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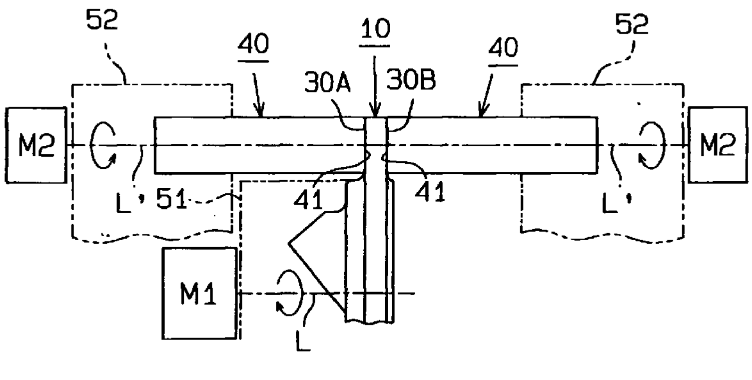
(54) Coating process for a swash plate of a compressor

(57) A method for forming a metallic coating with a component of a compressor is proposed. A supplier body (40) supplies the coating (31A; 31B) to the component (10; 20A; 20B) such as a swash plate (10). The supplier (40) is made of a material softer than that of the swash plate (10). The supplier is urged against a portion of predetermined areas (30A; 30B) of the swash plate (10). The supplier (40) is brought to a relative movement with respect to the swash plate (10) along an extending direction of the predetermined area (30A; 30B), thereby the material is gradually separated from supplier (40) and supplied to the predetermined area (30A; 30B).

Fig.6



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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to procedures for coating compressor components with metal, and, more particularly, to procedures for coating swash plate surfaces of swash-plate type compressors to enable shoes to slide smoothly along the coated surfaces.

[0002] The moving parts of a typical swash-plate type compressor are lubricated to prolong the compressor's life. Specifically, lubricant oil is retained in the compressor and is converted to mist by gas circulating in the compressor (refrigerant gas such as chlorofluorocarbon) when the compressor is operated. The oil mist is then supplied to the locations where relative motion and contact occur between parts. However, if the compressor is de-activated for a relatively long time, the lubricant oil that has been applied to these locations is removed by refrigerant gas when the compressor is re-started. Thus, when the compressor is re-started, the lubrication is inadequate.

[0003] Under these circumstances, it takes a certain time (approximately one minute) to obtain a sufficient amount of oil mist after the compressor is activated. During this period, the supply of oil to the moving parts remains insufficient. Accordingly, to ensure minimum lubrication even when the lubricant supply is insufficient, various procedures for coating the moving parts have been proposed.

[0004] Specifically, there are various procedures for coating the surfaces of the swash plate (that is, the surfaces along which shoes slide). Among those disclosed in patent literature and in practice, electrolytic or non-electrolytic plating with tin or the like and thermal spraying with copper or aluminum type alloys are known.

[0005] The electrolytic or non-electrolytic plating is capable of forming a relatively thin coating, or a coating having a thickness of several micrometers. However, this procedure is not suitable for forming a relatively thick coating having a thickness of, for example, several tens of micrometers or more. Further, plating may be performed only if the coating metal has a sufficient electrochemical affinity with the metal of the surface to be coated.

[0006] In contrast, thermally spraying molten metal powder on a surface to be coated is capable of forming a relatively thick coating. Further, the procedure may be employed regardless of the electrochemical affinity between the metal coating and the surface to be coated. However, the thermal spraying procedure causes problems as follows.

[0007] That is, before performing thermal spraying, it is often necessary to roughen a surface to be coated through, for example, shot blasting. This increases the number of steps. Further, hard particles must be used for the roughening step (as secondary material), thus increasing costs. In other words, the thermal spraying procedure prolongs production and increases costs. In addition, high level noise is produced during the roughening step, which makes working conditions difficult.

[0008] In addition, the portions that need not be coated must be masked before spraying is performed. This further prolongs the procedure and increases costs.

SUMMARY OF THE INVENTION

[0009] Accordingly, it is an objective of the present invention to provide a procedure for forming a metal coating that is generally performed under various conditions.

[0010] It is another objective of the present invention to provide a procedure for forming a metal coating that is relatively quiet.

[0011] It is another objective of the present invention to provide a low cost and relatively fast procedure for forming a metal coating.

[0012] To achieve the foregoing and other objectives and in accordance with the purpose of the present invention, a method for forming a metallic coating in a predetermined area in a surface of a metallic component of a compressor is provided. The method includes providing a supplier body that supplies a coating to the component, the supplier being made of a material softer than that of the component, and urging the supplier against a portion of the predetermined area and bringing the supplier to a relative movement with respect to the component along an extending direction of the predetermined area, whereby the material is gradually separated from supplier and supplied to the predetermined area.

[0013] Other aspects and advantages of the invention will become apparent from the following description, taken in conjunction with the accompanying drawings, illustrating by way of example the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] The invention, together with objects and advantages thereof, may best be understood by reference to the following description of the presently preferred embodiments together with the accompanying drawings in which:

Fig. 1 is a longitudinal cross-sectional view showing a swash plate type variable displacement compressor;

Fig. 2 is a front view showing a contact surface of a swash plate, with a supplier of a first embodiment according to the present invention shown in perspective;

Fig. 3 is a view schematically showing a coating apparatus of the first embodiment;

Fig. 4 is an enlarged, cross-sectional view showing the vicinity of the outer periphery of the swash plate along which shoes slide;

Fig. 5 is a front view showing a contact side of a swash plate, with a plurality of suppliers of a second embodiment according to the present invention each shown in perspective;

Fig. 6 is a view schematically showing a coating apparatus of a third embodiment;

Fig. 7 is a view schematically showing a coating apparatus of a fourth embodiment;

Fig. 8 is a view schematically showing a coating apparatus of a fifth embodiment; and

Fig. 9 is a view schematically showing a coating apparatus of a sixth embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0015] First to sixth embodiments of the present invention will now be described with reference to the attached drawings. In describing the second to sixth embodiments, only the differences from the first embodiment will be discussed. Same or like reference numerals are given to parts in the second to sixth embodiments that are the same as or like corresponding parts of the first embodiment.

[0016] As shown in Fig. 1, a swash plate type compressor includes a cylinder block 1, a front housing member 2, a valve plate 3, and a rear housing member 4. The front housing member 2 is coupled to a front end of the cylinder block 1. The front end is to the left in Fig. 1. The rear housing member 4 is connected to a rear end of the cylinder block 1 through the valve plate 3. The cylinder block 1, the front housing member 2, the valve plate 3, and the rear housing member 4 are securely fastened together with a plurality of through bolts (not shown) to define a compressor housing.

