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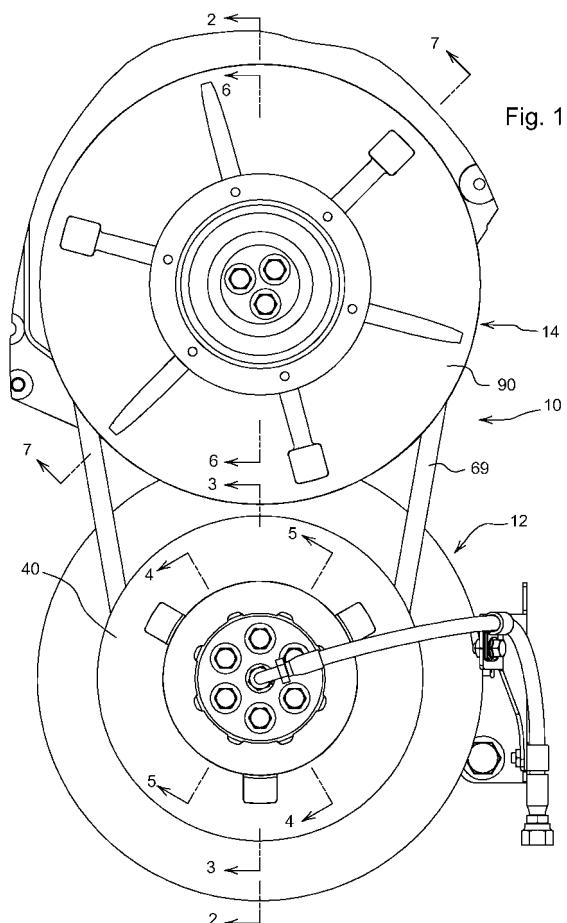
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(54) Variable speed fan drive

(57) The invention relates to a variable speed fan drive (10). There is a need for a variable speed fan drive (10) with fewer seals and bearings, which is operated by system hydraulic pressure, which has fewer parts and which is simpler to assemble. A variable speed fan drive (10) is provided for a vehicle powered by an internal combustion engine. The fan drive has a driver variable sheave unit (12), a driven variable sheave unit (14) and a belt (69) engaging both the driver and driven variable sheave units (12, 14). The driver variable sheave unit (12) includes a driver shaft (24) drivingly coupled to an engine output shaft (16), a first axially fixed half sheave (30) mounted for rotation with the driver shaft (24), and a first axially movable half sheave (40) member mounted for rotation with the driver shaft (24) and movable axially on the driver shaft (40). The first axially movable half sheave member (30) includes a belt engaging flange (44) formed integrally with an axially movable piston member mounted for rotation with the driver shaft (24) and movable axially in response to hydraulic pressure.



Description

[0001] The present invention relates to a variable speed fan drive.

[0002] Current variable speed fan drive systems used in work vehicles such as agricultural tractors typically use a viscous drive on the system cooling fan. A hydraulically operated variable speed fan drive is described in US Patent No. 7,165,514, issued in January 2007 and assigned to the assignee of this application. This variable speed fan drive has a driven sheave and fan which are mounted on an auxiliary shaft on the engine. This variable speed fan drive has a driver sheave unit with a non-rotating axially movable piston operated by pressurized engine oil controlled by a solenoid operated valve. A rotating driver shaft extends through the piston and is non-rotatably connected to an axially fixed driver sheave and an axially movable driver sheave. There are several seals and ball bearings between the rotating shaft and the non-rotating piston. These seals and ball bearings can leak or wear out. Engine oil must continuously circulate to the bearings to provide lubrication. Engine oil can become dirty and can clog the control solenoid. Engine oil is also at low pressure, typically less than 5 bar, and this requires that the piston have a large pressure-responsive area. The driven sheave unit requires a large spring to apply enough tension to the belt to minimize belt slip and wear.

[0003] Accordingly, there is a need to provide a variable speed fan drive system which requires fewer seals and bearings.

[0004] A further need is to provide such a variable speed fan drive system which is operated by high pressure hydraulic system fluid.

[0005] A further need is to provide such a variable speed fan drive system wherein the driving sheave unit is a stand-alone unit which can be pressure tested apart from an engine.

[0006] It is therefore the object of the present invention to comply with one, several or all of these needs.

[0007] This object is met according to the invention by the teaching of claim 1, 5 and 10 respectively, while features developing the solution in an advantageous manner are set forth in the further claims.

[0008] It is provided variable speed fan drive for a vehicle powered by an internal combustion engine.

[0009] The fan drive may have a driver variable sheave unit, a driven variable sheave unit and a belt engaging both the driver and driven variable sheave units. The driver variable sheave unit includes a driver shaft drivingly coupled to an engine output shaft, a first axially fixed half sheave mounted for rotation with the driver shaft, and a first axially movable half sheave member mounted for rotation with the driver shaft and movable axially on the driver shaft. The first axially movable half sheave member includes a belt engaging flange formed integrally with an axially movable piston member mounted for rotation with the driver shaft and movable axially in response to hydraulic pressure.

[0010] The driven variable sheave unit may comprise a driven shaft having an end rotatably supported by bearings in a housing, a second axially fixed half sheave fixed to the driven shaft for rotation therewith, an second axially movable half sheave mounted on the driven shaft for rotation therewith, a spring retainer mounted on the driven shaft for rotation therewith, and a plurality of return springs mounted between the retainer and the second axially movable half sheave. The return springs are spaced apart from each other and spaced apart from an exterior surface of the driven shaft. The second axially movable half sheave is located between the second axially fixed half sheave and the return springs. The driven shaft has a member formed thereon which engages the spring retainer and holds the spring retainer on the driven shaft against a bias of the return springs. The spring retainer has spaced apart tabs which project therefrom, and a magnetic sensor is mounted on the housing for generating a speed signal as the tabs move past the sensor.

[0011] In a second embodiment the variable speed fan drive for a vehicle powered by an internal combustion engine, may have a driving variable sheave assembly, a driven variable sheave assembly and a belt engaging both the driving variable sheave assembly and the driven variable sheave assembly, wherein the driving variable sheave assembly being driven by an engine output shaft, the driving variable sheave assembly having a first axially fixed half sheave and a first axially movable half sheave movable axially in response to hydraulic pressure; the driven variable sheave assembly drivingly coupled to a fan, the driven variable sheave assembly comprising a shaft having an end rotatably supported by bearings in a housing, a second axially fixed half sheave fixed to the shaft for rotation therewith, an second axially movable half sheave mounted on the shaft for rotation therewith, a spring retainer mounted on the shaft for rotation therewith, and a plurality of return springs mounted between the retainer and the second axially movable half sheave, the return springs being spaced apart from each other and spaced apart from an exterior surface of the shaft, and the second axially movable half sheave being located between the second axially fixed half sheave and the return springs, and the shaft having a member formed thereon which engages the spring retainer and holds the spring retainer on the shaft against a bias of the return springs.

