

BRIEF EXPLANATION OF THE DRAWINGS

Figure 1 is an embodiment of the impulse torque generator of this invention, Figure 1(a) is an elevation view of the impulse generator and Figure 1(b) is a cross sectional view along the line I-I of the Figure 1(a).

Figure 2 indicates a driving blade of the impulse generator.

Figure 3 is an embodiment of a main shaft of the impulse generator.

Figure 4 indicates an upper cover of the liner of the impulse generator.

Figure 5 indicates a lower cover of the liner of the impulse generator.

Figure 6 indicates an impulse generating process of the impulse generator of this invention.

Figure 7 is the second embodiment of the impulse torque generator of this invention, Figure 7(a) is an elevation view of the impulse generator and Figure 7(b) is a cross sectional view along the line II-II of the Figure 2(a).

Figure 8 indicates a driving blade of the impulse generator of the second embodiment.

Figure 9 is an embodiment of a main shaft of the impulse generator of the second embodiment.

Figure 10 indicates an upper cover of the liner of the impulse generator of the second embodiment.

Figure 11 indicates a lower cover of the liner of the impulse generator of the second embodiment.

Figure 12 indicates an impulse generating process of the impulse generator of the second embodiment.

Figure 13 is the third embodiment of the impulse torque generator of this invention, Figure 13(a) is an elevation view of the impulse generator and Figure (b) is a cross sectional view along the line III-III of the Figure 13(a).

Figure 14 indicates an impulse generating process of the impulse generator of the third embodiment.

Figure 15 is the fourth embodiment of the impulse torque generator of this invention, Figure 15(a) is an elevation view of the impulse generator and Figure 15(b) is a cross sectional view along the line IV-IV of the Figure 15(a).

Figure 16 indicates an driving blade of the impulse generator of the fourth embodiment.

Figure 17 indicates a main shaft of the fourth embodiment.

Figure 18 indicates an upper cover of the liner of the impulse generator of the fourth embodiment.

Figure 19 indicates a lower cover of the liner of the impulse generator of the fourth embodiment.

Figure 20 indicates an impulse generating process of the impulse generator of the fourth embodiment.

Figure 21 indicates an example of impulse torque wrench of the prior arts.

DETAILED EXPLANATION OF THE INVENTION

The invention is further explained according to the attached drawings.

Figure 1 to Figure 6 indicate the first embodiment of the hydraulically driven impulse torque generator.

A basic structure of the impulse torque generator of the invention is same as that of prior arts shown in Figure 21. The impulse torque wrench of this invention comprises a main valve 2 to start and to stop the supply of the compressed air and a direction switch valve 3 for selecting the direction of the rotation, and a rotor 4 which is driven by the compressed air supplied through the valves 2,3. An impulse torque generator which converts the rotational output torque into the impulse torque is mounted inside a front case 6 projected from the main body of the hydraulic impulse torque wrench 1.

The impulse torque generator 5 of the embodiment comprises a liner 11 disposed inside a liner case 7 filled with hydraulic oil and, a main shaft 9 coaxially mounted within the liner 11.

The liner 11 has an oval profile internal cavity section and there is provided at least four or two pairs of seal surfaces 11a, 11b being projected from the inner surface of the liner like a hill and are arranged symmetrically with respect to the center of the revolution at an angle of 180 degree.

The liner 11 is inserted inside the liner case 7 and both ends of the liner case 7 are covered with an upper cover 12 and a lower cover 13 which are secured to the liner 11 with knock-pins inserted into pin holes 12a, 13a thereby rotatable as one solid body. Further the upper cover 12 is covered with liner case cover 7a to conceal the hydraulic oil filled inside the liner 11.

A main shaft 9 mounted inside the liner 11 has two smooth shape projections 15a, 15b symmetrically disposed with respect to the revolution center at an angle of 180 degree. A radial length and an axial length of the two projection 15a, 15b are smaller than that of the liner thereby forming hydraulic oil passages at both ends of the liner and between the top of the projections and the inner surface of the liner.

Two driving blades 14a, 14b having a triangle shape and smooth section of the same size are inserted inside the liner 11 cavity separated by the projections 15a, 15b of the main shaft.

An axial length of the driving blade is same as that of the inner cavity of the liner so that the driving blade contacts the upper cover and the lower cover at both ends and seal surfaces are so designed that the seal surfaces 11a, 11b and the seal surfaces of the driving blades 14a, 14 b meet and contact each other to form seals two times at each revolution of the liner 11.

A passage ditch 16 is disposed at an outer surface of the liner which connects low pressure chambers L, L which are formed inside the liner cavity parted by the driving blades 14a, 14b. An output adjusting mechanism is disposed in the liner parallel to the axle of the liner. This mechanism is a well known mechanism for example comprising ports 10a, 10b which connect the high pressure chambers H, H which are formed inside the liner cavity parted by the driving blades 14a, 14b and an output adjusting valve 10c screwed into a screwed hole 13b disposed at the lower cover 13.

In this embodiment, the impulse torque generator comprises 4 sealing surfaces which are two pairs of sealing surfaces disposed inside the liner, two projections 15a, 15b radially projected from the main shaft 9, and two driving blades 14a, 14b. But number of the seal surfaces is selected depending on a number of impulse generated at one revolution of the liner, for instance if we want n impulses at one revolution of the liner, then a number of the seal surfaces inside the liner should be 2n (n pairs), n projections radially projected on the main shaft and n driving blades.

Now, a process of generation of an impulse is explained in more detail referring to Figure 6.

A compressed air is introduced into the rotor 4 of the main body by opening the main valve and the switch valve then the rotor 4 starts rotating. The revolution power is transmitted to the liner 11. As the liner rotates, the sate of the inside the liner case 7 changes as indicated in Figure 6 (a)-(b)-(c)-(d)-(a). Figure 6(a) indicates the state that no impulse is generated on the main shaft. Figure 6(b),(c) ,(d) indicates the state as the liner 11 rotates about an angle of 90 degree respectively.

An impulse is generated as indicated in Figure 6(b) and Figure 6(d) when the seal surfaces 11a, 11b and the seal surfaces of the driving blades meet together and the inner cavity of the liner 11 is divided into four chambers. The instant an impulse torque is generated on the main shaft a volume of a high pressure chamber H decreases and a volume of a low pressure chamber L increases because of the shape of the inner cavity of the liner and then the high pressure chamber changed to low pressure chamber and vise versa. That is, as the rotor drives the liner 11, seal surface 11a, 11b of the liner meet the seal surface of the driving blades 14a, 14b, each chamber becomes a high pressure chamber or a low pressure chamber, the driving blade 14a, 14b are pushed toward the low pressure chamber, then the seal surfaces have completely concealed thereby rotational power of the liner 11 is exerted on a projections 15a, 15b of the main shaft 9 through the driving blades 14a, 14b and gives an impulse on the main shaft 9, which is two impulses at one revolution of the liner applicable to tightening or loosening the bolts or nuts.

On the other hand, as indicated in Figure 6(a) and (c), as the liner rotates and seal surfaces 11a, 11b of the liner and the sealing surfaces of the driving blades meet, each chamber becomes high pressure or low pressure chamber for a instant. The driving blades are pushed toward the low pressure chamber then the seal between the seal surfaces are broken and the hydraulic compressed oil in the high pressure chamber will flow out through gaps between the seal surfaces into the low pressure chamber therefore no impulse is generated on the main shaft 9.

If the rotor is driven in a reverse direction, inside the liner case will change in the reverse direction of Figure 6, that is, the inside state changes as 6(d)- (c)- (b)- (a)-(d) and the reverse direction impulse is generated.

The second embodiment of the invention is shown in Figure 7 to Figure 12.

A basic structure of the second embodiment is same as the first embodiment explained before.

An impulse generator filled with hydraulic oil is disposed inside a liner case 7, and a main shaft 9 is coaxially mounted within the center of the liner 21.

The liner 21 has an oval profile internal cavity section and there is provided two pairs of 4 sealing surfaces 21a, 21b being projected from the inner surface of the liner like a hill and are arranged symmetrically with respect to the center of the revolution at an angle of 180 degree.

The cylindrical liner 21 is inserted inside the liner case 7 and both ends of the liner case 7 are covered with an upper cover 22 and a lower cover 23 which are secured to the liner 21 with knock-pins 27 inserted into pin holes 22a, 23a thereby assembled body is rotatable as a solid body. Further the upper cover 22 is covered with liner case cover 7a to fix the cover in the axial direction and to conceal the hydraulic oil filled inside the liner 21.

And there is provided grooves 28a, 28b on the surfaces of the upper cover 22 and the lower cover 23 for releasing the pressure of the hydraulic oil.

A main shaft 9 mounted inside the liner 21 has two smooth shape projections 25a, 25b symmetrically disposed with respect to the revolution center at an angle of 180 degree. A radial length and an axial length of the two projections 25a, 25b are smaller than that of the liner thereby forming hydraulic oil passages at both ends of the liner and between the top of the projections and the inner surface of the liner.

Two driving blades 24a, 24b having a triangle shape and smooth section of the same size are inserted inside the liner 21 cavity separated by the projections 25a, 25b of the main shaft.

An axial length of the driving blades is same as that of the inner cavity of the liner so that the driving blade contacts the upper cover and the lower cover at its both ends. There is provided grooves 29a, 29b on the surfaces of the driving blades 24a, 24b for releasing the pressure of the hydraulic oil and the seal surfaces 21a, 21b and the seal surfaces of the driving blades 24a, 24 b meet and contact each other to form seals two times at each revolution of the liner 21, but when the grooves 28a, 28b on the upper cover 22 and the lower cover 23 and the grooves 29a, 29b at the side of the driving blades 24a, 24b are through, the hydraulic oil is released from high pressure chamber to low pressure chamber consequently only one impulse is generated on the main shaft 9 at one revolution of the liner.

In this embodiment, the grooves 28a, 28b are disposed on both the upper and the lower cover but either one of the groove will do. A groove for releasing the hydraulic oil pressure is disposed on the side of the corresponding either of the driving blade 24a, 24b.