[0017] A crank chamber 5, a suction chamber 6, and a discharge chamber 7 are formed in the housing. A plurality of cylinder bores 1a (only one is shown in Fig. 1) are defined in the cylinder block 1. Each cylinder bore 1a accommodates a piston 8. The piston 8 moves in the associated cylinder bore 1a. A plurality of valves are provided in the valve plate 3 for selectively connecting the suction chamber 6 and the discharge chamber 7 with each cylinder bore 1a.

[0018] A drive shaft 9 is rotationally supported in the crank chamber 5. A swash plate 10 is fitted around the drive shaft 9. A through hole 10a extends in the middle of the swash plate 10. The drive shaft 9 extends through the through hole 10a. The swash plate 10 is connected with the drive shaft 9 through a hinge mechanism 13 and a lug plate to rotate integrally with the drive shaft 9. The swash plate 10 inclines with respect to the drive shaft 9 while axially sliding along the surface of the drive shaft 9.

[0019] One end of each piston 8 is connected with the swash plate 10 by a pair of shoes 20A, 20B. The shoes 20A, 20B slide along the periphery of the swash plate 10. When the swash plate 10 rotates integrally with the drive shaft 9 while inclined with respect to the drive shaft 9 by a predetermined angle, each piston 8 moves in the associated cylinder bore 1a by a stroke corresponding to the angle. In this manner, refrigerant gas is drawn from the suction chamber 6 (the zone in which suction pressure Ps acts) to the cylinder bore 1a. The gas is then compressed in the cylinder bore 1a and is discharged to the discharge chamber 7 (the zone in which discharge pressure Pd acts). This series of steps is repeated.

[0020] A spring 14 urges the swash plate 10 toward the cylinder block 1 (to decrease the inclination of the swash plate 10). A snap ring 15 is secured to the drive shaft 9 for determining the minimum angle of inclination θmin (for example, three to five degrees) of the swash plate 10. A counterweight 10b is provided on the swash plate 10. The counterweight abuts against a restricting portion 11a of the lug plate 11. This determines the maximum inclined angle θmax of the swash plate 10.

[0021] The inclined angle of the swash plate 10 is determined by the equilibrium of various types of moments. The moments include a moment of rotation due to centrifugal force caused by rotation of the swash plate 10, a moment of urging force caused by the spring 14, and a moment of gas pressure. The moment of gas pressure is varied in accordance with the difference between the pressure in each cylinder bore 1a and the pressure acting on the front ends of the pistons 8, or the crank pressure Pc, which is the pressure of the crank chamber 5.

[0022] The swash plate type compressor of Fig. 1 has a control valve 16 that adjusts the crank pressure Pc to alter the moment of the gas pressure as necessary. The control valve 16 thus selects the inclination of the swash plate 10 within a range between the minimum angle of inclination θmin and the maximum angle of inclination θmax.

[0023] The swash plate 10 includes a surface to be coated. Specifically, as shown in Figs. 1 and 4, a pair of annular contact surfaces 30A, 30B are located on opposite sides of the swash plate 10 at the periphery. One of the shoes 20A slides along the contact surface 30A, and the other shoe 20B slides along the other contact surface 30B.

[0024] The swash plate 10 is formed of relatively heavy, iron-based material (for example, cast iron FCD700) to optimize the moment of rotation due to centrifugal force caused by rotation of the swash plate 10. The shoes 20A, 20B are also formed of iron-based material (bearing steel) to increase their mechanical strength. If two different components formed of the same material (in this case, the swash plate 10 and the shoes 20A, 20B) slide against each other under severe conditions, seizure may occur. Accordingly, in the first embodiment, a pair of coatings 31A, 31B are formed at least on the associated contact surfaces 30A, 30B. The coatings 31A, 31B allow the shoes 20A, 20B to slide smoothly along the contact surfaces 30A, 30B. That is, the procedure of the present invention is performed on the contact surfaces 30A, 30B of the swash plate 10.

[0025] The coatings 31A, 31B are formed of metal different from that forming the body of the swash plate 10 and the bodies of the shoes 20A, 20B. The material of the coatings 31A, 31B may be Al-Si based material including, for example, silicon containing aluminum alloys and intermetallic compounds consisting of aluminum and silicon. The physical properties such as hardness and melting point of the Al-Si based material, or aluminum based material, vary in accordance with the silicon content of the material. In the first embodiment, the Al-Si based material contains 10 to 20 weight percent (preferably, approximately 17 percent) silicon. The coatings 31A, 31B formed of this material prevent seizure from occurring between the shoes 20A, 20B and the contact surfaces 30A, 30B. The coatings 31A, 31B also allow the shoes 20A, 20B to slide smoothly along the contact surfaces 30A, 30B of the swash plate 10. In other words, even when the lubricant oil supply to the compressor is insufficient, the coatings 31A, 31B ensure a certain level of lubrication between the swash plate 10 and the shoes 20A, 20B.

[0026] The iron based material forming the swash plate 10 and the shoes 20A, 20B is hardened. Further, the material's melting point is relatively high (a thousand and several hundreds of degrees Celsius or higher). In contrast, the Al-Si based material of the coatings 31A, 31B is softer than the iron type material. Further, the melting point of the Al-Si based material is relatively low (approximately 600 to 700 degrees Celsius). The difference in physical properties between the Al-Si based material and the iron based material allows the shoes 20A, 20B to slide smoothly along the contact surfaces 30A, 30B. In addition, the difference is advantageous in forming the coatings 31A, 31B.

[0027] A procedure for forming the coatings 31A, 31B will hereafter be described.

[0028] As shown in Fig. 2, the procedure is performed with a cylindrical supplier 40. The supplier 40 is formed of Al-Si based material. The supplier 40 has a planer end 41 having a diameter substantially equal to a radial dimension of the annular contact surface 30B of the swash plate 10 (the difference between the outer radius and the inner radius of the contact surface 30B).

[0029] As shown in Fig. 3, the swash plate 10 is mounted to a first drive mechanism 51, and the supplier 40 is connected to a second drive mechanism 52. The first drive mechanism 51 is driven by a first motor M1. When the first motor M1 drives the first drive mechanism 51, the swash plate 10 is rotated about an axis L. Specifically, with the swash plate 10 mounted to the first drive mechanism 51, the annular contact surface 30B is centered on the axis L and is perpendicular to axis L. In this state, a portion of the contact surface 30B faces and is spaced from the end 41 of the supplier 40.

[0030] The second drive mechanism 52 is operably connected to a linear mover 53 and a second motor M2. The mover 53 operates to move the supplier 40 axially. Specifically, the mover 53 enables the supplier 40 to contact the swash plate 10. The supplier 40 is then pressed against the contact surface 30B of the swash plate 10 by the mover 53. Afterwards, the mover 53 separates the supplier 40 from the swash plate 10. When the mover 53 moves the Supplier 40, the second motor M2 rotates the supplier 40 about the axis L', which is the axis of the supplier 40. When the supplier 40 is mounted to the second drive mechanism 52, the rotation axis L' of the supplier 40 is offset from axis L. That is, when the supplier 40 is pressed against the contact surface 30B of the swash plate 10, one point on the circumference of the end 41 touches the outer circumference of the contact surface 30B, and a diametrically opposite point on the end 41 touches the inner circumference of the contact surface 30B (as indicated by broken lines in Fig. 2).

