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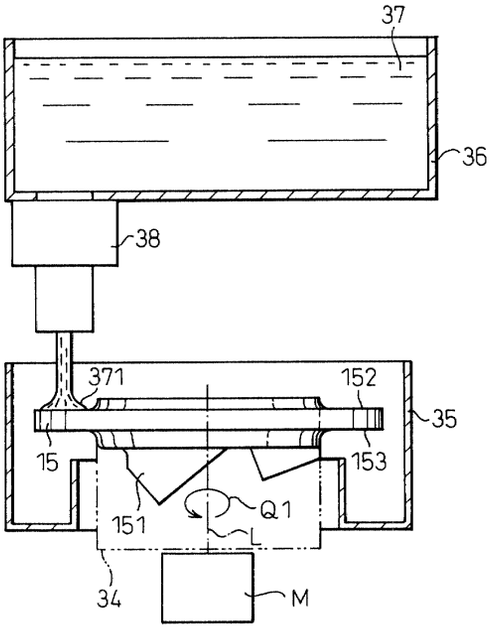
(54) Swash plate with film coating

(57) A film forming method for a compressor and a part of the compressor to be formed with a film are disclosed. A paint container (36) is arranged above a rotary holding mechanism (34) with a swash plate (15) of the compressor mounted thereon. A lubrication paint (37) in the paint container (36) is dripped on the end surface (152) of the swash plate (15) through a dripping unit (38). The swash plate (15) is rotated at high speed by the operation of a motor (M) so that the surplus portion of the lubrication paint (37) on the end surface (152) is removed by centrifugal force. The lubrication paint (37) remaining on the end surface (152) with the surplus portion thereof removed by centrifugal force has a uniform film thickness.

Fig.2A



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a part of a compressor to be formed with a film and a method of forming the film on the part.

2. Description of the Related Art

[0002] A method of coating a paint for lubrication on a part, such as the swash plate or the piston of a compressor, to be formed with a film is disclosed in Japanese Unexamined Patent Publications (Kokai) Nos. 10-26081 and 11-173263.

[0003] In the roll coating method disclosed in Kokai No. 10-26081, a paint is attached on the peripheral surface of a metal roller and then transferred to the peripheral surface of a rubber roller, and the paint transferred to the peripheral surface of the rubber roller is coated on the part to be formed with a film. The metal roller and the rubber roller are in sliding contact with each other, and so are the rubber roller and the part to be formed with a film. The paint attached on the metal roller is reduced to a predetermined thickness by being passed between a comma roller and the metal roller before being transferred to the rubber roller.

[0004] In the pad system disclosed in Kokai No. 11-173263, on the other hand, a paint of a predetermined thickness and a predetermined shape prepared on an intaglio plate is transferred to a pad and the paint thus transferred to the pad is printed on the part to be formed with a film.

[0005] According to the coating method disclosed in Kokai No. 10-26081, particle, if caught in the gap between the comma roller and the metal roller, generates a streak on the paint film that has passed between the comma roller and the metal roller. This streak is transferred also to the film formed by being coated on the part to be formed with a film thereby to deteriorate the quality of the film. Unless the particle is removed, the streak is generated on all the films subsequently formed on the part to be formed with the film.

[0006] According to the coating method disclosed in Kokai No. 11-173263, the film is liable to be wrinkled by the ununiform deformation of the pad. In the case where the surface of the pad pressed against the part to be formed with a film is flat, the air may be sealed in and make it impossible to form a satisfactory film. In the case where the surface of the pad pressed against the part to be formed is convex to avoid the air being sealed in, on the other hand, the force of pressing the pad against the part to be formed with a film increases toward the center of the particular surface of the pad, thereby making an ununiform film thickness. Therefore, the film must be ground, for adjusting the thickness, after being dried and baked.

SUMMARY OF THE INVENTION

[0007] The object of the present invention is to form a film of high quality on a part of the compressor to be formed with the film.