A passage ditch 26 is disposed at an outer surface of the liner 21 which connects low pressure chambers L, L which are formed inside the liner cavity parted by the driving blades 24a, 24b. An output adjusting mechanism is disposed in the liner parallel to the axle of the liner 21. This mechanism is a well known mechanism for example comprising ports 10a, 10b which connect the high pressure chambers H, H formed inside the liner cavity parted by the driving blades 24a, 24b and an output adjusting valve 10c screwed into a screwed hole 23b disposed at the lower cover 23.

In this embodiment, the impulse torque generator comprises 4 seal surfaces 21a, 21b, which are two pairs of seal surfaces disposed inside the liner 21, two projections 25a, 25b radially projected from the main shaft 9, and two driving blades 24a, 24b.

But a number of the seal surfaces is not restricted to this number. A number of the seal surfaces are selected depending on a strength of the impulse generated at one revolution of the liner, for instance if there is provided more than n(n is greater than 3) pairs of seal surfaces around the inner surface of the liner, then n projections radially projected on the main shaft and n driving blades are necessary consequently a greater impulse is generated.

Now, a process of generation of an impulse is explained in more detail referring to Figure 12.

A compressed air is introduced into the rotor 4 of the main body by opening the main valve 2 and the switch valve 3 then the rotor 4 starts rotating. The revolution power is transmitted to the liner 31. As the liner rotates, a state of the inside the liner case 7 changes as indicated in Figure 12 (a)-(b)-(c)-(d)-(a). Figure 12(a) indicates the state that no impulse is generated on the main shaft 9. Figure 12(b),(c) ,(d) indicates the state as the liner 31 rotates about an angle of 90 degree respectively.

An impulse is generated as indicated in Figure 12(b) when the seal surfaces 21a, 21b and the seal surfaces of the driving blades 24a, 24b meet together and the inner cavity of the liner 21 is divided into four chambers. The instant an impulse torque is generated on the main shaft 9 a volume of a high pressure chamber H decreases and a volume of a low pressure chamber L increases because of the shape of the inner cavity of the liner and then the high pressure chamber changed to low pressure chamber and vise versa. That is, as the rotor 4 drives the liner 21, seal surfaces 21a, 21b of the liner meet the sealing surfaces of the driving blade 24a, 24b, each parted chamber becomes a high pressure chamber or a low pressure chamber, the driving blades 24a, 24b are pushed toward the low pressure chamber, then the seal surfaces have completely concealed thereby rotational power of the liner 21 is exerted on a projections 25a, 25b of the main shaft 9 through the driving blades 24a, 24b and gives an impulse on the main shaft 9 intermittently, which is one impulse at one revolution of the liner applicable to tightening or loosening the bolts or nuts.

In the state as indicated in Figure 12(d), though the seal surfaces 21a, 21b of the liner 21 and the seal surfaces of the driving blades meet, hydraulic oil in the high pressure chamber H will be released out through the grooves 28a, 28b disposed at the upper and the lower cover, and the grooves 29a, 29b disposed on the side of the driving blades 24a, 24b and the inner cavity is not concealed therefore no impulse is generated on the main shaft 9 at this stage.

On the other hand, as indicated in Figure 12(a) and (c), as the liner 21 rotates and seal surfaces 21a, 21b of the liner and the seal surfaces of the driving blades meet, each chamber becomes high pressure or low pressure chamber for an instant, the driving blades are push toward the low pressure chamber then sealing between the seal surfaces are broken and the hydraulic compressed oil in the high pressure chamber will flow out through gaps between the seal surfaces into the low pressure chamber therefore no impulse is generated.

Further, a part of the hydraulic oil in the high pressure chamber flows out through the grooves 29a, 29b on the driving blades 24a, 24b and the grooves on the upper and the lower cover 22,23 of the liner 2 to the low pressure chamber.

If the rotor 4 is driven in a reverse direction, inside the liner case 7 will change in the reverse direction of Figure 12, that is, the state of the inside of the liner changes as 12(d)-(c)-(b)-(a)-(d) and the reverse direction impulse on the main shaft 9 is generated.

The third embodiment of the invention is shown in Figure 13 to Figure 14.

A basic structure of the second embodiment is same as the first embodiment explained before.

An impulse generator filled with hydraulic oil is disposed inside a liner case 7, and a main shaft 9 is coaxially mounted at the center of the liner 31.

The liner 31 has an oval profile internal cavity section and there is provided two pairs of 4 seal surfaces 31a, 31b being projected from the inner surface of the liner like a hill and are arranged unsymmetrically with respect to the center of the revolution at an angle of 180 degree.

The cylindrical liner 31 is inserted inside the liner case 7 and both ends of the liner case 7 are covered with an upper cover 32 and a lower cover 33 which are secured to the liner 31 with knock-pins 37 inserted into pin holes 32a, 33a thereby assembled body is rotatable as a solid body. Further the upper cover 32 is covered with liner case cover 7a to fix the cover in the axial direction and to conceal the hydraulic oil filled inside the liner 31.

A main shaft 9 mounted inside the liner 31 has two smooth shape projections 35a, 35b symmetrically disposed with respect to the revolution center at an angle of 180 degree. A radial length and an axial length of the two projections 35a, 35b are smaller than that of the liner thereby forming hydraulic oil passages between the driving blades and both ends of the liner 31 and between the top of the projections 35a,35b and the inner surface of the liner 31.

Two driving blades 34a, 34b having a triangle shape, a smooth section and of different size are inserted inside the liner cavity separated by the projections 35a, 35b of the main shaft 9.

The driving blade 34a is larger than the other driving blade 34b.

An axial length of the driving blades 34a, 34b is same as that of the inner cavity of the liner so that the driving blades contact the upper cover and the lower cover at their both ends.

There is provided sealing surfaces 34a, 34b at both ends of the driving blades and the sealing surfaces of the driving blades 34a, 34b meet and contact with the sealing surfaces 31a, 31b of the liner to form a sealing one time at each revolution of the liner 31.

In this embodiment, two pairs of 4 sealing surfaces 31a, 31b are disposed unsymmetrically with respect to the center of the revolution around the inner surface of the liner 31 at an angle of 180 degree and driving blades of different size are inserted in the liner 31 thereby the seal surfaces 31a, 31b and the seal surfaces of the driving blades 34a, 34b meet only one time at each revolution of the liner 31 and one impulse is generated on the main shaft 9. Instead of adapting the different sized driving blades, it is possible to generate one impulse at one revolution by adapting a symmetrically disposed crank-like shaped seal surface along the driving blade, an inclined seal surface along the driving blade, or a V-shaped seal surface.

A passage ditch 36 is disposed at an outer surface of the liner 31 which connects low pressure chambers L, L which are formed inside the liner cavity parted by the driving blades 34a, 34b. An output adjusting mechanism is disposed in the liner parallel to the axle of the liner 31. This mechanism is a well known mechanism for example comprising ports 10a, 10b which connect the high pressure chambers H, H formed inside the liner cavity parted by the driving blades 34a, 34b and an output adjusting valve 10c screwed into a screwed hole 33b disposed at the lower cover 33.

In this embodiment, the impulse torque generator comprises 4 seal surfaces 31a, 31b, which are two pairs of seal surfaces disposed inside the liner 31, two projections 35a, 35b radially projected from the main shaft 9, and two driving blades 34a, 34b.

But a number of the seal surfaces is not restricted to this number. A number of the seal surfaces are selected depending on a strength of the impulse generated at one revolution of the liner, for instance if there is provided more than n(n is greater than 3) pairs of seal surfaces around the inner surface of the liner, then it is necessary to provide n projections radially projected on the main shaft and n driving blades respectively consequently a greater impulse is generated.

Now, a process of generation of an impulse is explained in more detail referring to Figure 14.

A compressed air is introduced into the rotor 4 of the main body by opening the main valve 2 and the switch valve 3 then the rotor 4 starts rotating. The revolution power is transmitted to the liner 21. As the liner rotates, a state of the inside the liner case 7 changes as indicated in Figure 14 (a)-(b)-(c)-(d)-(a). Figure 14(a) indicates the state that no impulse is generated on the main shaft 9. Figure 14(b),(c) ,(d) indicates the state as the liner 31 rotates about an angle of 90 degree respectively.

An impulse is generated as indicated in Figure 14(b) when the seal surfaces 31a, 31b and the seal surfaces of the driving blades 34a, 34b meet together and the inner cavity of the liner 31 is divided into four chambers. The instant an impulse torque is generated on the main shaft 9, a volume of a high pressure chamber H decreases and a volume of a low pressure chamber L increases because of the shape of the inner cavity of the liner and then the high pressure chamber changed to low pressure chamber and vise versa. That is, as the rotor drives the liner 31, seal surfaces 31a, 31b of the liner meet the seal surfaces of the driving blades 34a, 34b, each parted chamber becomes a high pressure chamber or a low pressure chamber, the driving blade 24a, 24b are pushed toward the low pressure chamber, then the seal surfaces have completely concealed thereby rotational power of the liner 31 is exerted on a projections 35a, 35b of the main shaft 9 through the driving blades 34a, 34b and gives an impulse on the main shaft 9, which is one impulse at one revolution of the liner applicable to tightening or loosening the bolts or nuts.

In the state as indicated in Figure 14(a), instant the seal surfaces 31a, 31b of the liner 31 meet the seal surfaces of the driving blades 34a, 34b, each parted chamber becomes a high pressure chamber H or a low pressure chamber L for a very short period then the driving blades are pushed toward the low pressure chamber consequently the seal between the seal surfaces of the liner and the driving blades are broken, the hydraulic oil starts flowing from the high pressure chamber to the low pressure chamber through the broken seal and no impulse is generated on the main shaft 9 at this stage.

In figure 14(c),(d), the seal surfaces of the liner 31 never meet the seal surfaces of the driving blades because of the unsymmetrical layout of the seal surfaces 31b, 31a and different sized driving blades, no impulse is generated at this stage on the main shaft 9.

If the rotor 4 is driven in a reverse direction, inside the liner case 7 will change in the reverse direction of Figure 14, that is, the state of the inside of the liner changes as 14(d)-(c)-(b)-(a)-(d) and the reverse direction impulse on the main shaft is generated.

The fourth embodiment of the invention is shown in Figure 15 to Figure 20.