[0012] In another embodiment the variable speed fan drive for a vehicle powered by an internal combustion engine, may comprise a driver shaft coupled for rotation with an output shaft of the engine; a first axially fixed half sheave coupled for rotation with the driver shaft; a first axially movable half sheave mounted on the driver shaft for rotation with the driver shaft, the driver shaft and the first axially movable half sheave forming a pressure chamber, and the first axially movable half sheave being movable axially in response to hydraulic pressure in said chamber; a driven shaft supported for rotation on a hous-

ing of the engine; a second axially fixed half sheave fixed to the driven shaft for rotation therewith; a second axially movable half sheave mounted on the driven shaft for rotation therewith; a spring retainer mounted on the shaft for rotation therewith; a plurality of return springs mounted between the retainer and the second axially movable half sheave, the return springs being spaced apart from each other and spaced apart from an exterior surface of the shaft, and the second axially movable half sheave being located between the second axially fixed half sheave and the return springs, and the shaft having a member formed thereon which engages the spring retainer and holds the spring retainer on the shaft against a bias of the return springs; and a belt engaging all the half sheaves. The driven shaft may include a first fustoconical surface formed thereon; and the spring retainer may include a hollow hub including a second fustoconical surface formed thereon, the first fustoconical surface engaging the second fustoconical surface to hold the spring retainer on the shaft and to center the spring retainer thereon.

[0013] An embodiment of the invention described below is shown in the drawings, in which

Fig. 1 is an end view of a variable speed fan drive system;

Fig. 2 is a sectional view of the variable speed fan drive system of Fig. 1;

Fig. 3 is a sectional view of the driving sheave unit along lines 3-3 of Fig. 1;

Fig. 4 is a sectional view of the driving sheave unit along lines 4-4 of Fig. 1;

Fig. 5 is a sectional view of the driving sheave unit along lines 5-5 of Fig. 1;

Fig. 6 is a sectional view of the driven sheave unit along lines 6-6 of Fig. 1;

Fig. 7 is a sectional view of the driven sheave unit along lines 7-7 of Fig. 1; and

Fig. 8 is a perspective view of the spring retainer.

[0014] Referring to Figs. 1 and 2, a variable speed fan drive system 10 includes a driver sheave unit 12 and a driven sheave unit 14. A fan spacer 15 is fixed to the outer end of driven sheave unit 14. As best seen in Figs. 2, 3 and 4, a rotatable engine crankshaft 16 projects from a vehicle engine (not shown) and carries a crankshaft seal and damper hub 18 which is surrounded by a crankshaft seal package 20. A torsional damper 22 is bolted to the hub 18. A driver shaft 24 is bolted by a plurality of crankshaft screws 26 to an end of the crankshaft 16. Driver shaft 24 includes an axially outer larger diameter part

21, and an axially inner smaller diameter part 23. Driver shaft 24 also includes a plurality of bolt bores 25 which extend therethrough and which receive the screws 26. A central stepped bore 27 extends axially into the outer end of the shaft 24.

[0015] A rotating axially fixed driver half sheave 30 is mounted for rotation with the driver shaft 24 and includes a central hub 32 held between the damper 22 and an inner end of the shaft 24. Driver half sheave 30 also includes an angled belt flange 34 which projects outwardly from the hub 32. The bolt bores 25 and screws 26 also extend through hub 32.

[0016] A rotating axially movable driver half sheave 40 is mounted for rotation with the driver shaft 24 and is axially movable with respect to the driver shaft 24. Movable driver half sheave 40 includes a hollow hub 42 and an angled belt flange 44 which projects outwardly from the hub 42. Hub 42 includes a larger diameter part 46 and a smaller diameter part 48. Hub parts 46 and 48 are 20 slidable on driver shaft parts 23 and 21, respectively. Driver half sheave 40 and driver shaft 24 enclose a pressure chamber 50 which is sealed by seals 52 carried in grooves in hub part 48 and by seals 54 carried in grooves in hub part 46. Axially extending keys 56 are received by 25 corresponding grooves 58 on an inner surface of hub part 46. As a result of the cooperation of the keys 56 and grooves 58, the half sheave 40 rotates with the driver shaft 24, but is axially slidable with respect to driver shaft 24.

[0017] A non-rotating union member 60 is received in the bore 27 of the rotating driver shaft 24 and encloses a chamber 62. An end 64 of a hydraulic line 66 is sealingly connected to the outer end of union member 60. A passage 68 extends through union member 60 and communicates pressurized hydraulic fluid from line 66 to chamber 62. Radial passages 70 in the driver shaft 24 communicates pressurized hydraulic fluid from chamber 62 to chamber 50. A belt 69 is received between and is driven by half sheave flanges 34 and 44.

[0018] As best seen in Fig. 4, the driver shaft 24 includes an axially extending blind bore 71 which is aligned with bore 72 in the hub 32 of the driver half sheave 30. A dowel pin 74 is received in bores 71 and 72 so that driver half sheave 30 is coupled for rotation shaft 24 and driver half sheave 40.

[0019] As best seen in Fig. 5, the driver half sheave 30 is coupled to the driver shaft 24 by a pair of bolts 75 which are screwed into threaded bores 76 which extend into the inner end of shaft 24. As result, the driver sheave unit 12 is a stand-alone or self-contained unit which can be pressure tested apart from an engine.

[0020] Turning now to Fig. 6 and 7, the driven sheave unit 14 includes a driven shaft 80 with a mounting stub shaft 81 received and supported for rotation by bearings 82 and 83 which are mounted in a bore 84 in a part of the engine cover 86. An outwardly facing frustoconical shoulder surface 85 is formed on shaft 80 adjacent to stub 81.

[0021] A rotating axially fixed driven half sheave 90 is mounted for rotation with the driven shaft 80 and includes a central hub 92 which is attached to the end of shaft 80 by bolts 91. Driven half sheave 90 also includes an angled belt flange 94 which projects outwardly from the hub 92. A fan spacer 15 is bolted to the end of hub 92.

[0022] A rotating axially movable driven half sheave 100 is mounted for rotation with the driven shaft 80 and is axially movable with respect to the driven shaft 80. Driven half sheave 100 includes a hollow hub 102 and an angled belt flange 104 which projects outwardly from the hub 102. Axially extending keys 106 are formed on the shaft 80 and are received by corresponding grooves 108 on an inner surface of hub 102. As a result of the cooperation of the keys 106 and grooves 108, the half sheave 100 rotates with the driven shaft 80, but is axially slidably with respect to driven shaft 80. Belt 69 is engaged by flanges 94 and 104.

[0023] A hollow annular spring retainer 110 is mounted on the shaft 80, and has annular hub 111 with an inner frustoconical surface 112 which engages the shoulder surface 85 and which operates to center the spring retainer 110 on the shaft 80. Retainer 110 includes a plurality (such as six) of spring holding cups 114 spaced apart and positioned radially outwardly from the hub 111. Each cup 114 holds an end of a return spring 120. The other end of each return spring 120 engages movable driven half sheave 100, and is biased to urge driven half sheave 100 towards fixed half sheave 94. A plurality of legs or tabs 116 extend axially away from an outer peripheral edge of each cup 114.