[0008] To achieve this object, according to one aspect of the invention, there is provided a film forming method for forming a film by attaching a fluid paint on a film forming area, comprising the steps of attaching the fluid paint to the film forming area, and removing by centrifugal force the surplus portion of the fluid paint attached on the film forming area.

[0009] The method for removing the surplus portion of the paint by centrifugal force is effective for securing a uniform film thickness.

[0010] According to another aspect of the invention, there is provided a film forming method in which the paint is a resin containing a solid lubricant.

[0011] The resin containing a solid lubricant effectively forms a film for an improved slidability.

[0012] According to further another aspect of the invention, there is provided a film forming method, comprising further the step of spreading said paint on the flat surface of the film forming area due to the centrifugal force.

[0013] According to still another aspect of the invention, there is provided a film forming method described in the aforementioned first or second aspect, in which a film is formed on the film forming area of a part of the compressor to be formed with a film.

[0014] The film formed by removing the surplus portion of the paint by centrifugal force has a uniform thickness.

[0015] According to yet another aspect of the invention, there is provided a film forming method for the compressor of swash plate type comprising a piston and a swash plate rotated integrally with the rotary shaft, wherein at least a shoe is interposed between the swash plate and the piston in such a manner as to be in sliding contact with both the swash plate and the piston, wherein the rotation of the swash plate is transmitted to the piston through the shoe thereby to reciprocate the piston, and wherein the part to be formed with a film is the swash plate and the area of the swash plate in sliding contact with the shoe constitutes the film forming area.

[0016] The area of the swash plate in sliding contact with the shoe preferably constitutes a film forming area by removing the surplus portion of the paint by centrifugal force.

[0017] The present invention will be more fully understood with reference to the accompanying drawings and the preferred embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] Fig. 1A is a side sectional view of the whole

compressor formed with a film according to a first embodiment of the invention, and Fig. 1B an enlarged side sectional view of the essential parts thereof.

[0019] Fig. 2A is a sectional view of a film forming unit, and Fig. 2B is a plan view showing the manner in which the paint is dripped on an end surface 152 of a swash plate 15.

[0020] Fig. 3A is a sectional view of the paint film remaining on the end surface 152 after the removing operation by centrifugal force, and Fig. 3B is a front view of the paint film remaining on the end surface 152.

[0021] Fig. 4 is a sectional view of a film forming unit according to a second embodiment of the invention.

[0022] Fig. 5 is a sectional view showing the manner in which a coating roller 47 is pressed against the swash plate 15.

[0023] Fig. 6A is a plan view showing the manner in which the paint is coated on the swash plate 15, and Fig. 6B is a plan view showing a paint film 374 with the surplus portion thereof removed by centrifugal force.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0024] A first embodiment of the invention will be explained below with reference to Figs. 1A to 3.

[0025] Fig. 1A shows the internal structure of variable displacement refrigerant compressor. A rotary shaft 13 is supported on a front housing 12 and a cylinder block 11 forming a control pressure chamber 121. The rotary shaft 13 is driven by an external drive source (such as a vehicle engine). A rotary support member 14 is fixedly mounted on the rotary shaft 13, and a swash plate 15 is slidably and inclinably supported along the axis of the rotary shaft 13. The swash plate 15 of iron material is formed integrally with a support member 151 on which a guide pin 16 is secured. The guide pin 16 is slidably fitted in a guide hole 141 formed in the rotary support member 14. The swash plate 15 is rotatable integrally with the rotary shaft 13 and inclinably along the axis of the rotary shaft 13 in collaboration between the guide hole 141 and the guide pin 16. The inclination of the swash plate 15 is guided by the slide guide relation between the guide hole 141 and the guide pin 16 on the one hand and the sliding support function of the rotary shaft 13 on the other.