A basic structure of the second embodiment is same as the first embodiment explained before.

An impulse generator filled with hydraulic oil is disposed inside a liner case 7, and a main shaft 9 is coaxially mounted at the center of the liner 41.

The liner 41 has an oval profile internal cavity section and there is provided two pairs of 4 seal surfaces 41a, 41b being projected from the inner surface of the liner like a hill and are arranged symmetrically with respect to the center of the revolution at an angle of 180 degree.

The cylindrical liner 41 is inserted inside the liner case 7 and both ends of the liner case 7 are covered with an upper cover 42 and a lower cover 43 which are secured to the liner 41 with knock-pins(not shown) inserted into pin holes 42a, 43a thereby assembled body is rotatable as a solid body. Further the upper cover 42 is covered with liner case cover 7a to fix the cover in the axial direction and to conceal the hydraulic oil filled inside the liner 41.

And there is provided guide grooves 42c, 43c on the surface of the upper cover 42 and the lower cover 43. As shown in Figure 18 and Figure 19, the guide grooves 42c, 43c are eccentrically disposed with respect to the revolution center O of the liner and further the direction of the eccentricity of the two guide grooves is in the 180 degree opposite direction.

Also there is provided an hole 43e and an oil inlet 43f in the lower cover 43. A pin 48 is inserted in the hole 43e to fix the cover to the liner cover and to prevent the revolution of the lower cover 43 with respect to the liner case 7. This construction is applicable to the embodiments of the application explained before.

A main shaft 9 mounted inside the liner 41 has two smooth shape projections 45a, 45b symmetrically disposed with respect to the revolution center at an angle of 180 degree. A radial length and an axial length of the two projections 45a, 45b are smaller than that of the liner thereby forming hydraulic oil passages at both ends of the liner and between the top of the projections and the inner surface of the liner.

Two driving blades 44a, 44b having a triangle shape and smooth section of the same size are inserted inside the liner cavity separated by the projections 45a, 45b of the main shaft.

An axial length of the driving blades is same as that of the inner cavity of the liner so that the driving blades contact the upper cover and the lower cover at their both ends.

Both radial ends of the driving blades 44a, 44b are formed as a sealing surfaces to contact with the sealing surfaces of the liner 41. As shown in figure 16, there is provided a guide pin 47a, 47b, which are inserted in the guide grooves 42c, 43c at either one of the longitudinal end of the driving blades 44a, 44b, more specifically the guide pin 47b is inserted in the guide groove 42c and guide pin 47a in the guide groove 43c. As the guide grooves 42c, 43c are disposed eccentrically with respect to the center of the revolution, when the sealing surfaces of the liner and driving blades meet two times at each revolution of the liner, but the motion of the driving blade is limited not to meet by the guide line therefore the impulse is generated every other meet. So only one impulse is generated at each revolution of the liner.

A passage ditch 46 is disposed at an outer surface of the liner 41 which connects low pressure chambers L, L which are formed inside the liner cavity parted by the driving blades 44a, 44b. An output adjusting mechanism is disposed in the liner parallel to the axle of the liner 41. This mechanism is a well known mechanism for example comprising ports 10a, 10b which connect the high pressure chambers H, H formed inside the liner cavity parted by the driving blades 44a, 44b and an output adjusting valve 10c screwed into a screwed hole 43b disposed at the lower cover 43.

An accumulator 49 for absorbing the heat expansion of the hydraulic oil is disposed parallel to the axle of the liner 41.

The accumulator 49 comprises a piston 49a, and an air permeable member 49b in which one end of the accumulator 49 is connected to the inner cavity of the liner 41 via a small passage 43d disposed in the lower cover 43 of the liner and the other end is connected to the open air through the air permeable member 49b, a small hole 42b disposed in the upper cover 43 and a gap between the upper cover 42 and the liner case 7a.

In this embodiment, the impulse torque generator comprises 4 sealing surfaces 41a, 41b, which are two pairs of seal surfaces disposed inside the liner 41, two projections 45a, 45b radially projected from the main shaft 9, and two driving blades 44a, 44b.

But a number of the seal surfaces is not restricted to this number. A number of the seal surfaces are selected depending on a strength of the impulse generated at one revolution of the liner, for instance if there is provided more than n(n is greater than 3) pairs of sealing surfaces around the inner surface of the liner, then n projections radially projected on the main shaft and n driving blades are necessary consequently a greater impulse is generated.

It is possible to generate one impulse by eccentrically disposing a proper shape and a proper number of guide grooves on the upper and the lower cover of the liner.

Now, a process of generation of an impulse is explained in more detail referring to Figure 20.

A compressed air is introduced into the rotor 4 of the main body by opening the main valve 2 and the switch valve 3 then the rotor 4 starts rotating. The revolution power is transmitted to the liner 41. As the liner rotates, a state of the inside the liner case 7 changes as indicated in Figure 20 (a)-(b)-(c)-(d)-(a). Figure 20(a) indicates the state that no impulse is generated on the main shaft 9. Figure 20(b),(c) ,(d) indicates the state as the liner 41 rotates about an angle of 90 degree respectively.

An impulse is generated as indicated in Figure 12(b) when the sealing surface 41a, 41b and the sealing surface of the driving blades 44a, 44b meet together and the inner cavity of the liner 41 is divided into four chambers. The instant an impulse torque is generated on the main shaft 9 a volume of a high pressure chamber H decreases and a volume of a low pressure chamber L increases because of the shape of the inner cavity of the liner 41 and then the high pressure chamber changed to low pressure chamber and vise versa. That is, as the rotor 4 drives the liner 41, sealing surfaces 41a, 41b of the liner meet the sealing surfaces of the driving blades 44a, 44b, each parted chamber becomes a high pressure chamber or a low pressure chamber, the driving blades 44a, 44b are pushed toward the low pressure chamber, then the sealing surfaces have completely concealed thereby rotational power of the liner 41 is exerted on a projections 45a, 45b of the main shaft 9 through the driving blade 44a, 44b and gives an impulse on the main shaft 9 intermittently, which is one impulse at one revolution of the liner applicable to tightening or loosening the bolts or nuts.

In the state as indicated in Figure 20(d), when the sealing surfaces 41a, 41b of the liner 41 and the sealing surfaces of the driving blades almost meet, the guide pins 47a, 47b of the driving blades inserted in the eccentric guide grooves 42c, 43c limit the movement of the driving blades subsequently the sealing between the liner and the driving blades is not completely sealed and no impulse is not generated on the main shaft 9.

As indicated in Figure 20(a),(c), the liner rotates and sealing surfaces 41a, 41b of the liner and the sealing surfaces of the driving blade meet, each parted chamber becomes high pressure or low pressure chamber, the driving blades are pushed toward the low pressure chamber then sealing between the sealing surfaces are broken and the hydraulic compressed oil in the high pressure chamber will flow out through gaps between the sealing surfaces into the low pressure chamber therefore no impulse is generated on the main shaft.

If the rotor 4 is driven in a reverse direction, inside the liner case 7 will change in the reverse direction of Figure 20, that is, the state of the inside of the liner changes as 20(d)-(c)-(b)-(a)-(d) and the reverse direction impulse on the main shaft 9 is generated.

Claims

1 An impulse torque generator for a hydraulic power driven wrench comprising a liner(11,21,31,41), driven by a rotor, having inner cavity and at least four, or two pairs (2n) of seal surfaces around its inner surface, a main shaft(9) having at least two (n) projections on its surface mounted coaxially within the liner (11,21,31,41) and at least two (n) driving blades(14a,14b,24a,24b,34a,34b,44a,44b) generating impulse torque on the main shaft abutting the projections of the main shaft.
(n is an integer greater than or equal to 2)

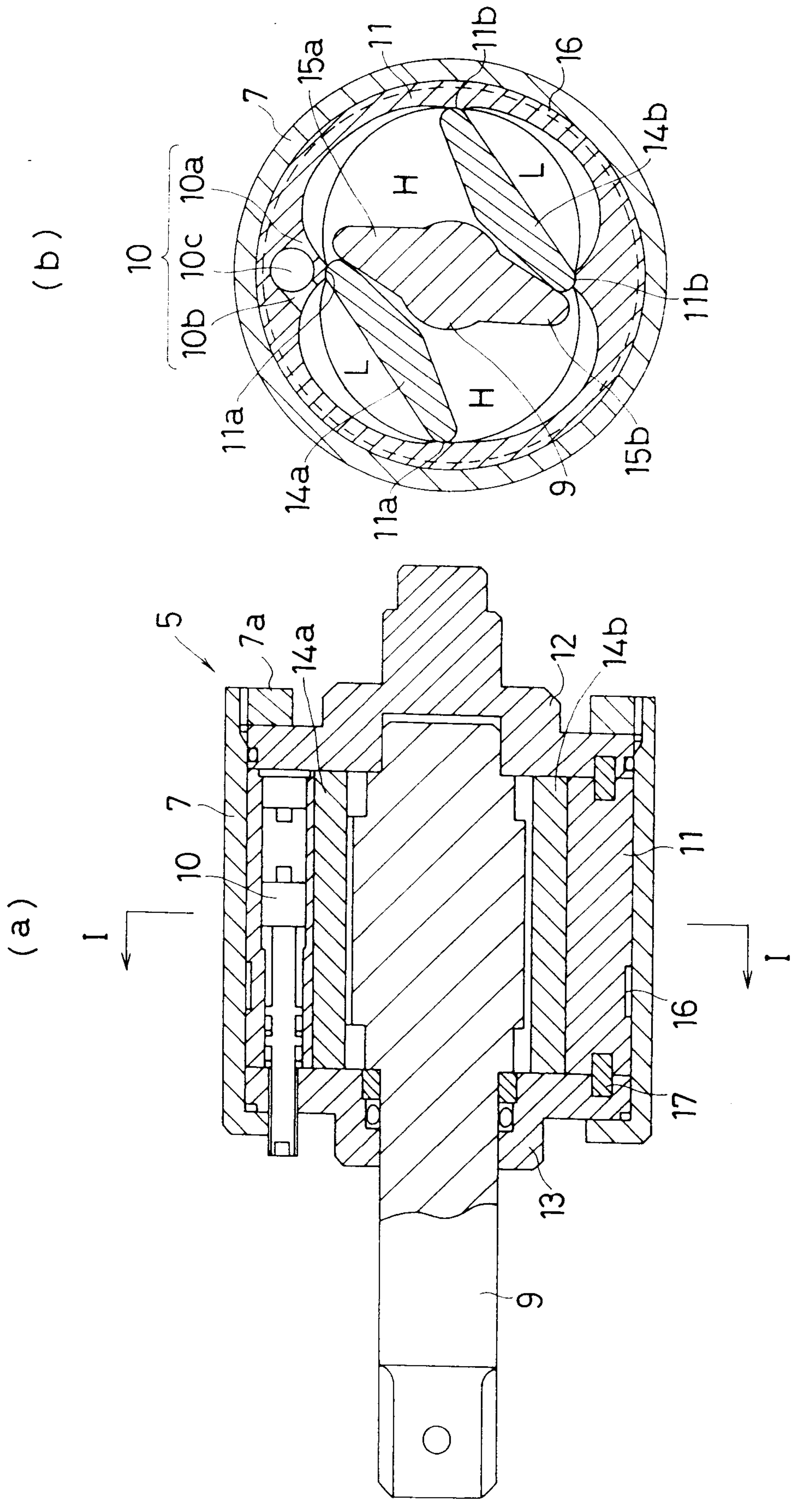
2 An impulse torque generator for a hydraulic power driven wrench of claim 1 wherein the pair of seal surfaces of the liner(11) are symmetrically arranged with respect to the center of the revolution at an angle of 360/n degree thereby generating n impulses on the main shaft(9)at one revolution of the liner.