[0024] As best seen in Figs. 7 and 8, three or half of the cups 114 have central hollow projections 122 through which extend stepped bores 124. Screw threads are formed on the smaller diameter portion of each bore 124. Each bore 124 threadably receives a spring retainer screw 126. Each spring retainer screw 126 extends through a bore 128 in the half sheave 100, through a corresponding one of the springs 120 and into a corresponding one of bores 124. Screws 126 have heads 127 which are engagable with the half sheave 100, and thus hold the half sheave 100, spring retainer 110 and springs 120 together as a sub-assembly.

[0025] As best seen in Fig. 7, a speed sensor 130 is mounted in a bore in an arm 132 which projects from the engine cover 86, and is held in a position close to an outer edge of a circular path through which the legs 116 rotate. The sensor 130 generates signals as the legs 116 move past, and is preferably a commercially available variable reluctance type sensor.

[0026] While the present invention has been described in conjunction with a specific embodiment, it is understood that many alternatives, modifications and variations will be apparent to those skilled in the art in light of the foregoing description. Accordingly, this invention is intended to embrace all such alternatives, modifications and variations which fall within the spirit and scope of the appended claims.

Claims

1. A variable speed fan drive (10) for a vehicle powered by an internal combustion engine, the fan drive (10) having a driver variable sheave unit (12), a driven variable sheave unit (14) and a belt (69) engaging both the driver and driven variable sheave units (12, 14), **characterized by** the driver variable sheave unit (12) comprising: a driver shaft (24) drivingly coupled to an engine output shaft (16); a first axially fixed half sheave (30) mounted for rotation with the driver shaft (24); and a first axially movable half sheave member (40) mounted for rotation with the driver shaft (24) and movable axially on the driver shaft (24), the first axially movable half sheave member (40) comprising a belt (69) engaging flange (44) formed integrally with an axially movable piston member mounted for rotation with the driver shaft (24) and movable axially in response to hydraulic pressure.
2. The variable speed fan drive according to claim 1, **characterized in that** the driven variable sheave unit (14) comprises: a shaft (80) having an end rotatably supported by bearings (82, 83) in a housing (86), a second axially fixed half sheave (90) fixed to the shaft (80) for rotation therewith, an second axially movable half sheave (100) mounted on the shaft (80) for rotation therewith, a spring retainer (110) mounted on the shaft (80) for rotation therewith, and a plurality of return springs (120) mounted between the retainer (110) and the second axially movable half sheave (100), the return springs (120) being spaced apart from each other and spaced apart from an exterior surface of the shaft (80), and the second axially movable half sheave (100) being located between the second axially fixed half sheave (90) and the return springs (120), and the shaft (80) having a member formed thereon which engages the spring retainer (110) and holds the spring retainer (110) on the shaft (80) against a bias of the return springs (120).
3. The variable speed fan drive according to claim 1 or 2, **characterized in that** the piston member and the driver shaft (24) cooperate to form a pressure chamber (50) therebetween, and the piston member being movable axially in response to fluid pressure in said chamber (50).
4. The variable speed fan drive according to one or several of the previous claims, **characterized in that** the driver shaft (24) includes a larger diameter part (23) connected to a smaller diameter part (21) by an axially facing annular shoulder; and the piston member includes a hollow hub (32) having a larger diameter bore (46) receiving the larger diameter part (23) of the driver shaft, a smaller diameter bore (48) receiving the smaller diameter part (21) of the driver

shaft (24), and an axially facing annular wall connecting the larger diameter bore (46) with the smaller diameter bore (48), the smaller diameter part (21), the wall, the shoulder and a wall of the larger diameter bore (46) enclosing a pressure chamber (50), and the piston member being movable axially in response to fluid pressure in said chamber (50).

5. A variable speed fan drive (10) for a vehicle powered by an internal combustion engine, the fan drive (10) having a driving variable sheave assembly or unit (12), a driven variable sheave assembly or unit (14) and a belt (69) engaging both the driving variable sheave assembly (12) and the driven variable sheave assembly (14), **characterized by**: the driving variable sheave (12) assembly being driven by an engine output shaft (16), the driving variable sheave assembly (12) having a first axially fixed half sheave (30) and a first axially movable half sheave (40) movable axially in response to hydraulic pressure; the driven variable sheave assembly (14) drivingly coupled to a fan, the driven variable sheave assembly (14) comprising: a shaft (80) having an end rotatably supported by bearings (82, 83) in a housing (86), a second axially fixed half sheave (90) fixed to the shaft (80) for rotation therewith, an second axially movable half sheave (100) mounted on the shaft (80) for rotation therewith, a spring retainer (110) mounted on the shaft (80) for rotation therewith, and a plurality of return springs (120) mounted between the retainer (110) and the second axially movable half sheave (100), the return springs (120) being spaced apart from each other and spaced apart from an exterior surface of the shaft (80), and the second axially movable half sheave (100) being located between the second axially fixed half sheave (90) and the return springs (120), and the shaft (80) having a member formed thereon which engages the spring retainer (110) and holds the spring retainer (110) on the shaft (80) against a bias of the return springs (120).

10. The variable speed fan drive according to claim 5, **characterized by** a plurality of spaced apart projecting tabs (116) which are mounted for rotation with the second axially movable half sheave (100); and a magnetic sensor (130) mounted on the housing (86) for generating a speed signal as the tabs (116) move past the sensor (130), the tabs (116) preferably project from the spring retainer (110).

15. The variable speed fan drive according to 5 or 6, **characterized in that** the shaft (80) includes an outwardly facing fustoconical surface (85) formed thereon; and the spring retainer (110) includes a hollow hub (111) including an inwardly facing fustoconical surface (112) formed thereon, the inwardly facing fustoconical surface (112) engaging the outwardly

facing fustoconical surface (85) to hold the spring retainer (110) on the shaft (80) and to center the spring retainer (110) thereon.

20. The variable speed fan drive according to one or several of the claims 5 to 7, **characterized in that** the driver variable sheave unit (12) comprises a non-rotating hydraulic member (60) for communicating with a source of hydraulic pressure, the hydraulic member (60) having a first passage (68) extending therethrough; and a driver shaft (24) coupled for rotation with the engine output shaft (16), the first axially movable half sheave (40) being mounted on the driver shaft (24), the driver shaft (24) and the first axially movable half sheave (40) forming pressure chamber (50) therebetween, the first axially movable half sheave (40) being movable in response to fluid pressure in said pressure chamber (50), the driver shaft (24) having a blind bore (27) in an end thereof, the hydraulic member (60) being rotatably received in the blind bore (27), and the driver shaft (24) having a second passage (71) therein, the second passage (70) communicating the first passage (68) to the pressure chamber (50).

25. The variable speed fan drive according to one or several of the claims 5 to 8, **characterized by** a plurality of coupling members which couple the spring retainer (110) to the second axially movable half sheave (100), each coupling member preferably extending through a corresponding one of the return springs (120) and/or each coupling member comprising a bolt or screw (126) which is screwed into a threaded bore (124) in the spring retainer (110).