[0031] After the swash plate 10 and the supplier 40 are mounted on the associated drive mechanisms 51, 52, the second motor M2 rotates the supplier 40 at a predetermined speed (for example, 1,500 rpm) about the axis L'. The mover 53 causes the supplier 40 and the second drive mechanism 52 to approach the swash plate 10. After the supplier 40 contacts the contact surface 30B of the swash plate 10, the supplier 40 is pressed against the contact surface 30B until the pressure reaches a predetermined value (for example, 18 MPa). The predetermined pressure is then maintained.

[0032] When the supplier 40 is pressed against the contact surface 30B, the first motor M1 rotates the swash plate 10 by a predetermined rotation speed (for example, 1 rpm). That is, the swash plate 10 is rotated at a relatively low speed (as compared to that of the supplier 40) to cause the supplier 40 to follow an annular path around the axis L along the contact surface 30B. In other words, the supplier 40 and the contact surface 30B move relative to each other along the contact surface 30B.

[0033] Heat, which is caused by friction, is generated between the end 41 of the supplier 40 and the contact surface 30B. The heat is mainly caused by the relatively rapid rotation of the supplier 40. The heat softens a portion of the supplier 40 near its end 41. Molten metal is then supplied from the soft portion of the supplier 40 to a corresponding portion of the contact surface 30B. Accordingly, while the supplier 40 is moving relative to the contact surface 30B, molten metal is continuously supplied from the supplier 40 to the contact surface 30B along the annular path of the surface 30B.

[0034] When at least one rotation cycle is completed by the swash plate 10, molten metal is supplied to the entire surface 30B. This forms the coating 31B of Al-Si based material. The thickness of the coating 31B is, for example, 70 to 100 micrometers. The thickness is determined by adding a finishing allowance (which is, for example, 20 to 50 micrometers) to the desired coating thickness (which is, for example, 50 micrometers). After the coating 31B is formed on the contact surface 30B, the mover 53 causes the supplier 40 and the second drive mechanism 52 to separate from the swash plate 10.

[0035] Afterwards, the surface of the coating 31B is machined through cutting or grinding to adjust the thickness of the coating 31B as desired.

[0036] The same procedure is repeated for applying the opposite coating 31A, which is also formed of Al-Si based material, on the opposite contact surface 30A.

[0037] As described, according to the present invention, the coatings 31A, 31B are efficiently and quickly applied to the associated contact surfaces 30A, 30B of the swash plate 10 in a simple manner.

[0038] In the first embodiment, unlike the prior art thermal spraying, no treatment is performed on the contact surfaces 30A, 30B of the swash plate 10 before forming the coatings 31A, 31B. This simplifies the coating procedure and reduces the time and cost needed for the procedure.

[0039] Further, no unpleasant noise is produced when the supplier 40 is pressed to the swash plate 10, which improves the working conditions.

[0040] In the first embodiment, application of the coatings 31A, 31B on the associated contact surfaces 30A, 30B is accomplished essentially through physical bonding. That is, the procedure has no strict requirements regarding chemical affinity between the coatings 31A, 31B and the associated contact surfaces 30A, 30B. Accordingly, the procedure may be generally performed under various conditions.

[0041] The procedure of the present invention greatly improves bonding between the coatings 31A, 31B and the associated contact surfaces 30A, 30B. Specifically, it is thought that atoms of the material forming the supplier 40 are diffused in the material of the swash plate 10 due to the force pressing the supplier 40 to the swash plate 10 and the frictional heat generated by the force. As a result, a microscopic diffusion layer is formed in portions of the contact surfaces 30A, 30B that contact the associated coatings 31A, 31B. It is thought that the diffusion layer contributes to the improved bonding between the coatings 31A, 31B and the associated contact surfaces 30A, 30B.

[0042] In the first embodiment, molten metal is reliably separated from the supplier 40 and is supplied to the contact surfaces 30A, 30B. That is, a predetermined amount of metal is reliably supplied from the supplier 40 to the contact surfaces 30A, 30B. The coatings 31A, 31B thus have a desired uniform thickness along the entire contact surfaces 30A, 30B.

[0043] When the coatings 31A, 31B are formed, planar contact is achieved between the end 41 of the supplier 40 and the corresponding contact surface 30A, 30B. Thus, when the supplier 40 and the contact surface 30A, 30B move relative to each other, a given portion of the contact surface 30A, 30B contacts the end 41 of the supplier 40 over a sufficient period. Accordingly, molten metal is reliably supplied from the supplier 40 to the contact surface 30A, 30B. The coatings 31A, 31B are thus formed in a stable manner.

[0044] The supplier 40 is rotated while being pressed against the corresponding contact surface 30A, 30B of the swash plate 10 to form the coatings 31A, 31B. In this state, different points on the end 41 of the supplier 40 are successively located at positions corresponding to the inner and outer radii of the contact surface 30A, 30B. Accordingly, molten metal is supplied uniformly from the entire end 41 of the supplier 40 to the contact surface 30A, 30B. The supplier 40 is thus reduced uniformly. As a result, the coatings 31A, 31B are formed on the contact surfaces 30A, 30B in a stable manner until the supplier 40 is completely consumed. In contrast, if the supplier 40 remains unmoved when the swash plate 10 is rotated, the supplier 40 is consumed non-uniformly due to the difference between the speed of the inner radius part and the speed of the outer radius part of the contact surface 30A, 30B.

[0045] Since the swash plate 10 is relatively heavy, rotation of the swash plate 10 around axis L becomes unstable if the swash plate 10 is rotated at high speed. However, in the first embodiment, the swash plate 10 is rotated at a relatively low speed while the supplier 40 is rotated at a relatively high speed such that the supplier 40 is heated and softened. Accordingly, the rotation of the swash plate 10 around axis L and formation of the coatings 31A, 31B are stable, as compared to a case in which, for example, the swash plate 10 is rotated at a relatively high speed and the supplier 40 is rotated at a relatively low speed.

[0046] In the first embodiment, the supplier 40 is formed by inexpensive metal material in a cylindrical form. Accordingly, the quality of the coatings 31A, 31B of the first embodiment is relatively high and the cost is relatively low.

[0047] As shown in Fig. 5, a second embodiment of the present invention employs a plurality of (three, in this embodiment) suppliers 40 for forming the coating 31B (31A) on the corresponding contact surface 30B (30A). The suppliers 40 are located at various angular locations around the axis L, and they are separated by equal angular intervals.

[0048] In the second embodiment, when at least one third of a rotation cycle is completed by the swash plate 10, molten metal is supplied from the suppliers 40 to the entire contact surface 30B (30A). The coating 31B (31A) is thus quickly formed on the contact surface 30B (30A). Further, the number of the suppliers 40 is not restricted to three. That is, two, four, five or six suppliers 40 may be provided.