3 An impulse torque generator for a hydraulic power driven wrench of claim 1 wherein the pair of seal surfaces of the liner(21) are symmetrically arranged with respect to the center of the revolution at an angle of 360/n degree, and further grooves(28a,28b,29a,29b) for releasing the hydraulic oil pressure are disposed at the surface of the liner cover(22,23) and the side of the driving blades(24a,24b) thereby generating one impulse at one revolution of the liner.

4 An impulse torque generator for a hydraulic power driven wrench of claim 1 wherein the pair of seal surfaces of the liner(31) are unsymmetrically arranged with respect to the center of the revolution at an angle of 360/n degree thereby generating one impulse at one revolution of the liner.

5 An impulse torque generator for a hydraulic power driven wrench of claim 1 wherein the pair of seal surfaces of the liner(41) are symmetrically arranged with respect to the center of the revolution at an angle of 360/n degree, and further guide grooves(42c,43c) are eccentrically disposed on the surface of the liner cover(42,43) and guide pins(47a,47b) introduced into the guide grooves are disposed at the end of the driving blades(44a,44b) thereby generating one impulses at one revolution of the liner.

Fig. 1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(b)
I
I
5
7a
14a
12
14b
7
10
11
16
17
13
9
10
10a
10b
10c
11
11b
15a
16
14b
H
L
11a
14a
9
15b

Fig. 2

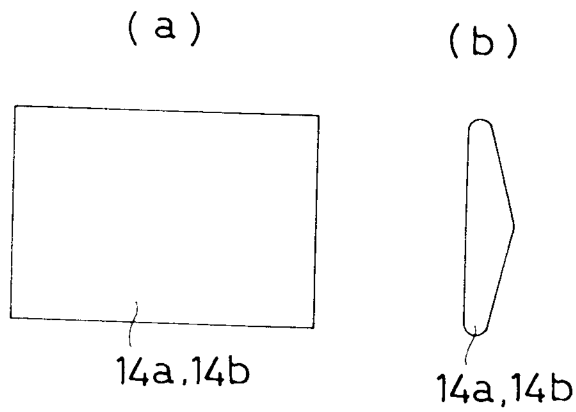


Fig. 3

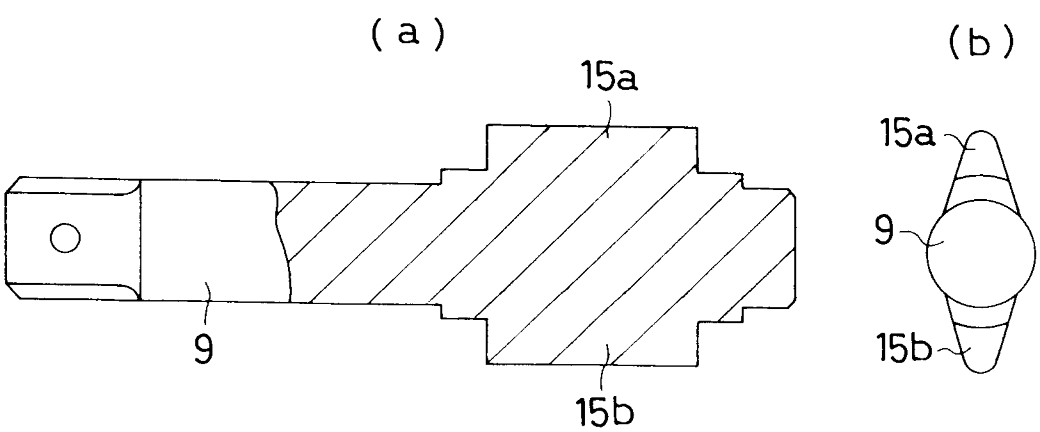


Fig. 4

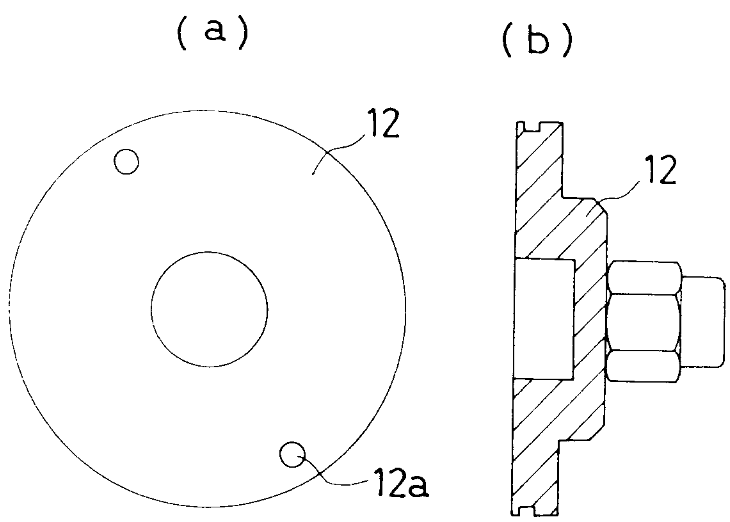


Fig. 5

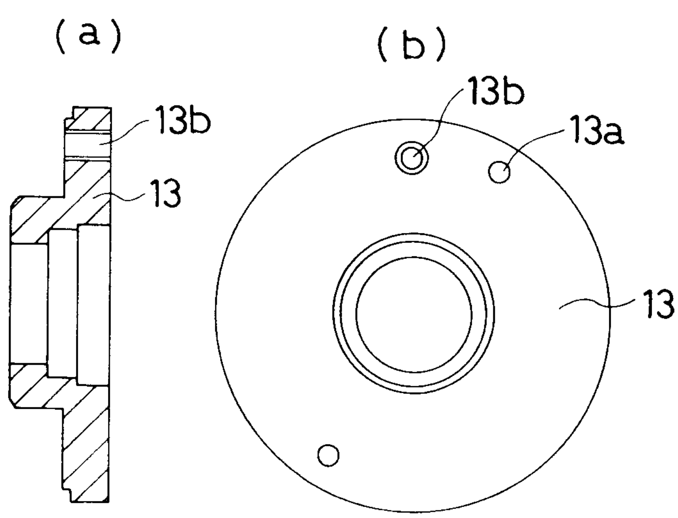
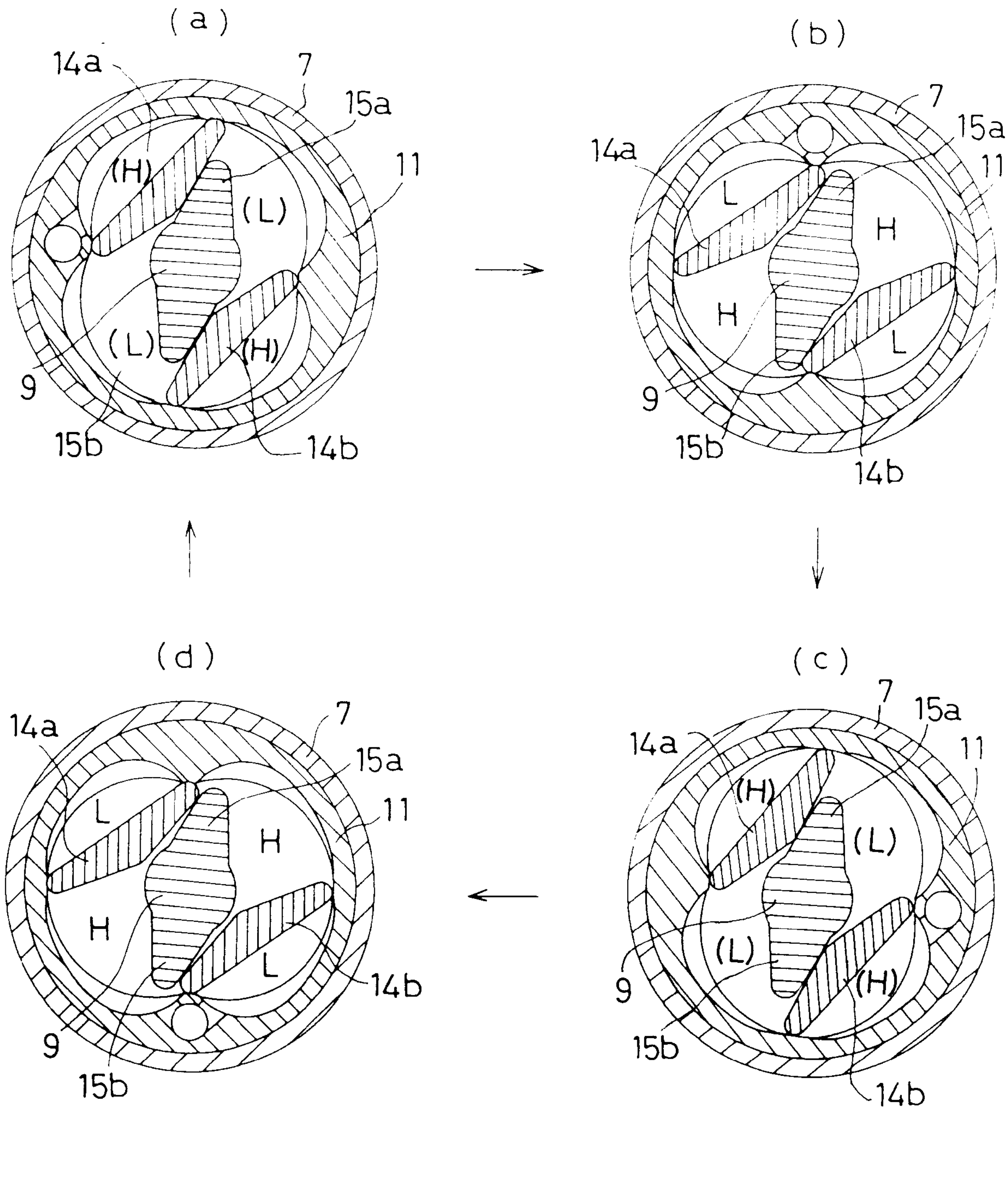