30. A variable speed fan drive (10) for a vehicle powered by an internal combustion engine, the fan drive assembly (10) comprising: a driver shaft (24) coupled for rotation with an output shaft (16) of the engine; a first axially fixed half sheave (30) coupled for rotation with the driver shaft (24); a first axially movable half sheave (40) mounted on the driver shaft (24) for rotation with the driver shaft (24), the driver shaft (24) and the first axially movable half sheave (40) forming a pressure chamber (50), and the first axially movable half sheave (40) being movable axially in response to hydraulic pressure in said chamber (50); a driven shaft (80) supported for rotation on a housing (86) of the engine; a second axially fixed half sheave (90) fixed to the driven shaft (80) for rotation therewith; a second axially movable half sheave (100) mounted on the driven shaft (80) for rotation therewith; a spring retainer (110) mounted on the shaft (80) for rotation therewith; a plurality of return springs (120) mounted between the retainer (110) and the second axially movable half sheave (100), the return springs (120) being spaced apart from each other and spaced apart from an exterior surface

35. The variable speed fan drive according to one or several of the claims 5 to 8, **characterized by** a plurality of coupling members which couple the spring retainer (110) to the second axially movable half sheave (100), each coupling member preferably extending through a corresponding one of the return springs (120) and/or each coupling member comprising a bolt or screw (126) which is screwed into a threaded bore (124) in the spring retainer (110).

40. A variable speed fan drive (10) for a vehicle powered by an internal combustion engine, the fan drive assembly (10) comprising: a driver shaft (24) coupled for rotation with an output shaft (16) of the engine; a first axially fixed half sheave (30) coupled for rotation with the driver shaft (24); a first axially movable half sheave (40) mounted on the driver shaft (24) for rotation with the driver shaft (24), the driver shaft (24) and the first axially movable half sheave (40) forming a pressure chamber (50), and the first axially movable half sheave (40) being movable axially in response to hydraulic pressure in said chamber (50); a driven shaft (80) supported for rotation on a housing (86) of the engine; a second axially fixed half sheave (90) fixed to the driven shaft (80) for rotation therewith; a second axially movable half sheave (100) mounted on the driven shaft (80) for rotation therewith; a spring retainer (110) mounted on the shaft (80) for rotation therewith; a plurality of return springs (120) mounted between the retainer (110) and the second axially movable half sheave (100), the return springs (120) being spaced apart from each other and spaced apart from an exterior surface

45. The variable speed fan drive according to one or several of the claims 5 to 8, **characterized by** a plurality of coupling members which couple the spring retainer (110) to the second axially movable half sheave (100), each coupling member preferably extending through a corresponding one of the return springs (120) and/or each coupling member comprising a bolt or screw (126) which is screwed into a threaded bore (124) in the spring retainer (110).

50. The variable speed fan drive according to one or several of the claims 5 to 8, **characterized by** a plurality of coupling members which couple the spring retainer (110) to the second axially movable half sheave (100), each coupling member preferably extending through a corresponding one of the return springs (120) and/or each coupling member comprising a bolt or screw (126) which is screwed into a threaded bore (124) in the spring retainer (110).

55. The variable speed fan drive according to one or several of the claims 5 to 8, **characterized by** a plurality of coupling members which couple the spring retainer (110) to the second axially movable half sheave (100), each coupling member preferably extending through a corresponding one of the return springs (120) and/or each coupling member comprising a bolt or screw (126) which is screwed into a threaded bore (124) in the spring retainer (110).

of the shaft (80), and the second axially movable half sheave (100) being located between the second axially fixed half sheave (100) and the return springs (120), and the shaft (80) having a member (85) formed thereon which engages the spring retainer (110) and holds the spring retainer (110) on the shaft (80) against a bias of the return springs (120); and a belt (69) engaging all the half sheaves (30, 40, 90, 100), preferably the driven shaft (80) including a first fustoconical surface (85) formed thereon; and the spring retainer (110) including a hollow hub (11) including a second fustoconical surface (112) formed thereon, the first fustoconical surface (85) engaging the second fustoconical surface (112) to hold the spring retainer (110) on the shaft (80) and to center the spring retainer (80) thereon.