[0049] As shown in Fig. 6, a third embodiment of the present invention employs a pair of suppliers 40 and a pair of second drive mechanisms 52. In this manner, the coatings 31A, 31B are formed on the associated contact surfaces 30A, 30B simultaneously (that is, opposite surfaces are coated at one time).

[0050] Specifically, the coatings 31A, 31B are formed on the associated contact surfaces 30A, 30B after mounting the swash plate 10 to the first drive mechanism 51 only once. That is, it in unnecessary to reverse the swash plate 10 with respect to the first drive mechanism 51 for coating the opposite contact surface 30A, 30B. This shortens the time needed for forming the coatings 31A, 31B and simplifies the procedure.

[0051] Further, the suppliers 40 held by the second drive mechanisms 52 are axially aligned. Accordingly, when the suppliers 40 are pressed to the associated contact surfaces 30A, 30B, one supplier 40 directly receives the force applied by the other supplier 40. This prevents deformation of the swash plate 10 due to the force of the supplier 40. In addition, the resulting coatings 31A, 31B have a uniform thickness, and the suppliers 40 can be pressed against the contact surfaces 30A, 30B with greater force (pressure). Accordingly, bonding between the coatings 31A, 31B between the contact surfaces 30A, 30B is improved.

[0052] As shown in Fig, 7, a fourth embodiment of the present invention supplies inactive gas to a portion of the swash plate 10 pressed by the supplier 40 when forming the coatings 31A, 31B. The inactive gas stops oxidization of metal being supplied from the supplier 40 to the swash plate 10. The inactive gas may be carbon dioxide, nitrogen, or argon. The gas is retained in a high-pressure state in a gas cylinder 54. The gas is sprayed to a predetermined position through a nozzle 55 as necessary.

[0053] Specifically, the inactive gas suppresses oxidization of metal supplied from the supplier 40 to the swash plate 10, which hinders bonding of the metal with the corresponding contact surfaces 30A, 30B. Therefore, the coatings 31A, 31B are reliably bonded with the associated contact surfaces 30A, 30B. That is, the coatings 31A, 31B cannot be easily separated from the swash plate 10.

[0054] However, inactive gas sprayed toward the swash plate 10 pressed by the supplier 40 cools the swash plate 10. This counters the frictional heat generated between the supplier 40 and the swash plate 10, thus hindering the supply of metal from the supplier 40 to the swash plate 10. To overcome this problem, the heat generation must be increased. Specifically, the pressure with which the supplier 40 is pressed against the swash plate 10 may be increased. Alternatively, the rotation speed of the supplier 40 is increased. In these cases, more energy is consumed for forming the coatings 31A, 31B. Further, if excessive pressure is applied to the swash plate 10 by the supplier 40, the swash plate 10 may deform.

[0055] The fourth embodiment may be modified such that the inactive gas is pre-heated to prevent overcooling of the swash plate 10. This retains heat for forming the coatings 31A, 31B, and the coatings 31A, 31B are formed in a stable manner.

[0056] As shown in Fig. 8, in the second drive mechanism 52 of a fifth embodiment according to the present invention the supplier 40 is supported with its axis L' perpendicular to axis L. Thus, when the second drive mechanism 52 causes the supplier 40 to touch the swash plate 10, the cylindrical surface 42 of the supplier 40 contacts a portion of the contact surface 30B (30A).

[0057] Specifically, linear contact occurs between the supplier 40 (cylindrical surface 42) and the swash plate 10 (contact surfaces 30A, 30B) for forming the coatings 31A, 31B. This increases the pressure applied by the supplier 40 to the swash plate 10. That is, the supplier 40 is pressed against the swash plate 10 with high pressure to supply metal from the supplier 40 to the corresponding contact surface 30A, 30B. The resulting coatings 31A, 31B thus reliably bond with the associated contact surfaces 30A, 30B of the swash plate 10.

[0058] As shown in Fig. 9, in a sixth embodiment according to the present invention, the end 41 of the supplier 40 is conical, and the conical end forms a top angle T. The second drive mechanism 52 holds the supplier 40 such that the axis L' of the supplier 40 is inclined with respect to rotation axis L of the swash plate 10 by an angle determined by the top angle T ((180 degrees - T)/2).

[0059] Specifically, linear contact occurs between the supplier 40 (the conical end 41) and the swash plate 10 for forming the coatings 31A, 31B. This increases the pressure applied by the supplier 40 to the swash plate 10. That is, the supplier 40 is pressed to the swash plate 10 with high pressure to supply metal from the supplier 40 to the corresponding contact surface 30A, 30B. The resulting coatings 31A, 31B thus reliably bond with the associated contact surfaces 30A, 30B of the swash plate 10.

[0060] Further, since the supplier 40 makes linear contact with the swash plate 10, the supplier 40 may have a relatively large diameter, as compared to the case in which planar contact occurs between the supplier 40 and the swash plate 10 (for example, the first embodiment). Accordingly, an increased number of swash plates 10 can be coated successively with a single supplier 40. That is, the supplier 40 of the sixth embodiment lasts for a relatively long time before needing replacement. This saves time when coating a number of swash plates 10, thus improving the work efficiency.

[0061] Although several embodiments of the present invention have been described herein, it should be apparent to those skilled in the art that the present invention may be embodied in many other specific forms without departing from the sprit or scope of the invention. Particularly, it should be understood that the invention may be embodied in the following forms.

[0062] In the first to fourth embodiments, the supplier 40 may be shaped like a prism.

[0063] In the first to sixth embodiments, the supplier 40 may remain unmoved while the swash plate 10 is rotated at a relatively high speed. This structure requires only a single drive mechanism, thus simplifying the structure of the coating apparatus. Further, the coating procedure is simplified.

[0064] In the first to sixth embodiments, the supplier 40 may be rotated at a relatively low speed while the swash plate 10 is rotated at a relatively high speed. In this case, heating and softening of the supplier 40 is achieved mainly by the rotation of the swash plate 10.

[0065] In the first to sixth embodiments, the swash plate 10 may remain unmoved while the supplier 40 is revolved around axis L while being rotated around its own axis L'.

[0066] In the first to sixth embodiments, the supplier 40 may be pre-heated and softened before being pressed to the swash plate 10. In this case, even when the frictional heat is generated between the supplier 40 and the swash plate 10 is relatively low, metal is quickly supplied from the supplier 40 to the corresponding contact surface 30A, 30B. This shortens the time needed for forming the coatings 31A, 31B.

[0067] In the first to sixth embodiments, the supplier 40 may be formed of copper based material instead of aluminum based material.

[0068] The procedure of the present invention may be applied to swash plates 10 formed of aluminum based material instead of iron based material.

[0069] Although the procedure of the present invention is performed on the contact surfaces 30A, 30B of the swash plate 10, other compressor components may be coated using the procedure. For example, the flat surface of each shoe 20A, 20B, which contacts the associated contact surface 30A, 30B, may be coated using the procedure of the present invention.