Fig. 6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15a
11
(H)
(L)
(L)
(H)
9
15b
14b
(b)
7
15a
14a
11
L
H
H
L
9
15b
14b
(c)
7
15a
14a
11
(H)
(L)
(L)
(H)
9
15b
14b
(d)
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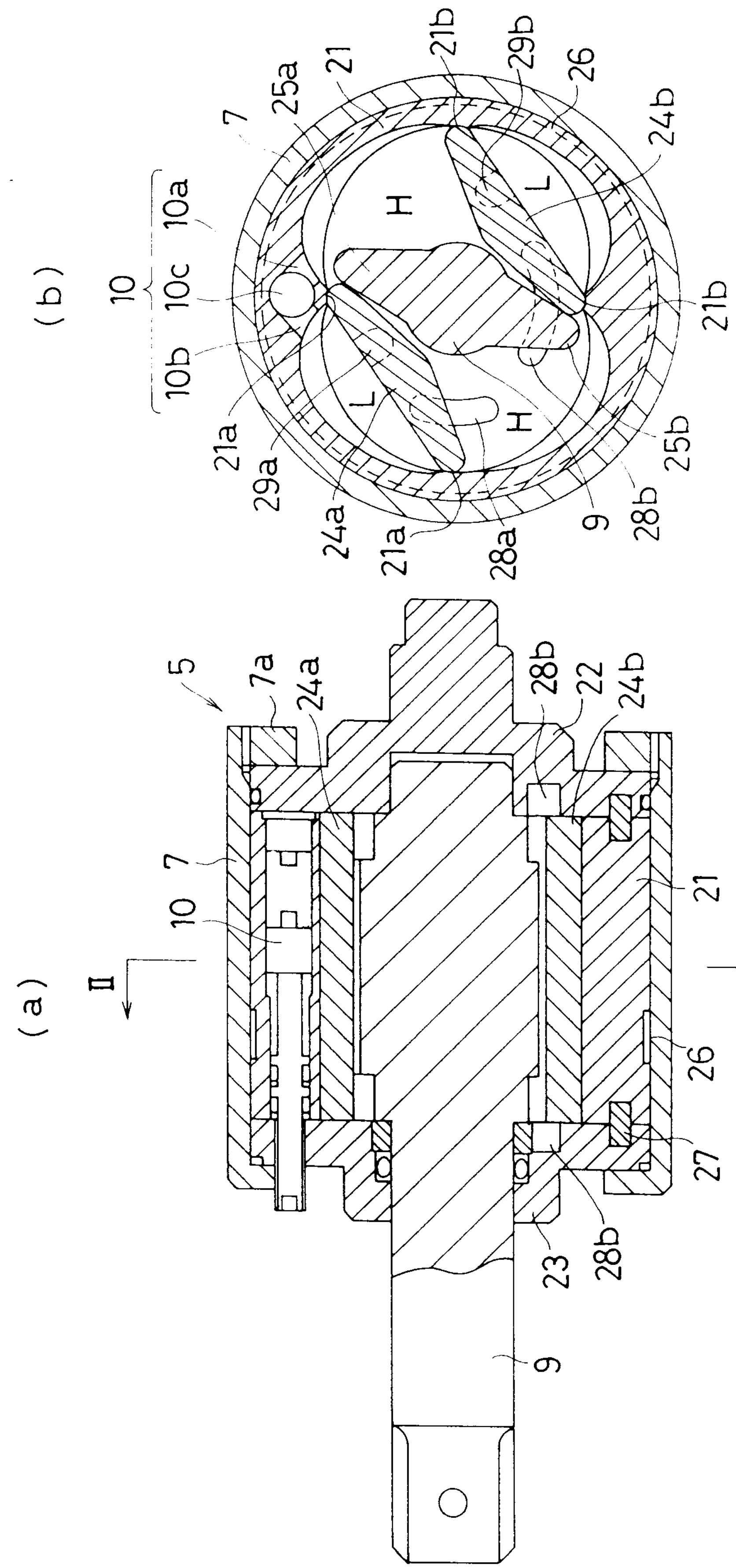
7
15a
11
L
H
H
L
14b
9
15b

Fig. 7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(b)
II
II
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7a
24a
7
10
28b
22
24b
21
26
27
23
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9
10
10a
10b
10c
25a
21b
29b
24b
21a
29a
24a
28a
9
28b
25b
H
L

Fig. 8

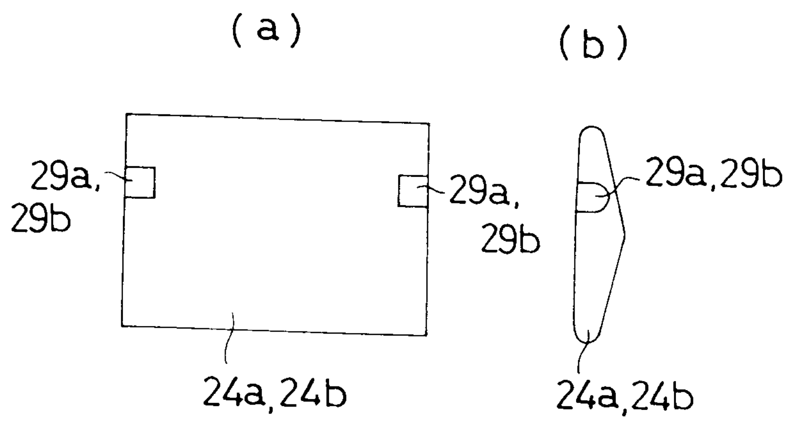


Fig. 9

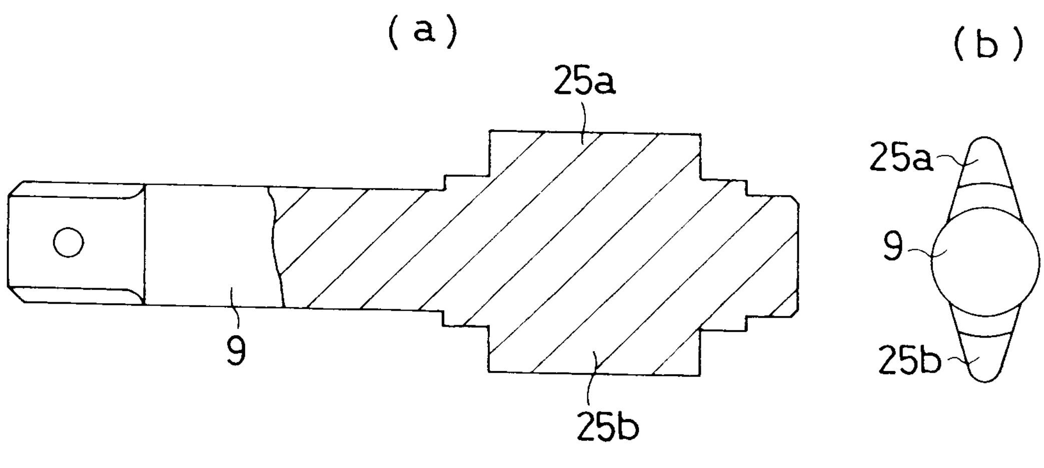
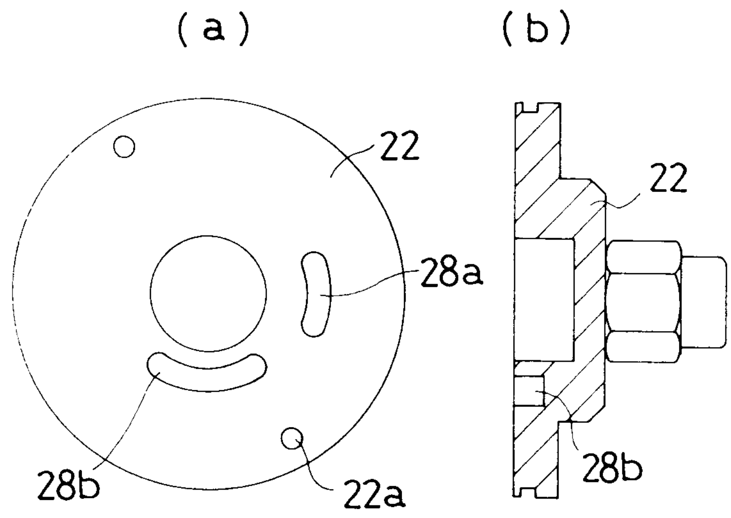