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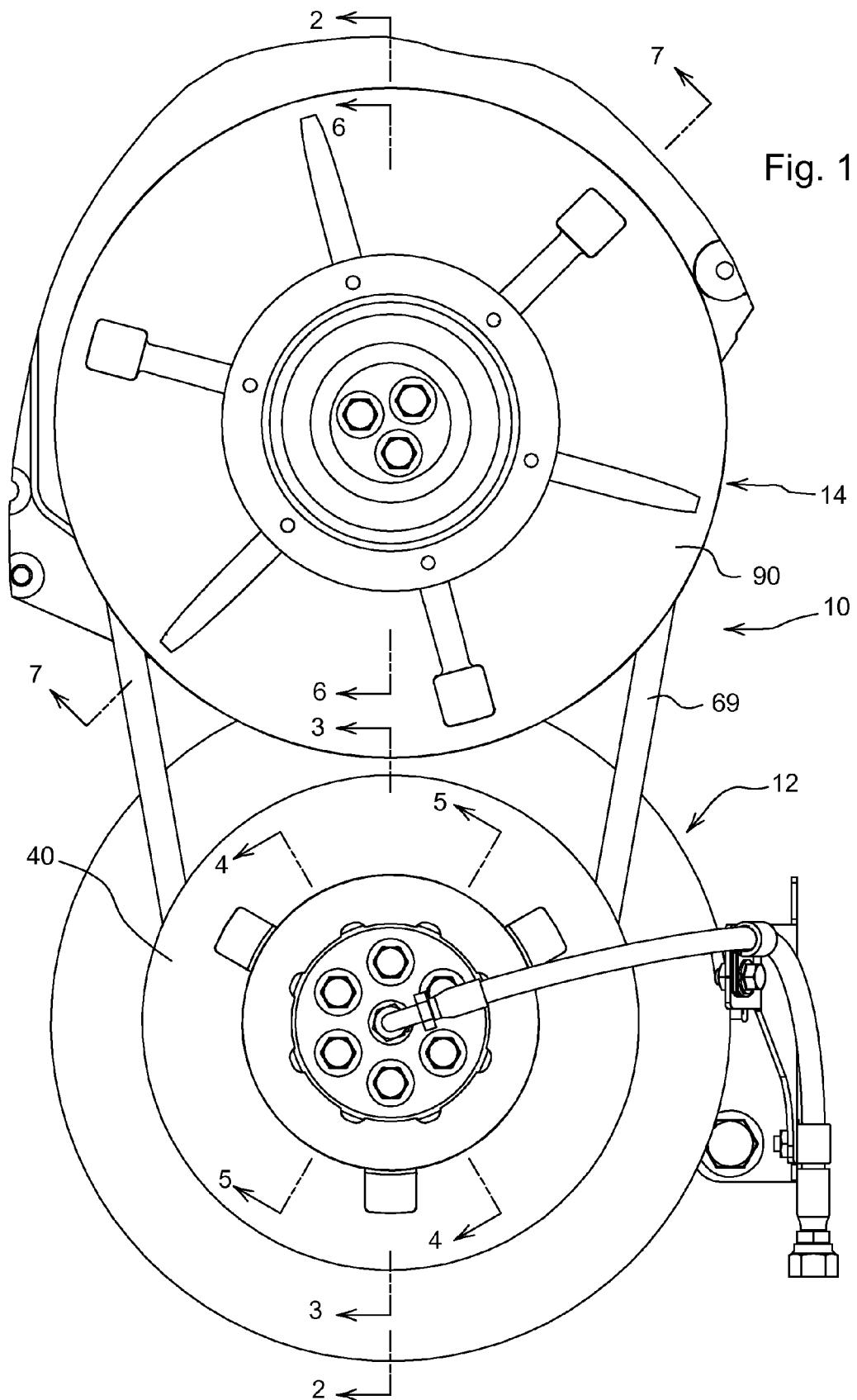
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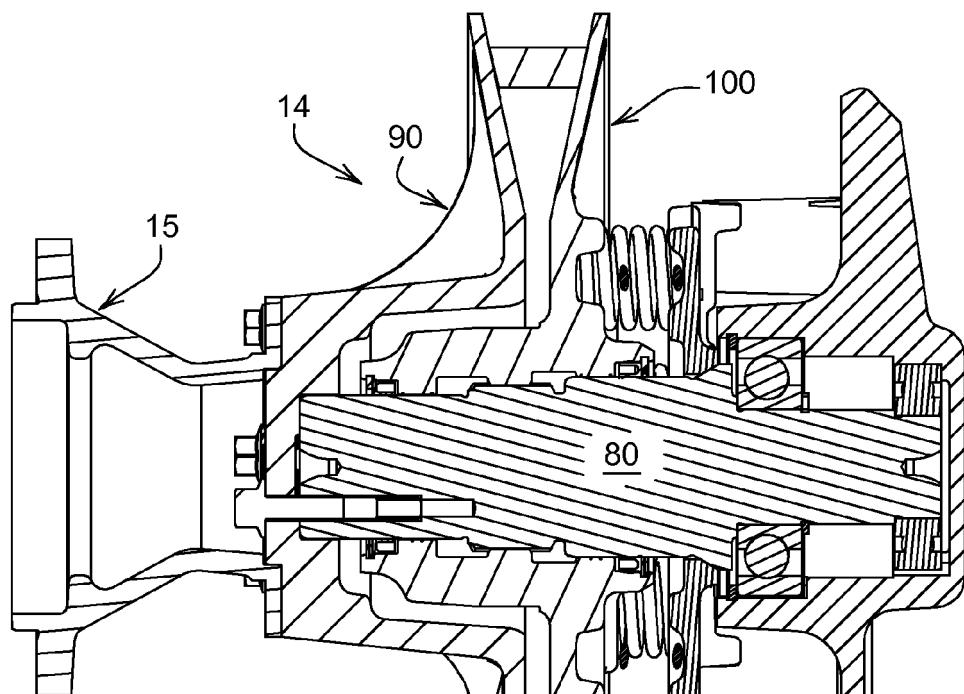
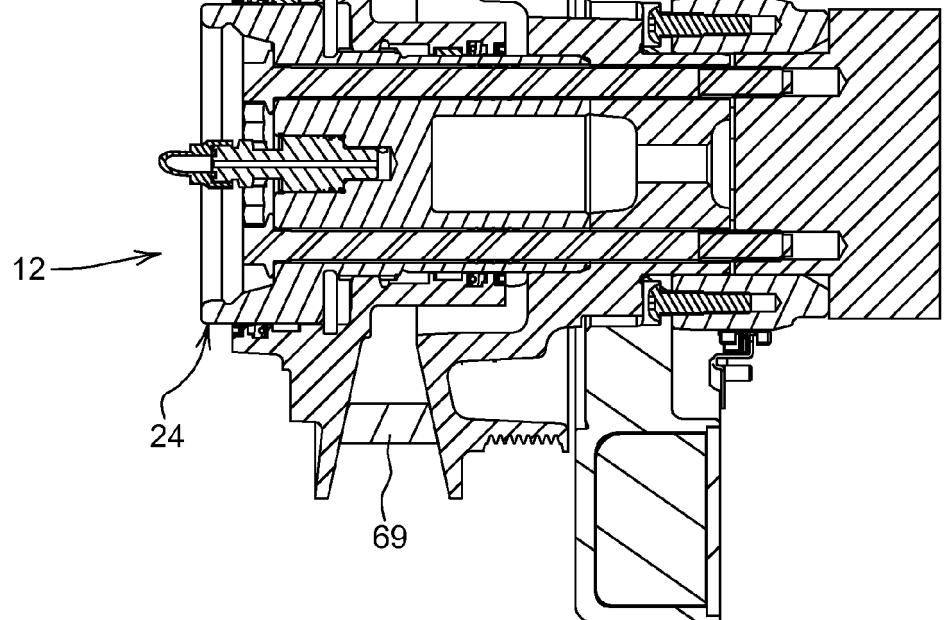