[0070] The procedure of the present invention may be applied to a scroll type compressor having a fixed scroll member and a movable scroll member. Specifically, a surface of each scroll member may be coated by the procedure of the present invention.

[0071] Therefore, the present examples and embodiments are to be considered as illustrative and not restrictive and the invention is not to be limited to the details given herein, but may be modified within the scope and equivalence of the appended claims.

[0072] A method for forming a metallic coating with a component of a compressor is proposed. A supplier body (40) supplies the coating (31A; 31B) to the component (10; 20A; 20B) such as a swash plate (10). The supplier (40) is made of a material softer than that of the swash plate (10). The supplier is urged against a portion of predetermined areas (30A; 30B) of the swash plate (10). The supplier (40) is brought to a relative movement with respect to the swash plate (10) along an extending direction of the predetermined area (30A; 30B), thereby the material is gradually separated from supplier (40) and supplied to the predetermined area (30A; 30B).

Claims

1. A method for forming a metallic coating in a predetermined area in a surface of a metallic component of a compressor, **said method being characterized by steps of** providing a supplier body (40) that supplies the coating (31A; 31B) to the component (10; 20A; 20B), said supplier (40) being made of a material softer than that of the component (10; 20A; 20B), and urging the supplier (40) against a portion of the predetermined area (30A; 30B) and bringing the supplier (40) to a relative movement with respect to the component (10; 20A; 20B) along an extending direction of the predetermined area (30A; 30B), whereby the material is gradually separated from supplier (40) and supplied to the predetermined area (30A; 30B).

2. The method as set forth in Claim 1, **characterized in that** said supplier (40) is in a cylindrical shape and rotated about its axis (L') while being urged against the predetermined area (30A; 30B), and wherein said component (10; 20A; 20B) is in a disk shape and rotated about its axis (L).

3. The method as set forth in Claim 2, **characterized by that** said supplier (40) is arranged perpendicular to a surface of the component (10; 20A; 20B) and has an end urged (41) against the predetermined area (30A; 30B), whereby the material is gradually separated from the end (41) and supplied to the predetermined area (30A;30B) when the component (10; 20A; 20B) is rotated about its axis (L).

4. The method as set forth in Claim 2, **characterized by that** said supplier (40) is arranged parallel to a surface of the component (10; 20A; 20B) and urged against the predetermined area (30A; 30B) with an distal cylindrical surface (42) of the supplier (40), whereby the material is gradually separated from the distal cylindrical distal surface (42) and supplied to the predetermined area (30A; 30B) when the component (10; 20A; 20B) is rotated about its axis (L).

5. The method as set forth in Claim 2, **characterized by that** said supplier (40) has a conical end, and wherein said supplier (40) is arranged oblique to a surface of the component (10; 20A; 20B) to urge a conical end surface (41) against the predetermined range (30A; 30B), whereby the material is separated from the conical end surface (41) and supplied to the predetermined area (30A; 30B).

6. The method as set forth in any one of the preceding claims, **characterized by that** said supplier (40) is made of the material having a melting point lower than that of the material forming the component

(10; 20A; 20B).

7. The method as set forth in any one of the preceding claims, **characterized by that** said component (10; 20A; 20B) is made of an iron based material, and wherein said supplier (40) is made of an aluminum based material.

8. The method as set forth in any one of Claims 1 to 6, **characterized by that** said component (10; 20A; 20B) is made of an iron based material, and wherein said supplier (40) is made of a copper based material.

9. The method as set forth in any one of the preceding claims, **characterized by that** said supplier (40) is urged against the predetermined area (30A; 30B) in an inactive gas atmosphere.

10. The method as set forth in any one of the preceding claims, **characterized in that** said component is in slidable contact with another working element in the compressor.

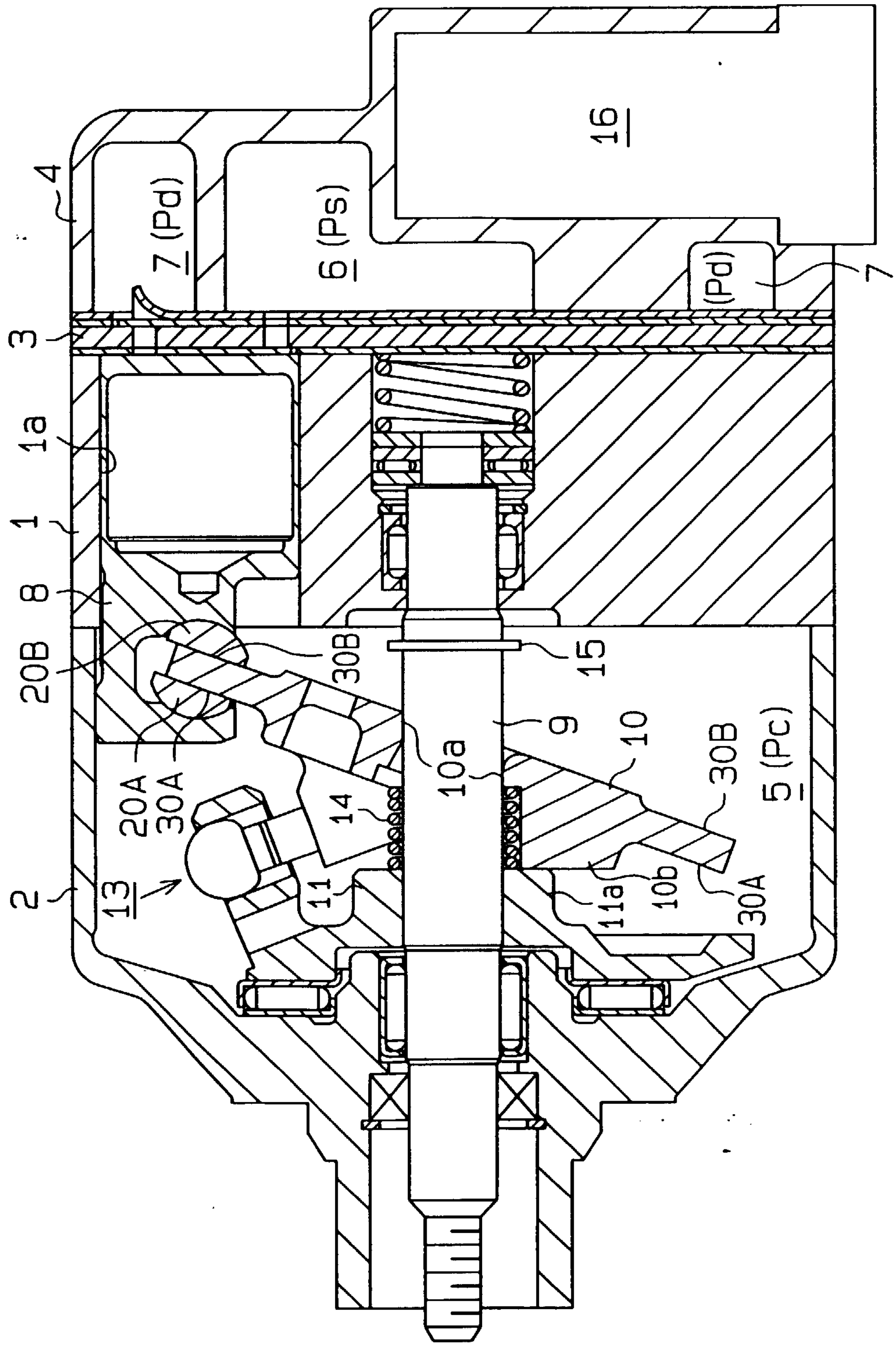
11. The method as set forth in Claim 10, **characterized in that** said component includes a swash plate (10).