[0026] The inclination angle of the swash plate 15 can be changed by controlling the internal pressure of the control pressure chamber 12. With the increase in the internal pressure of the control pressure chamber 121, the inclination angle of the swash plate 15 decreases, and vice versa. The refrigerant in the control pressure chamber 121 flows out to a suction chamber 191 in a rear housing 19 through a discharge passage not shown, and the refrigerant in a discharge chamber 192 in the rear housing 19 is adapted to be supplied to the control pressure chamber 121 through a pressure supply passage not shown. A replacement control valve 25 is interposed on the pressure supply passage, so that the flow rate of the refrigerant supplied from the discharge chamber 192 to the control pressure chamber 121 is controlled by a replacement control valve 25. With the increase in the flow rate of the refrigerant supplied from the discharge chamber 192 to the control pressure chamber 121, the internal pressure of the control pressure chamber 121 increases, and vice versa. In this way, the inclination angle of the swash plate 15 is controlled by the replacement control valve 25.

[0027] The maximum inclination angle of the swash plate 15 is defined by the contact between the swash plate 15 and the rotary support member 14. The minimum inclination angle of the swash plate 15, on the other hand, is defined by the contact between the swash plate 15 and a snap ring 24 on the rotary shaft 13.

[0028] In the cylinder block 11, a plurality of cylinder bores 111 (only two are shown in Fig. 1A) are arranged around the rotary shaft 13. Each cylinder bore 111 contains a piston 17. In Fig. 1A, the upper piston 17 is located at the top dead center and the lower piston 17 at the bottom dead center. The motion of the swash plate 15 rotated integrally with the rotary shaft 13 is transformed into the longitudinal reciprocal motion of the piston 17 through hemispherical shoes 18A, 18B, so that the piston 17 reciprocates longitudinally in the cylinder bore 111. The shoe 18A of iron material is in sliding contact with one sliding contact surface 30 of the swash plate 15 and the shoe 18B of iron material is in sliding contact with the other sliding contact surface 31 of the swash plate 15.

[0029] As the result of the return motion (from right to left in Fig. 1A) of the piston 17, the refrigerant in the suction chamber 191 flows into the cylinder bore 111 by forcibly pushing off a suction valve 211 on a valve forming plate 21 from a suction port 201 on the valve plate 20. As the result of the ongoing motion (left to right in Fig. 1A) of the piston 17, on the other hand, the refrigerant that has flowed into the cylinder bore 111 is discharged into a discharge chamber 192 by forcibly pushing off a discharge valve 221 on a valve forming plate 22 from a discharge port 202 on the valve plate 20. The opening degree of the discharge valve 221 is controlled by contact with a retainer 231 on a retainer forming plate 23.

[0030] The discharge chamber 192 and the suction chamber 191 are connected to each other through an external refrigerant circuit 26. The refrigerant that has flowed out from the discharge chamber 192 to an external refrigerant circuit 26 recirculates into the suction chamber 191 through a condenser 27, an expansion valve 28 and an evaporator 29.

[0031] A holding portion 171 is formed on the piston 17 and has formed thereon a pair of spherical recesses 172, 173. As shown in Fig. 1B, the shoe 18A in sliding contact with the sliding contact surface 30 of the swash plate 15 is held unremovably in the recess 172, and the shoe 18B in sliding contact with the other sliding contact surface 31 of the swash plate 15 is held unremovably

on the recess 173. The end surfaces 152, 153 making up the film forming area are formed with films 32, 33, respectively. The surface of the film 32 constitutes the sliding contact surface 30, and the surface of the film 33 makes up the sliding contact surface 31.

[0032] The films 32, 33 are formed by use of a film forming unit shown in Fig. 2A. The swash plate 15 is mounted on a rotary holding mechanism 34 rotated in the direction of arrow Q1 by a motor M. A receptacle 35 is arranged around the rotary holding mechanism 34. A paint container 36 is arranged above the rotary holding mechanism 34. A fluid lubrication paint 37 is contained in the paint container 36. The lubrication paint 37 includes a thermosetting resin and a solid lubricant such as molybdenum disulfide, tungsten disulfide and graphite. A dripping unit 38 is mounted on the bottom wall of the paint container 36. The dripping unit 38 can be switched between the supply mode for allowing the lubrication paint 37 to drip from within the paint container 36 and the stationary mode for not allowing the lubrication paint 37 to drip from within the paint container 36.