Fig. 2



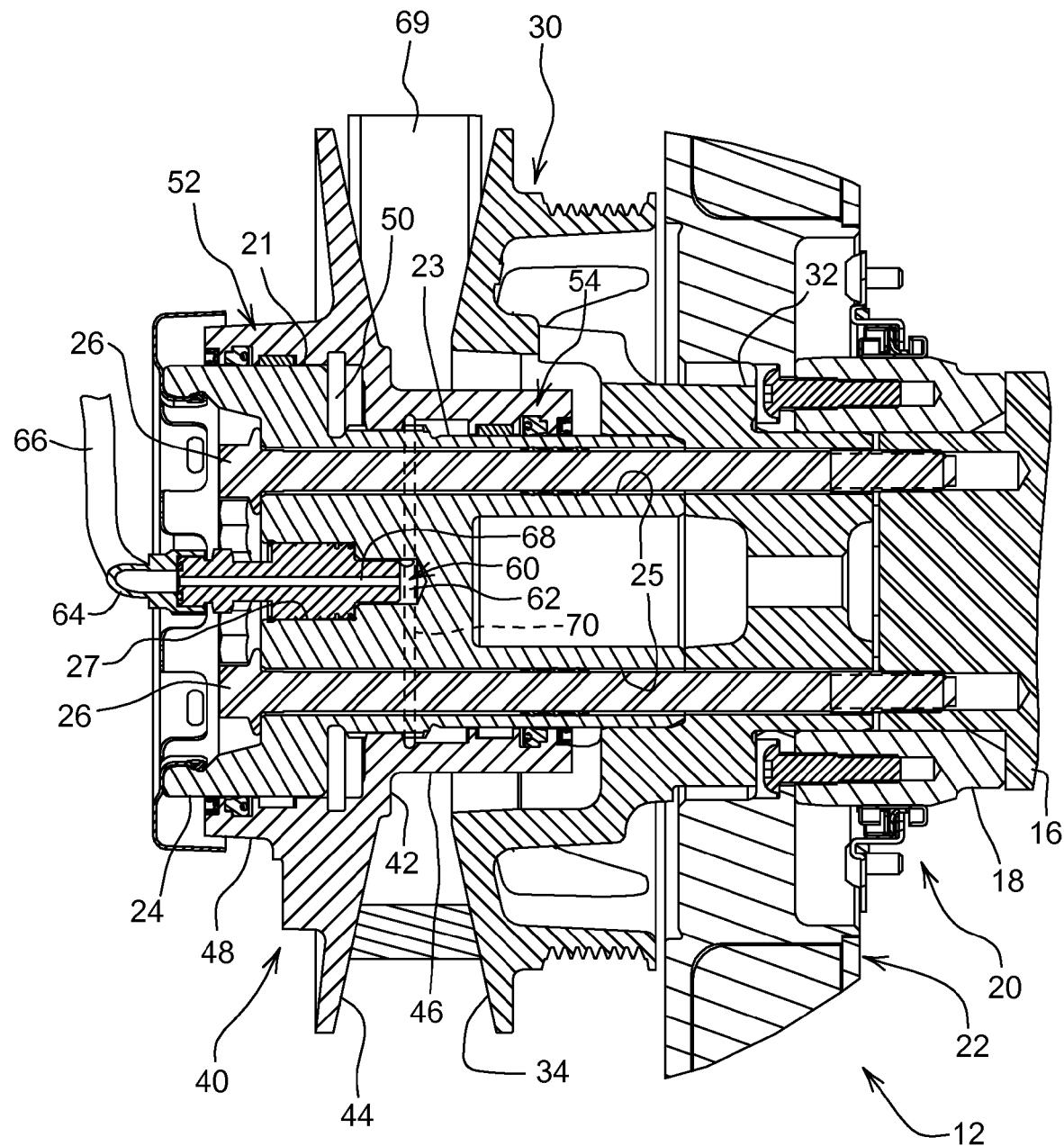


Fig. 3

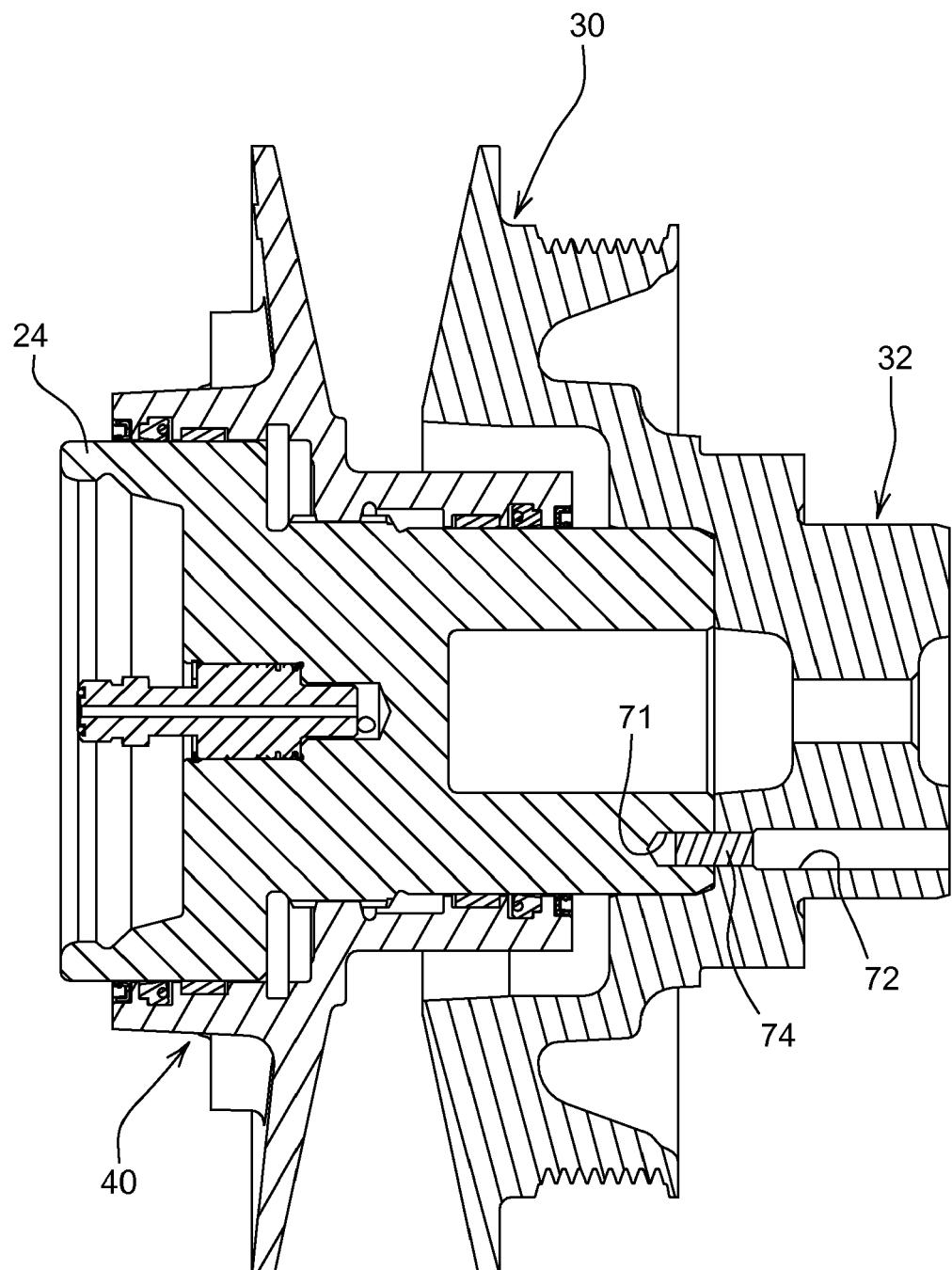


Fig. 4

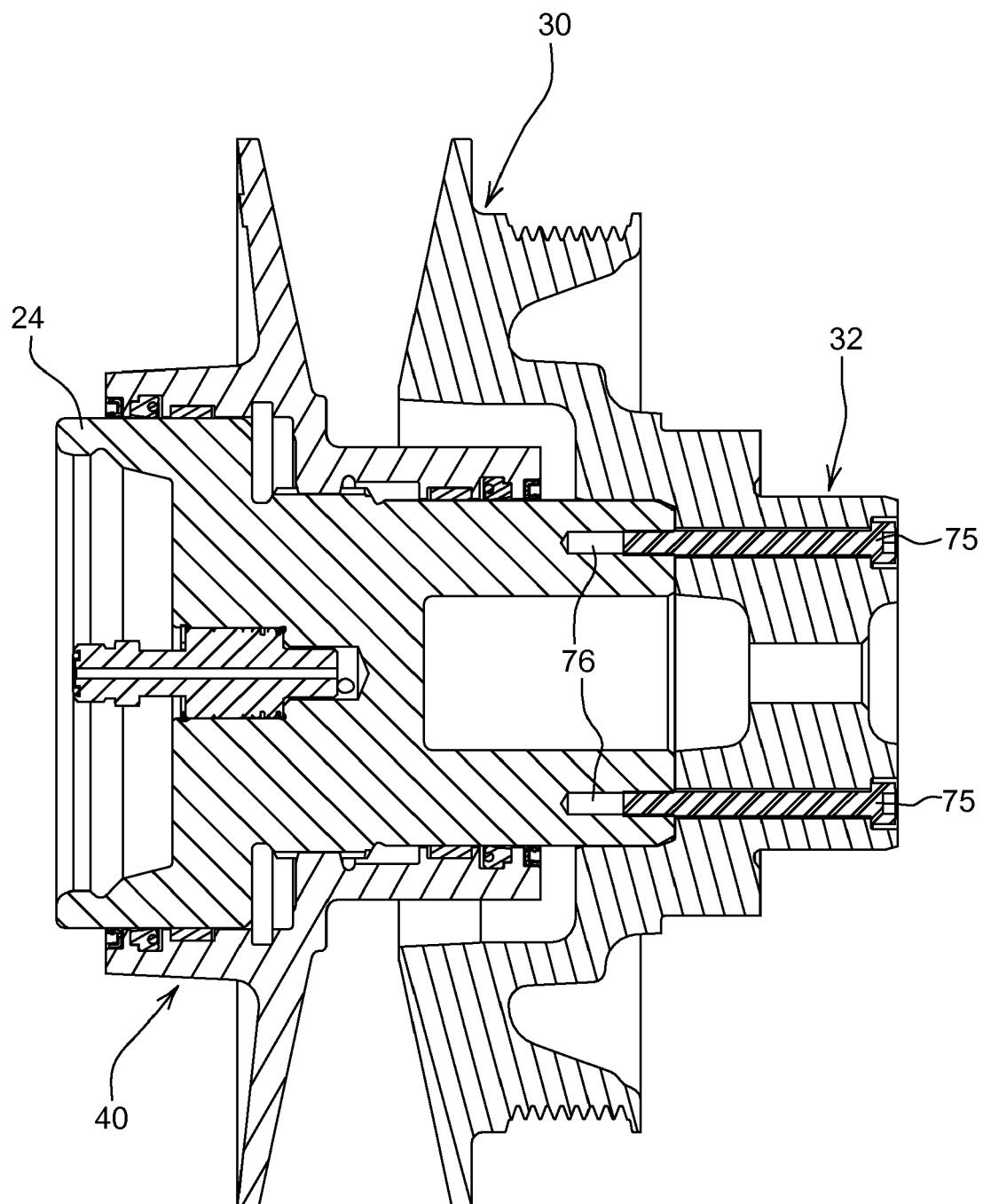