12. The method as set forth in Claim 11, **characterized in that** said predetermined area (30A; 30B) extends in the entire outer periphery of the swash plate (10) and slidably contact with at least one shoe (20A; 20B).

13. The method as set forth in Claim 12, **characterized by that** said swash plate (10) has opposed surfaces respectively kept in a slidable contact with the shoes (20A; 20B), and wherein the metallic coating (31A; 31B) is formed with each of the opposed surfaces.

14. The method as set forth in Claim 10, **characterized in that** said component includes at least one shoe (20A; 20B).

Fig.1


4
7 (Pd)
6 (Ps)
16
(Pd)
7
3
1a
1
8
20B
30B
15
9
10
10a
20A
30A
14
30B
5 (Pc)
2
13
11
11a
10b
30A

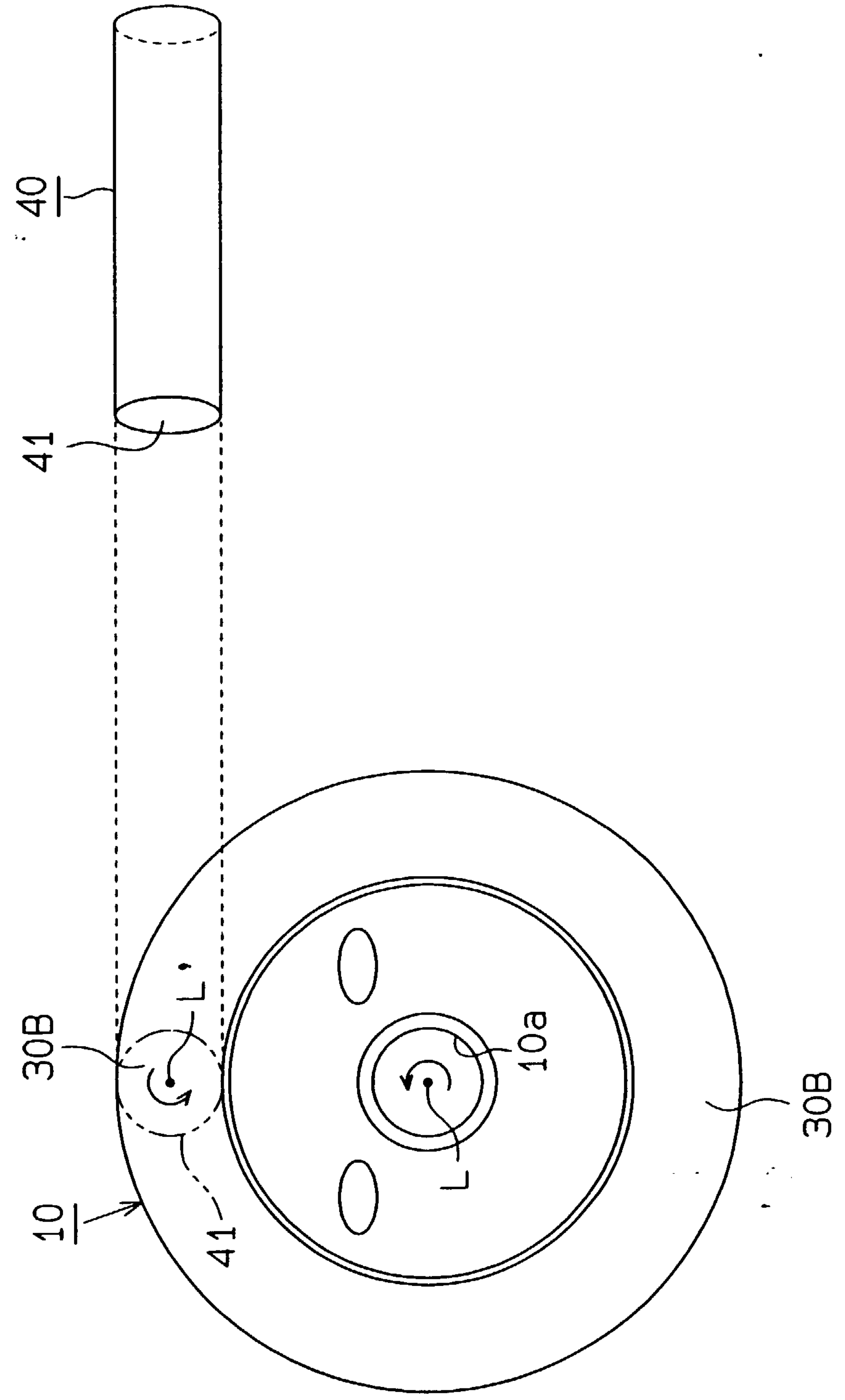


Fig.2

Fig. 3