Fig. 10



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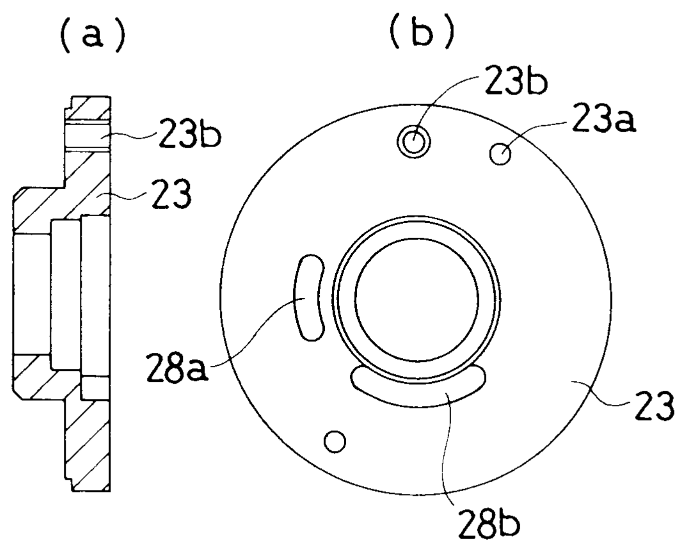
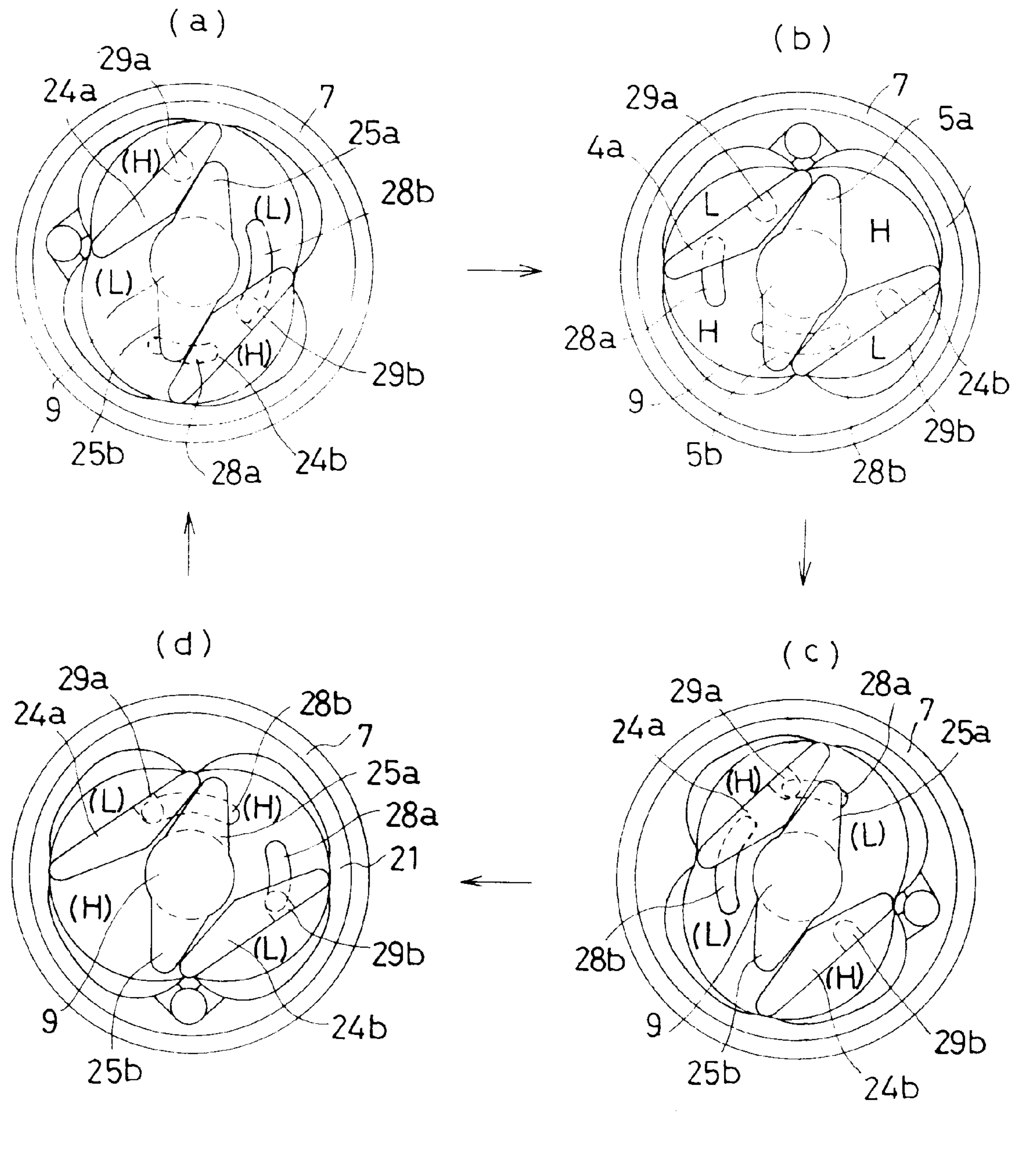


Fig. 12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24a
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25a
28b
(H)
(L)
(L)
(H)
29b
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25b
28a
24b
(b)
29a
7
5a
4a
L
H
28a
H
L
24b
9
29b
5b
28b
(c)
29a
28a
7
25a
24a
(H)
(L)
28b
(L)
(H)
29b
9
25b
24b
(d)
29a
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(L)
29b
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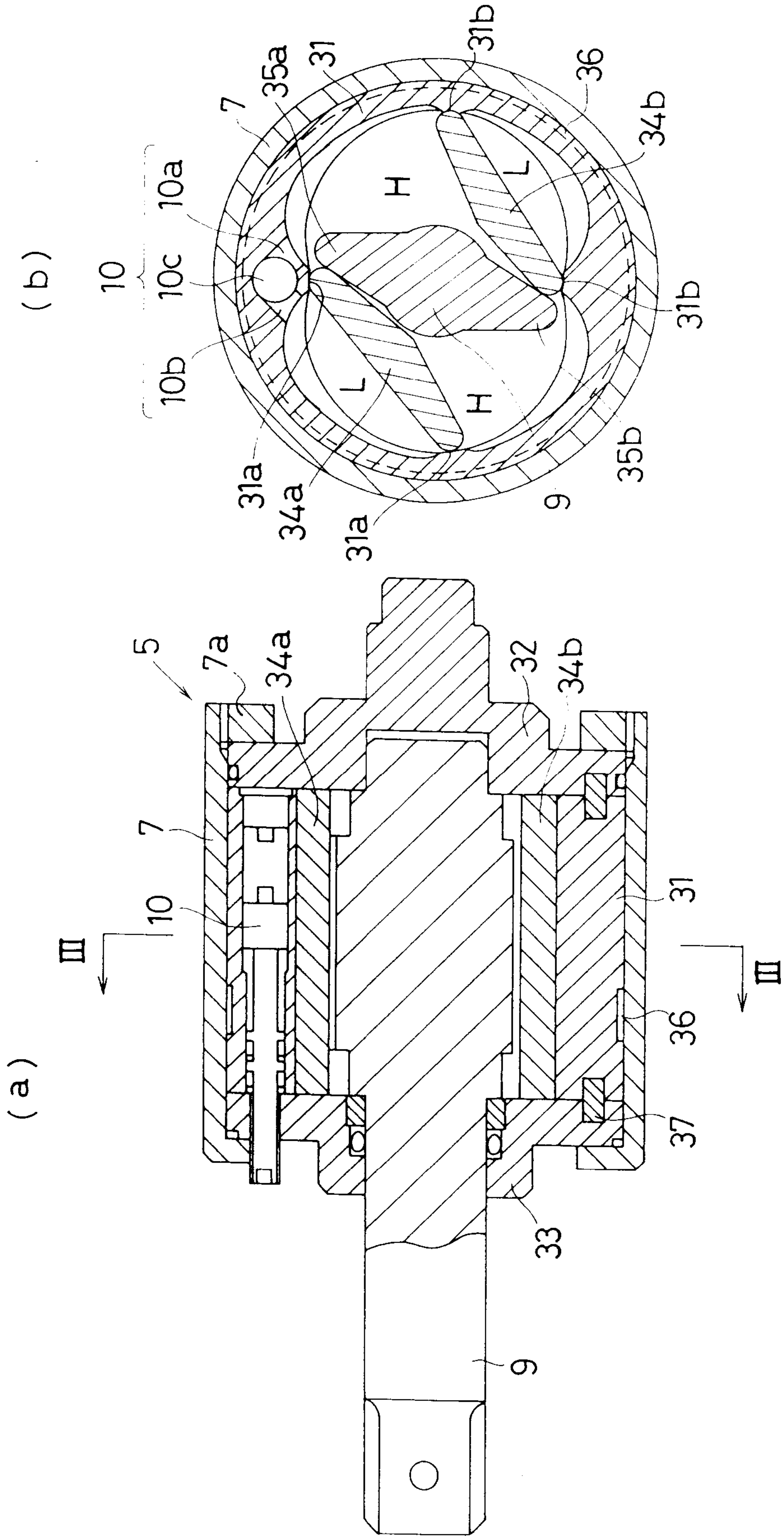
24b
25b