Fig. 5

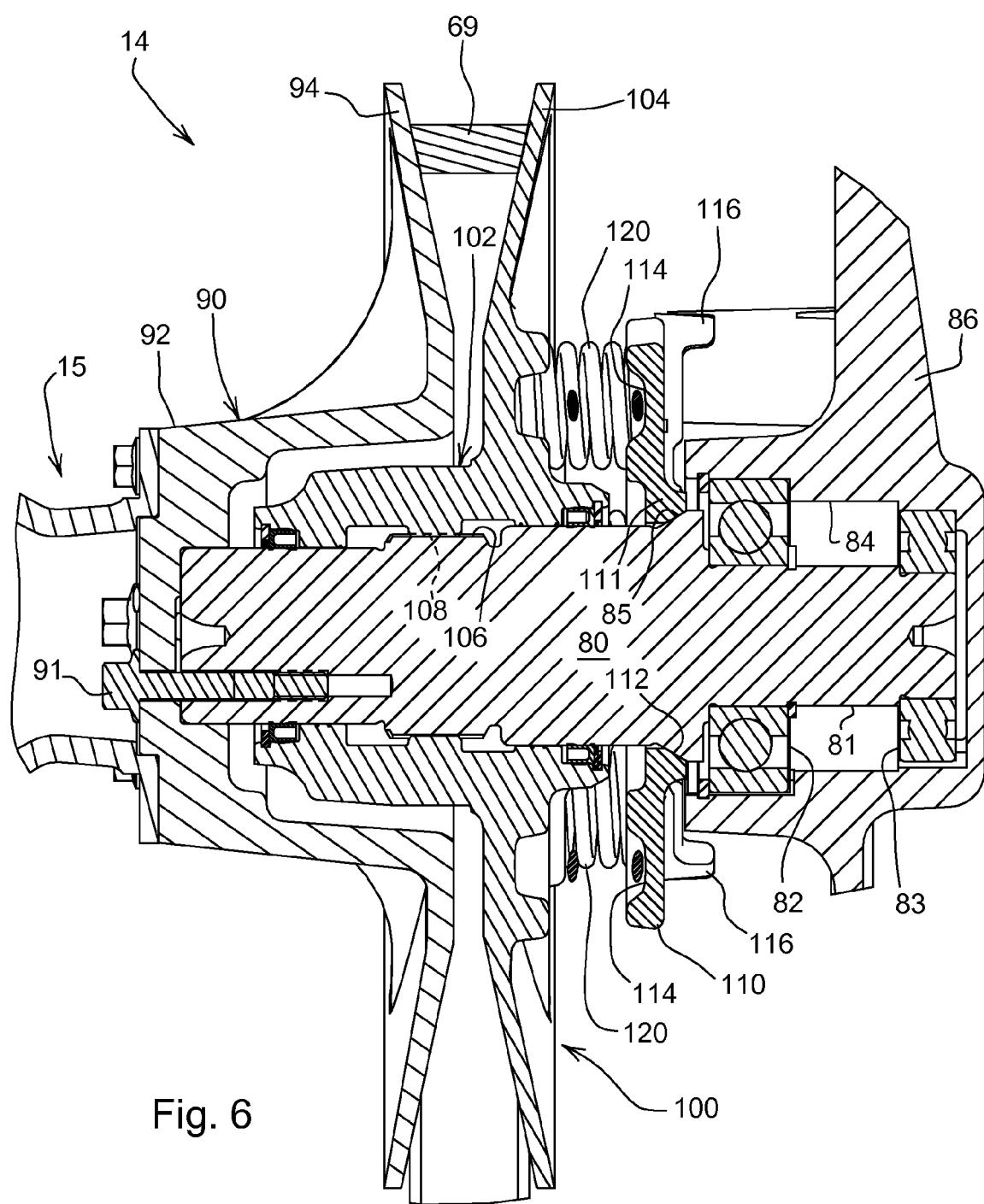


Fig. 6

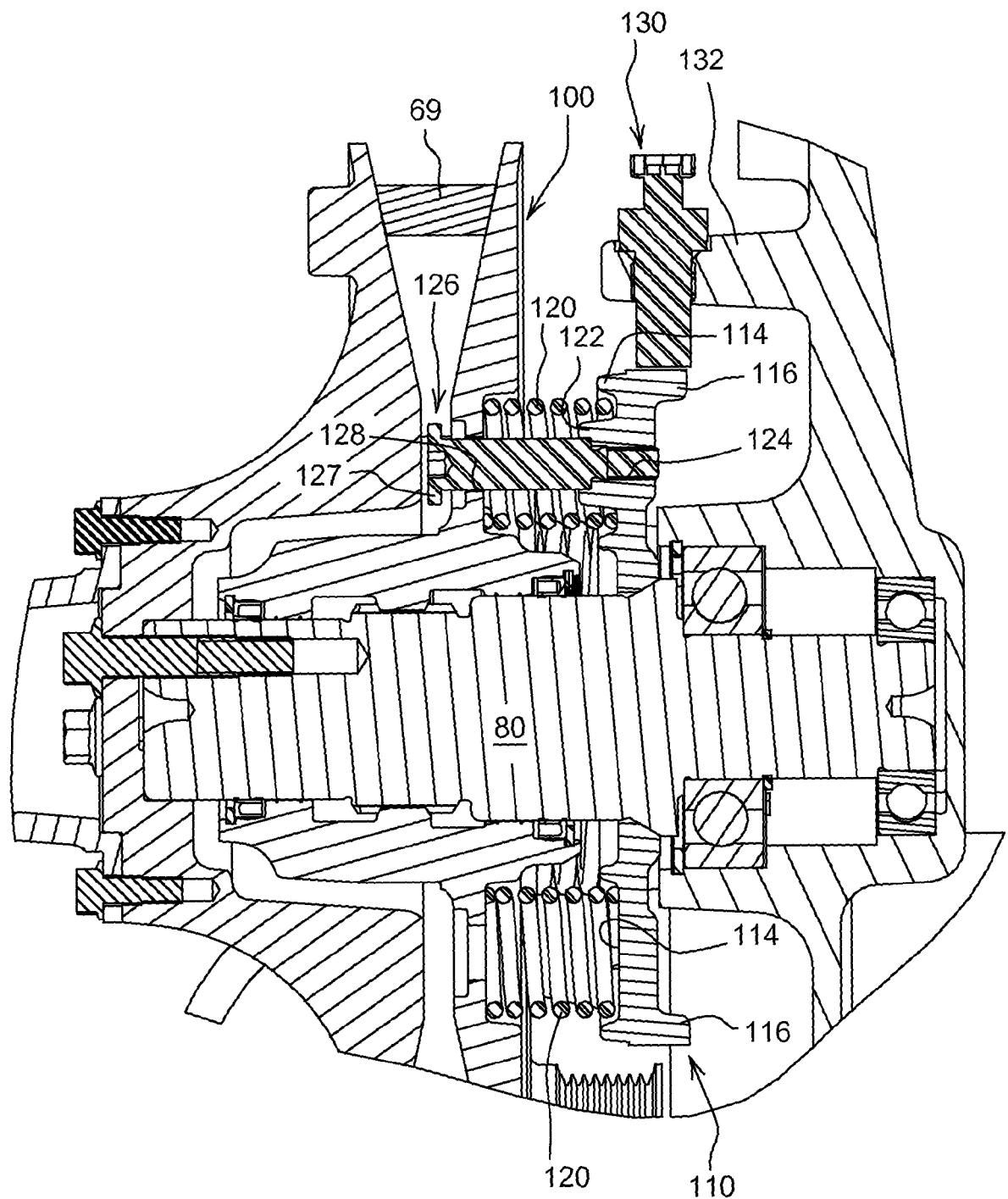