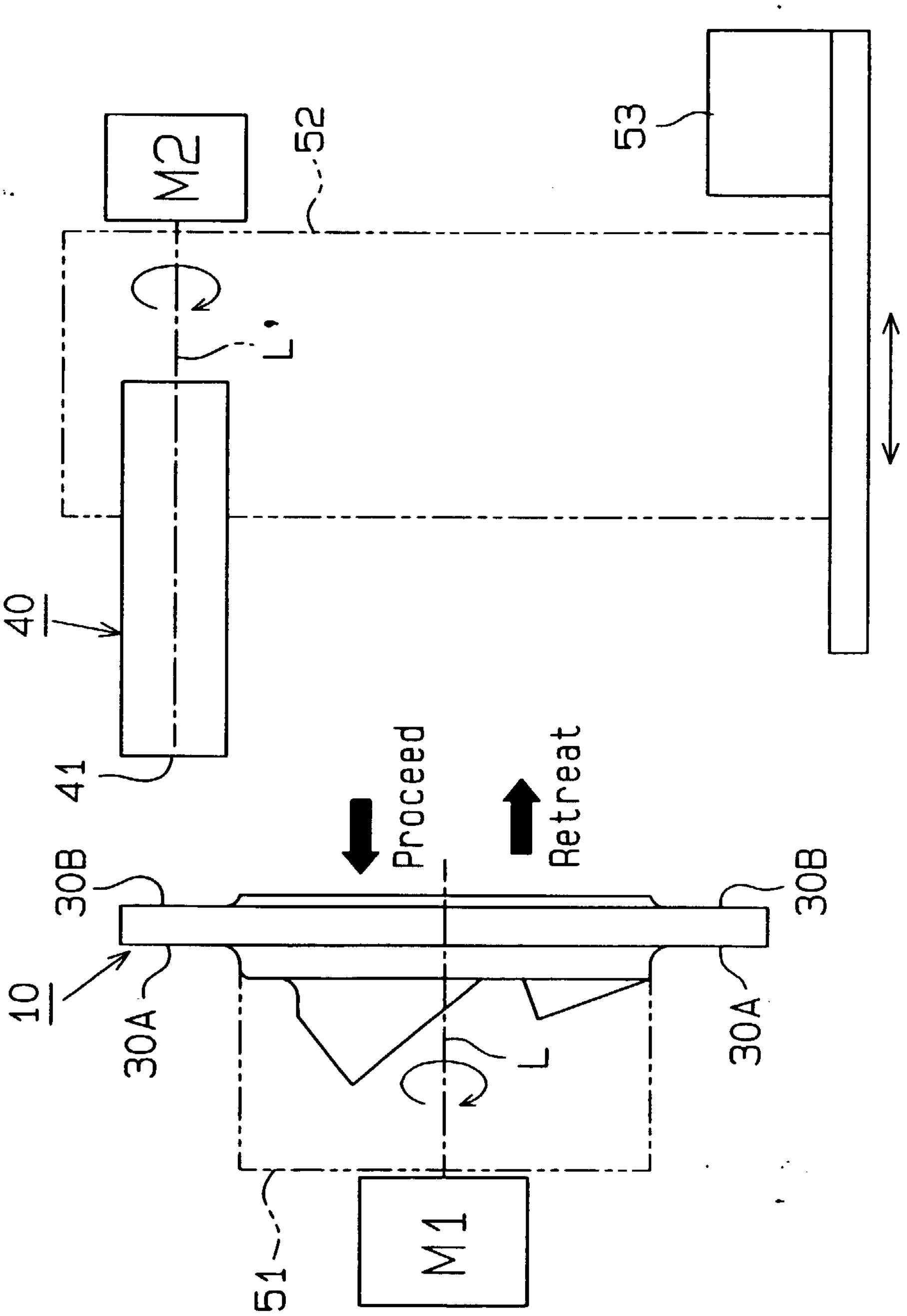


Fig.4

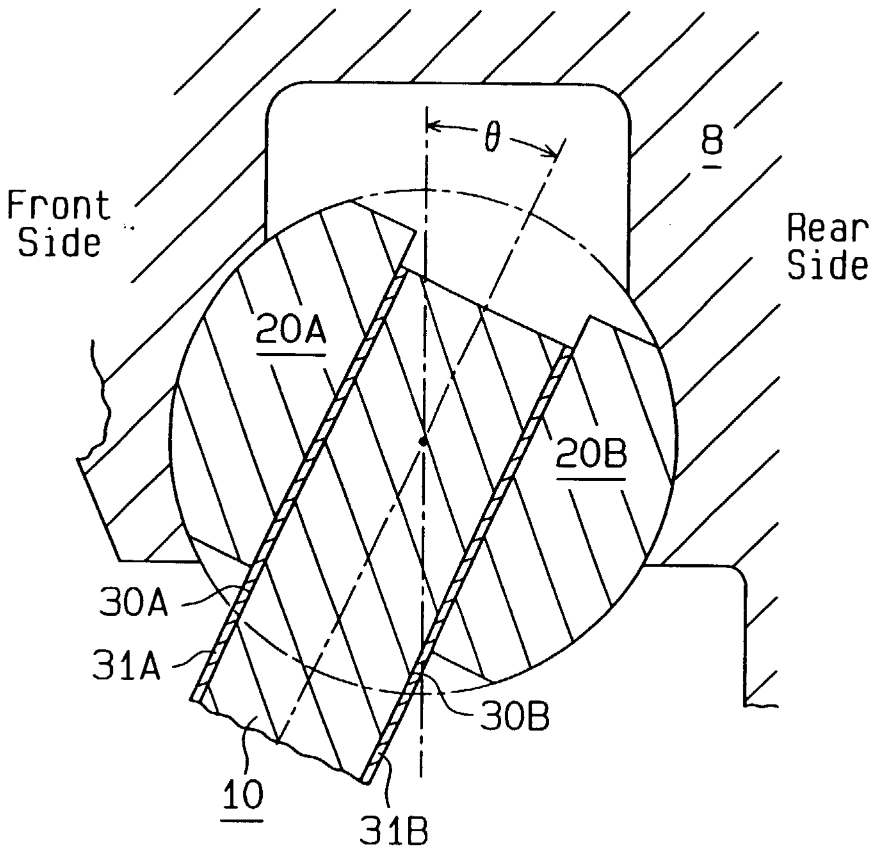


Fig. 5

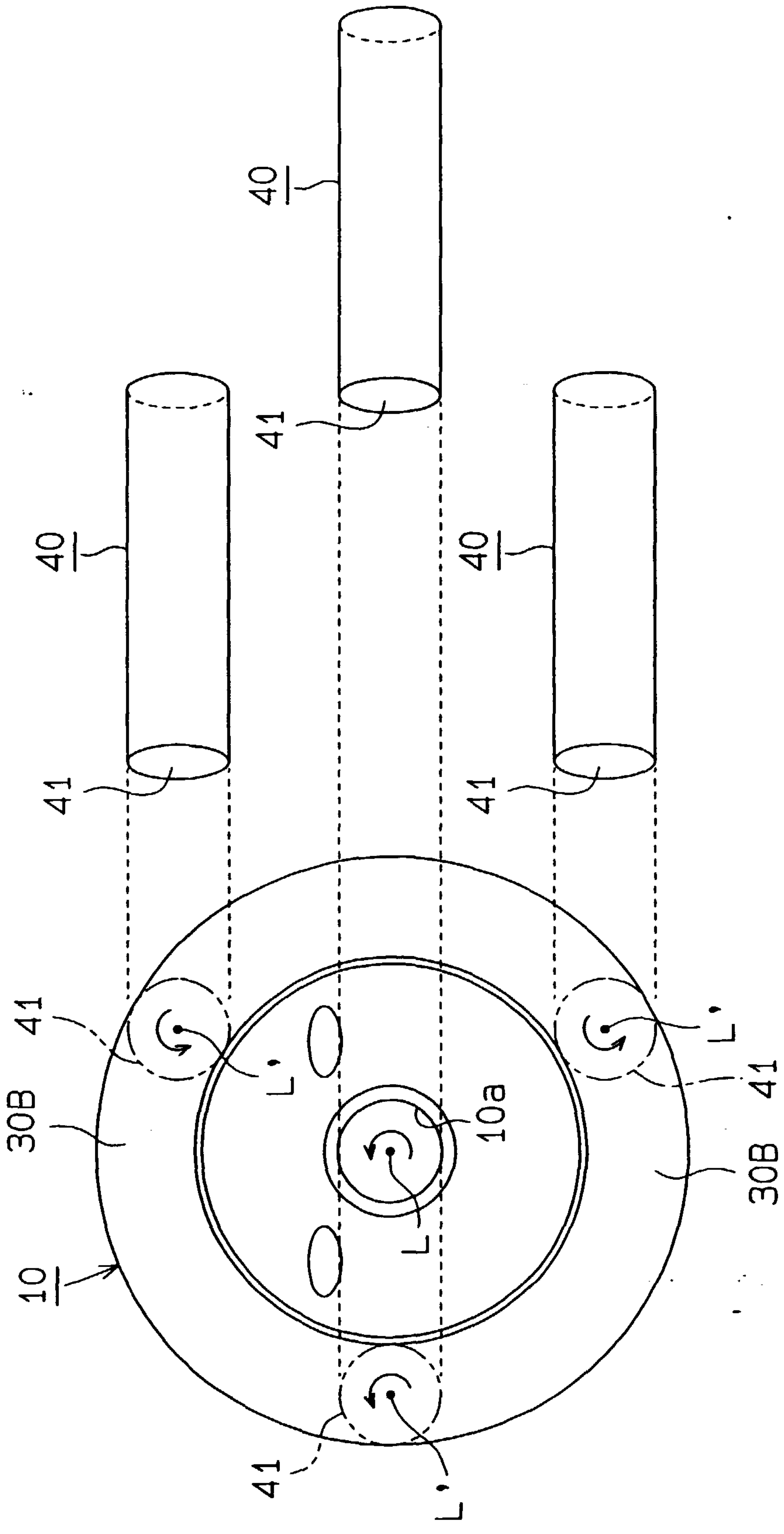


Fig.6

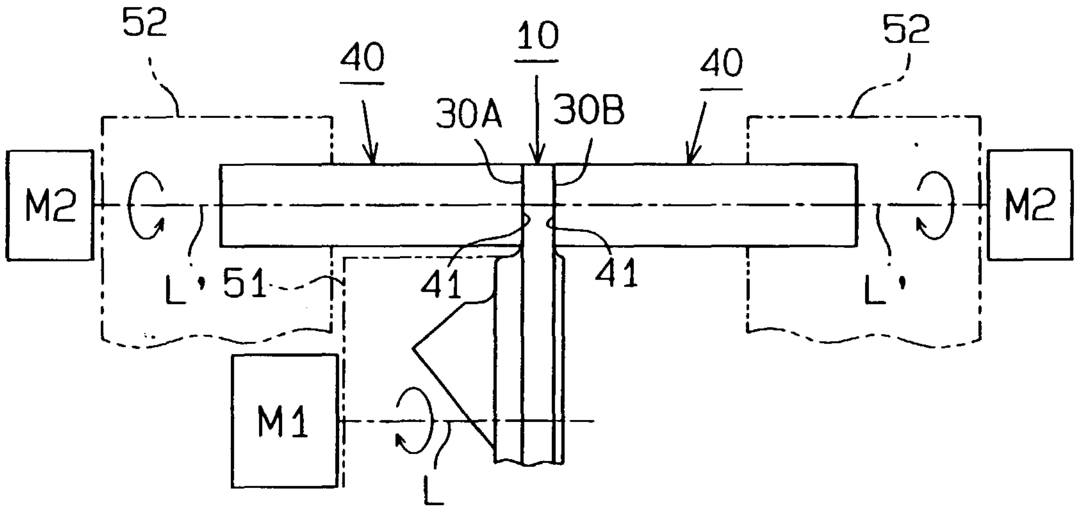

52
40
10
30A
30B
40
52
M2
M2
L'
51
41
41
L'
M1
L

Fig.7

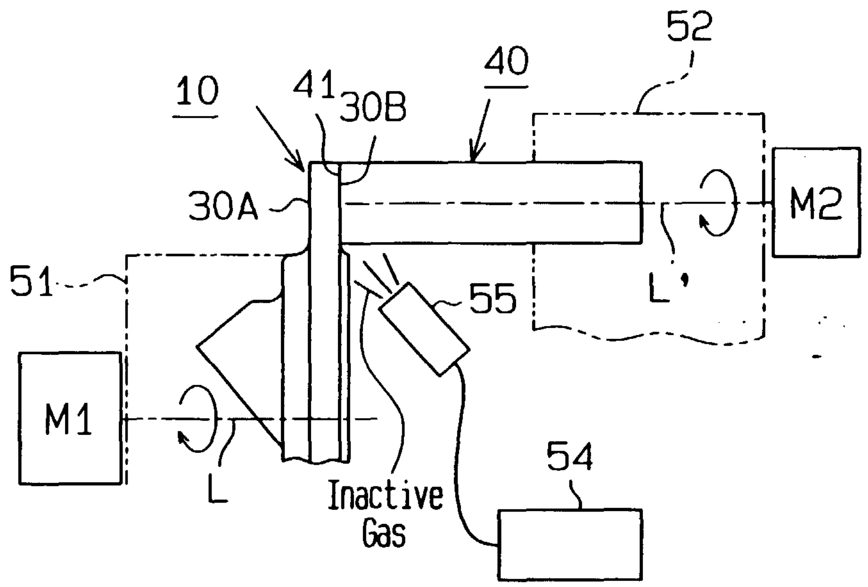

52
40
10
41
30B
30A
M2
51
55
L'
M1
L
Inactive
Gas
54

Fig.8

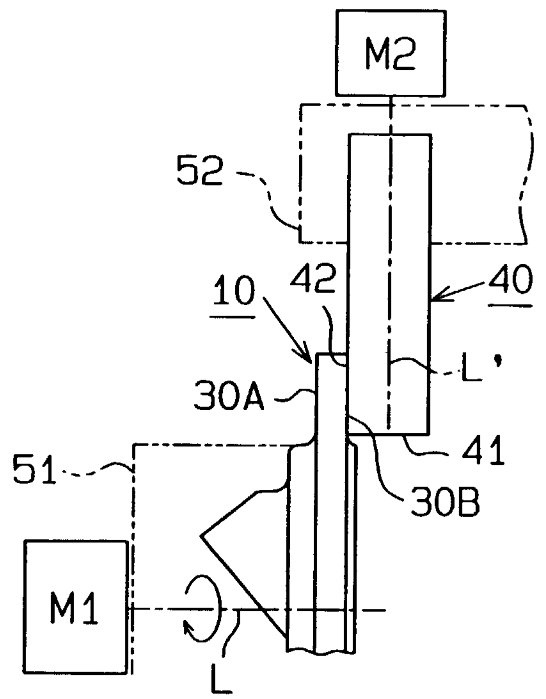


Fig.9