Fig. 13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9
III
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10a
10c
10b
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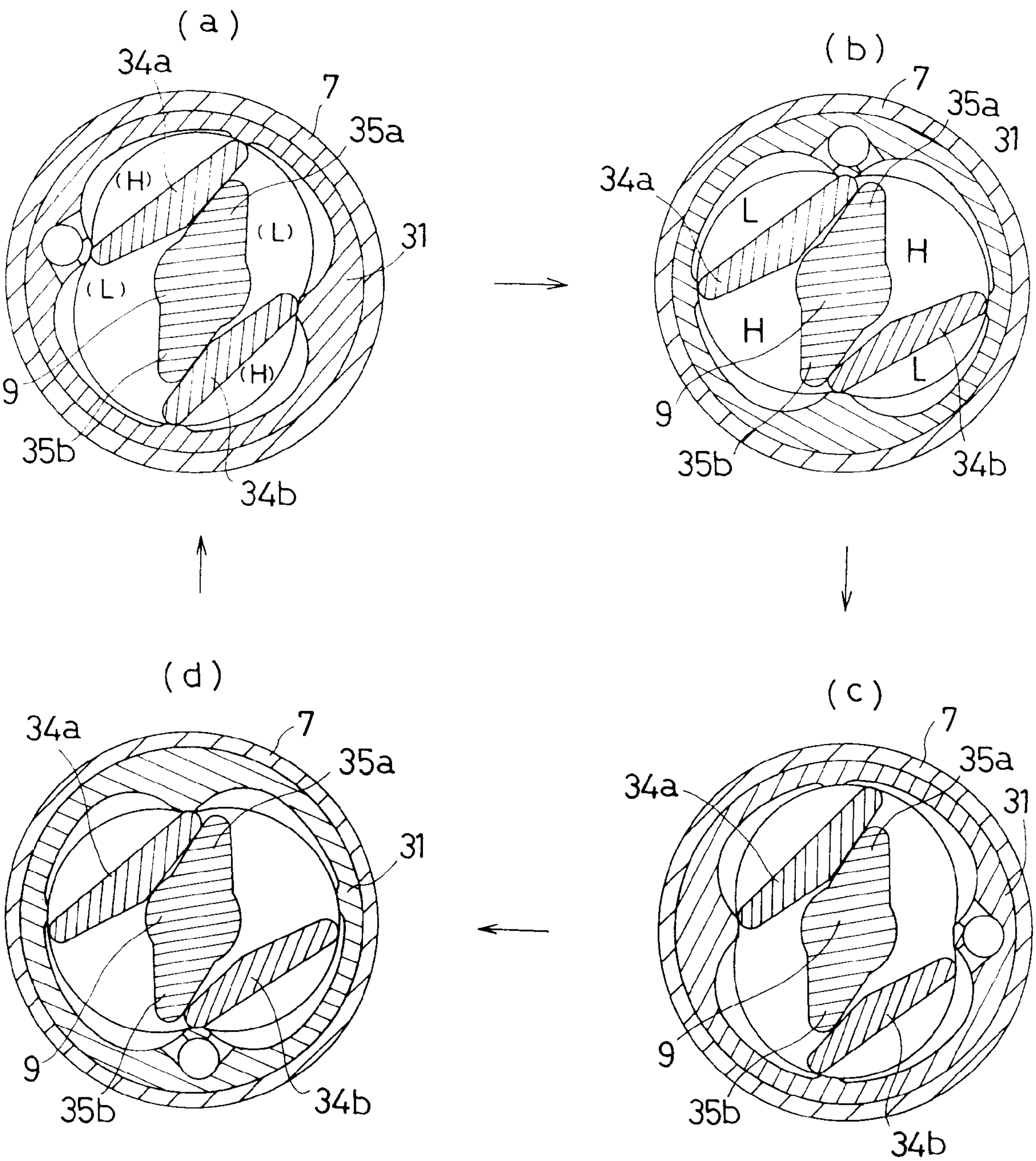
31b
36
34b
31b
35b
9
31a
34a
31a
H
L
H
L

Fig. 14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L
9
35b
34b
(d)
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9
35b
34b
(c)
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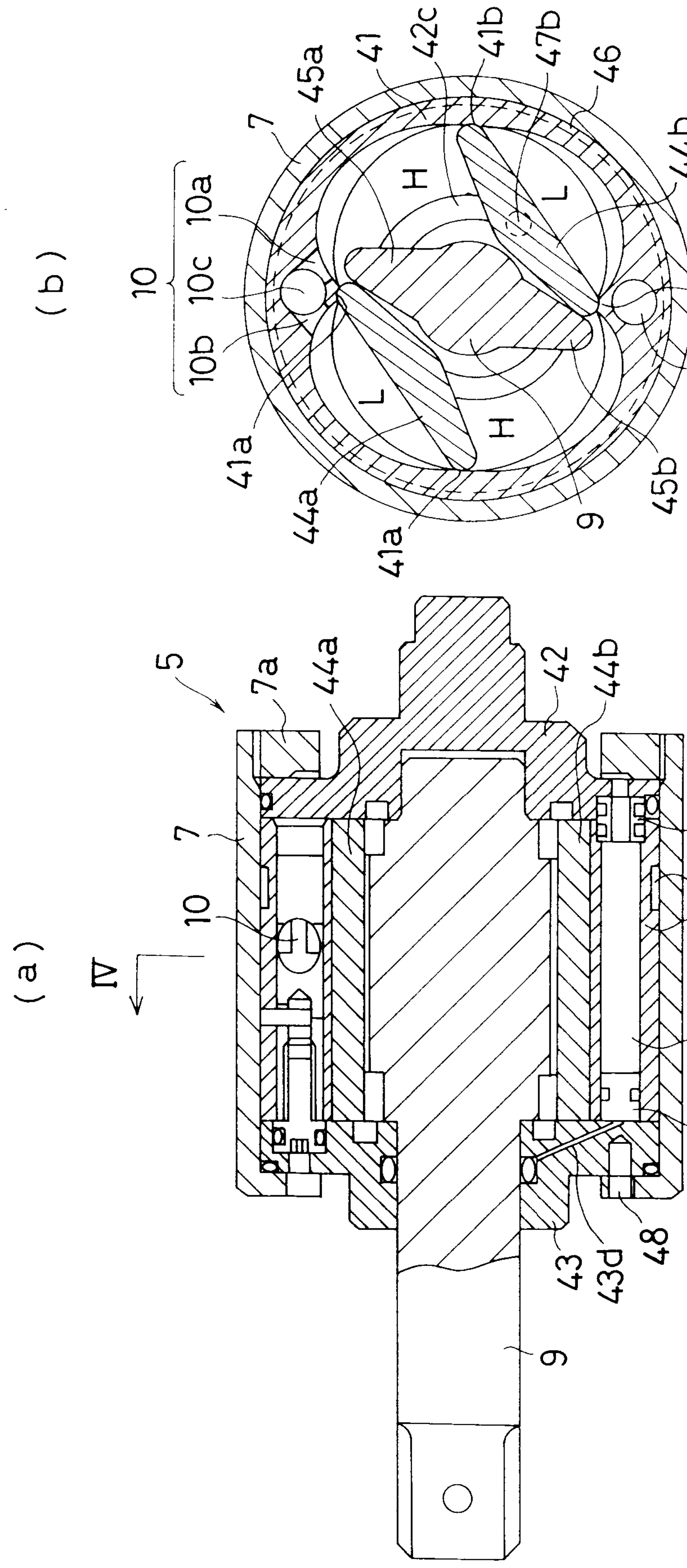
35a
34a
31
9
35b
34b

Fig. 15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44a
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49a
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43d
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IV
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10b
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45b
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41a
41b
42c
47b
H
L

Fig. 16

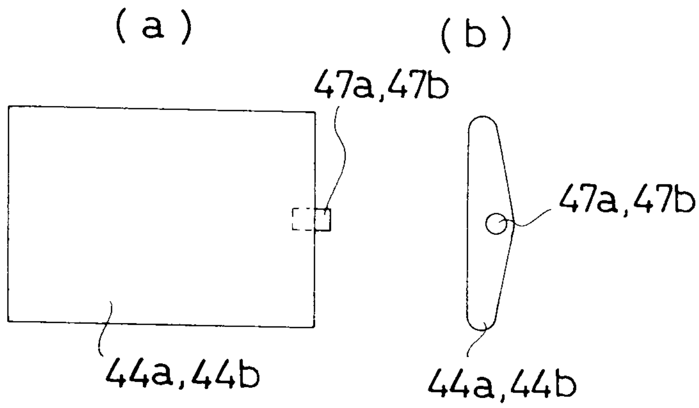


Fig. 17

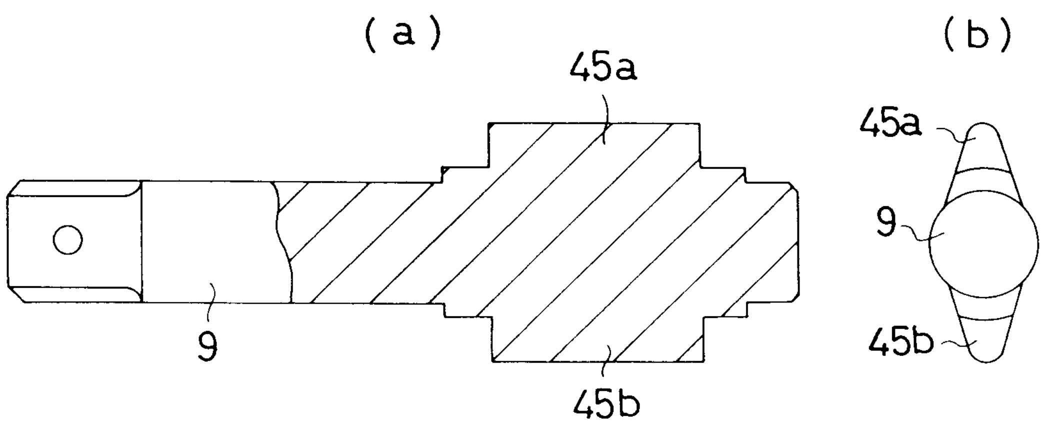
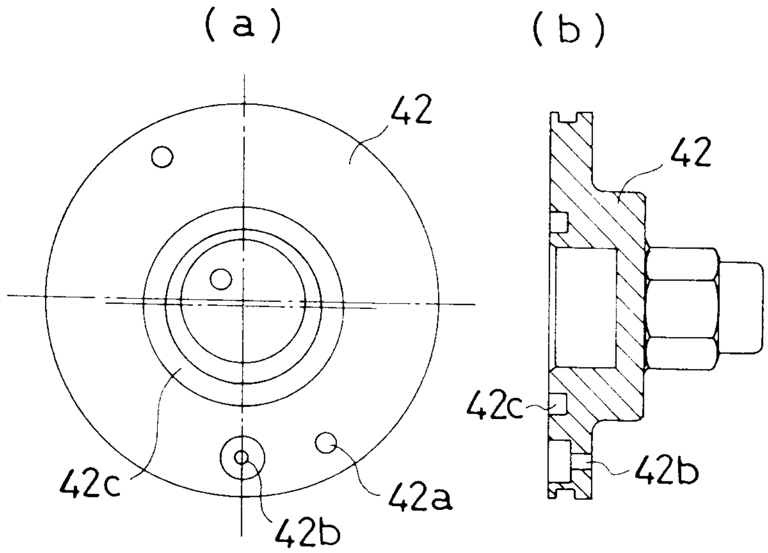