[0033] After the swash plate 15 is mounted on the rotary holding mechanism 34 in the state shown in Fig. 2A, the dripping unit 38 is switched to the supply mode while at the same time rotating the motor M at a speed as low as 10 rpm, for example. The lubrication paint 37 in the paint container 36 drips on the end surface 152 of the swash plate 15 rotating at low speed, so that the fluid lubrication paint 37 sequentially attaches along the peripheral direction of the end surface 152 as shown by hatching in Fig. 2B.

[0034] Once the lubrication paint 37 has been dripped over the entire periphery of the end surface 152, the dripping unit 38 stops while at the same time the motor M is rotated at high speed. A part of the lubrication paint 37 attached on the end surface 152 is removed from the end surface 152 by the centrifugal force due to the high-speed rotation of the swash plate 15. The lubrication paint 37 that has been removed from the end surface 152 by the centrifugal force is pooled in the receptacle 35. Figs. 3A, 3B show the coating film 372 of the lubrication paint remaining on the end surface 152.

[0035] The coating film 372 of the lubrication paint remaining on the end surface 152 is dried. After the coating film on the end surface 152 is dried, the swash plate 15 is mounted on the rotary holding mechanism 34 with the end surface 153 directed up. Then, the lubrication paint 37 is dripped on the end surface 153, and a part of the lubrication paint 37 attached on the end surface 153 is removed by centrifugal force. After the coating film on the end surface 153 is dried, the coating film 372 on the end surface 152 and the coating film on the end surface 153 become films 32, 33, respectively, through the baking process.

[0036] According to the first embodiment, the following advantages are obtained.

(1-1) The lubrication paint 371 attached on the end surfaces 152, 153 has a uniform film thickness due to the centrifugal force of the high-speed rotation of the swash plate 15. Also, the amount of the lubrication paint 371 removed from the end surfaces 152, 153 by the centrifugal force of the high-speed rotation of the swash plate 15 can be adjusted according to the conditions including the rotational speed of the swash plate 15, the rotation time of the swash plate 15, the viscosity of the lubrication paint 37 and the surface tension of the lubrication paint 37. The method of removing the surplus portion of the lubrication paint 371 by the centrifugal force is effective for securing the desired uniform thickness of the films 32, 33.

(1-2) In the case where the thickness of the coating film 372 before being dried is set in advance by taking the change of the film thickness due to the drying and baking of the coating film 372 into account, the surfaces of the films 32, 33 need not be polished to adjust the film thickness.

(1-3) The method in which the lubrication paint 37 is dripped on the end surfaces 152, 153 is convenient for attaching the lubrication paint 37 on the end surfaces 152, 153.

(1-4) The resin containing the solid lubricant is advantageous for forming the films 32, 33 with an improved slidability.

(1-5) The end surfaces 152, 153 of the swash plate 15 are flat, and the swash plate 15 is rotated at high speed without changing the position of the flat surfaces. The fluid lubrication paint 371 on the flat surfaces fixed in position is liable to spread uniformly on the flat surfaces due to the centrifugal force. Also, the end surfaces 152, 153 are comparatively distant from the rotation center L of the swash plate 15 indicated in Fig. 3A, and the distance between an arbitrary position on each of the end surfaces 152, 153 and the rotation center L is substantially the same. As a result, the lubrication paint 371 at an arbitrary position on the end surfaces 152, 153 receives a comparatively uniform centrifugal force. The lubrication paint 371 on the end surfaces 152, 153 which receives a comparatively uniform centrifugal force is spread to a uniform thickness. Thus, the end surfaces 152, 153 constituting the sliding contact area of the swash plate 15 in sliding contact with the shoes 18A, 18b suitably constitute areas for forming the films 32, 33 by removing the surplus portion of the lubrication paint 371 due to the centrifugal force.