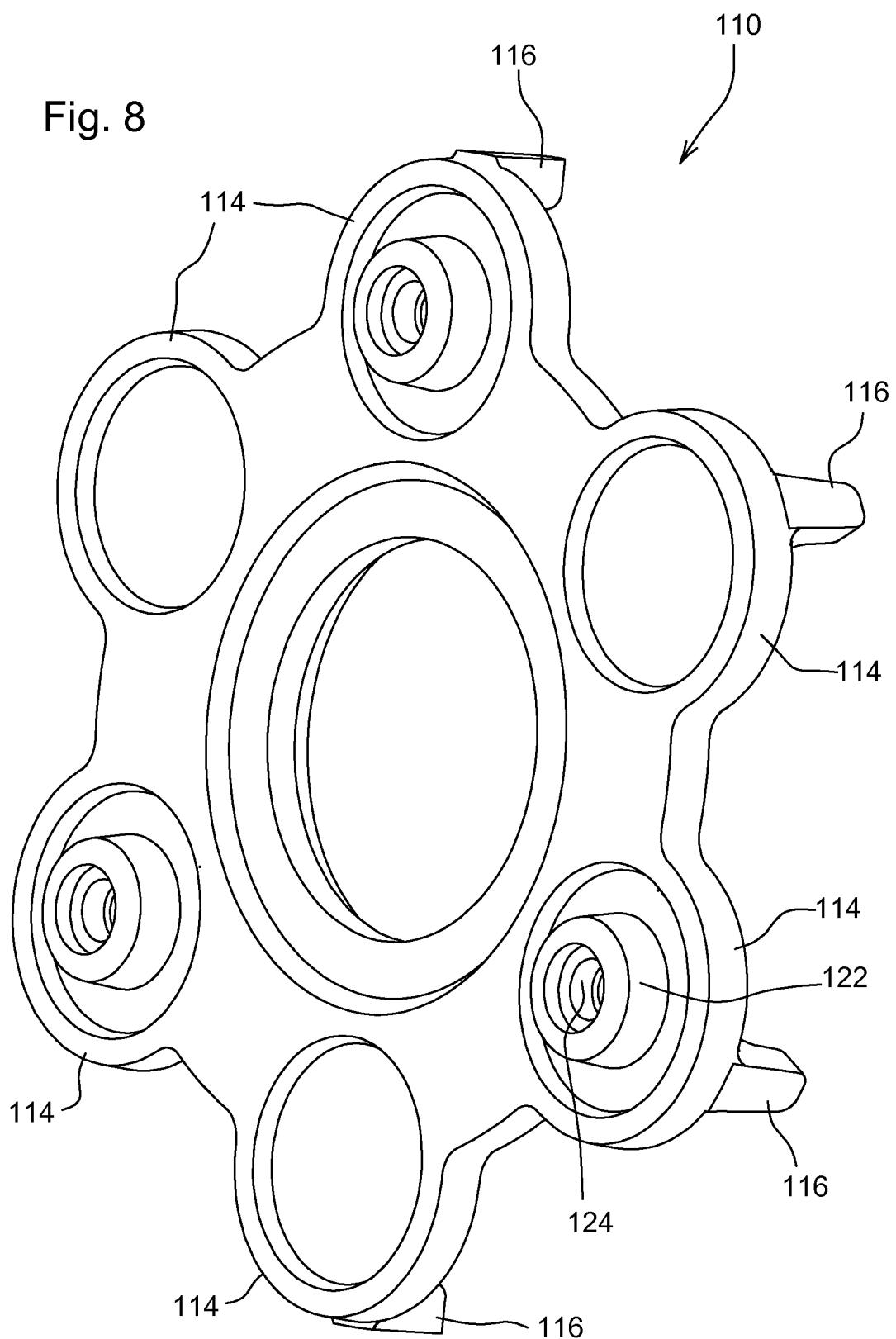


Fig. 7

Fig. 8



REFERENCES CITED IN THE DESCRIPTION

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