Fig. 18


(a)
(b)
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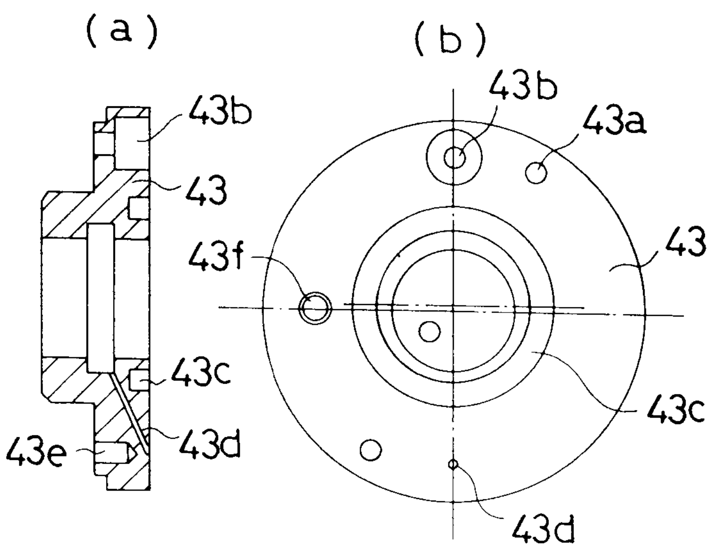
42c
42c
42b
42b
42a

Fig. 19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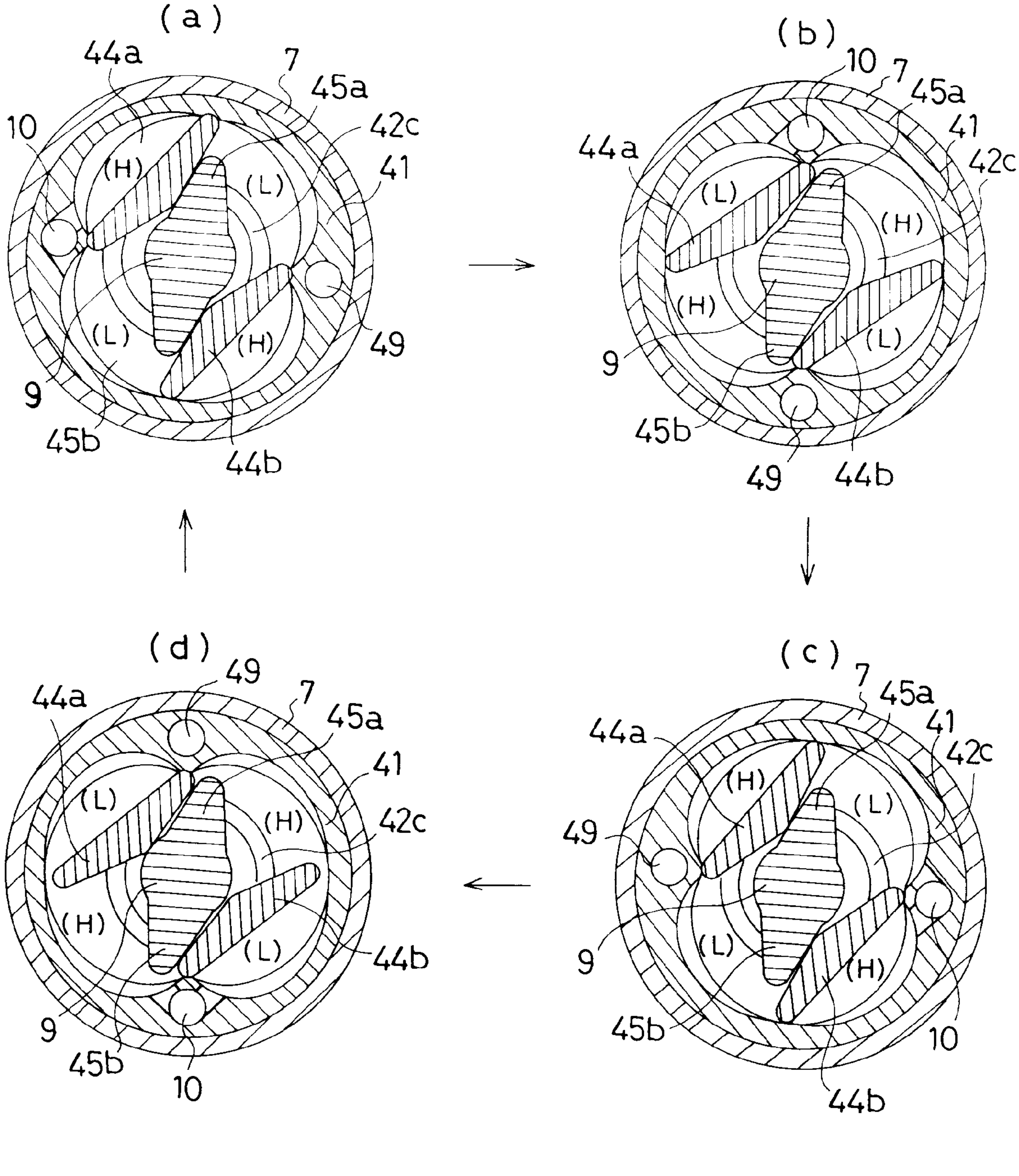
43d
43d
43e

Fig. 20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(L)
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45a
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44a
42c
(L)
(H)
(H)
9
(L)
45b
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44b
(c)
7
45a
44a
41
42c
(H)
(L)
49
9
(L)
(H)
45b
10
44b
(d)
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(H)
42c
(H)
(L)
44b
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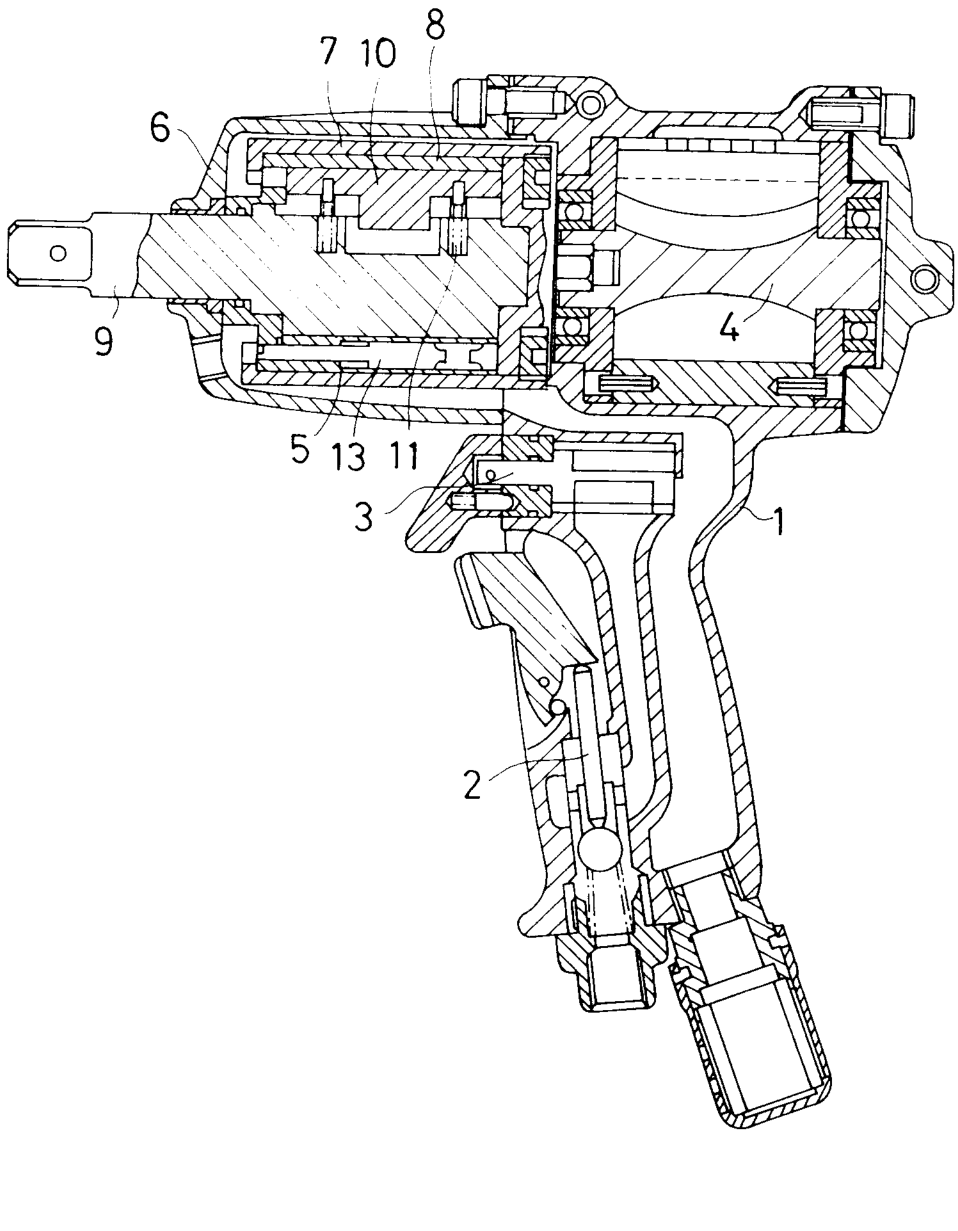
45b
10

Fig. 21



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 30 2273

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	EP-A-0 254 699 (ATLAS COPCO AB) 27 January 1988 * column 1, line 44 - column 2, line 40; figures *	1,4	B25B21/02
Y		2,3,5	
Y	EP-A-0 569 344 (ATLAS COPCO TOOLS AB) 10 November 1993 * column 2, line 19 - line 27 *	2	
Y	GB-A-2 240 500 (DESOUTTER LTD) 7 August 1991 * abstract *	3	
Y	EP-A-0 243 334 (ATLAS COPCO AB) 28 October 1987 * abstract; figures *	5	
A	GB-A-1 074 078 (INGERSOLL-RAND) 28 June 1967 * the whole document *	1	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)
B25B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	11 July 1995	Garella, M

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