[0037] Now, a second embodiment of the invention will be explained with reference to Figs. 4 to 6B. The same component parts as the corresponding ones of the first embodiment are designated by the same reference numerals, respectively.

[0038] As shown in Fig. 4, a first drive unit 42 and a second drive unit 43 are assembled on a base frame 41.

An intaglio 44 arranged horizontally is driven reciprocally by the first drive unit 42. A paint container 45 is arranged just above the intaglio 44. The paint container 45 contains the lubrication paint 37. The intaglio 44 is reciprocated horizontally at a position of predetermined height in sliding contact with the lower end of the paint container 45. The intaglio 44 thus is reciprocated between the paint supply position shown in Fig. 4 and the paint ready position shown in Fig. 5. A band-shaped holding groove 441 is recessed on the upper surface of the intaglio 44. As long as the intaglio 44 is located at the paint ready position, the holding groove 441 is located just under the paint container 45. When the intaglio 44 is located at the paint supply position, on the other hand, the holding groove 441 is located at a paint preparation position S off the position just under the paint container 45. In the case where the intaglio 44 is relocated from the paint ready position to the paint supply position, a part of the paint in the paint container 45 is filled in the holding groove 441.

[0039] A support base plate 40 is fixedly secured at the lower end of a support shaft 39 movable both vertically and horizontally by the second drive unit 43. A motor 46 is mounted on the lower surface of the support base plate 40. A coating roller 47 of rubber is securely fixed on the output shaft 461 of the motor 46. A motor M and a rotary holding mechanism 34 are arranged on the extension of the intaglio 44. The swash plate 15 is mounted on the rotary holding mechanism 34.

[0040] As shown in Fig. 6A, the width of the coating roller 47 is approximately equal to the width of the end surface 152 of the swash plate 15.

[0041] As shown in Fig. 4, the coating roller 47 is moved along the arrows r1, r2, r3 in that order by the operation of the second drive unit 43. In the process of travel as indicated by arrow r2, the coating roller 47 rotates in the direction along arrow Q2 at the same peripheral speed as the travel speed of the coating roller 47, so that the lubrication paint 373 prepared in the holding groove 441 is transferred to the peripheral surface of the coating roller 47. The coating roller 47 is rotated in sliding contact with the intaglio 44 in such a manner that the side (lower side in the drawing) of the coating roller 47 pressed against the intaglio 44 is moved in advance in the same direction as the travel direction of the coating roller 47. As shown in Fig. 5, the coating roller 47 with the coating film 374 attached thereon is moved along arrows r4, r5, r6, r7 in that order by the operation of the second drive unit 43. As long as the coating roller 47 is pressed against the swash plate 15, the coating roller 47 rotates in the direction indicated by arrow Q3, so that the coating film 374 attached on the peripheral surface of the coating roller 47 is transferred to the end surface 152 of the swash plate 15. The rotational speed at the transverse center of the end surface 152 is equal to the peripheral speed of the coating roller 47.

[0042] The coating roller 47 comes into sliding contact with the swash plate 15 by rotating in such a manner that the side (the lower side in Fig. 5) of the coating roller 47 pressed against the swash plate 15 moves in advance in the same direction as that of the relative motion of the coating roller 47. The coating film 374 on the coating roller 47 is transferred to the end surface 152 as the coating roller 47 comes into sliding contact with the swash plate 15.

[0043] After transfer of the coating film 374 to the swash plate 15, the swash plate 15 rotates at high speed with the high-speed rotation of the motor M thereby to remove the surplus portion of the coating film 374 on the swash plate 15. Fig. 6B shows the coating film 374 after removal of the surplus portion thereof by the centrifugal force. A similar coating film is formed also on the end surface 153. Once the coating film is dried and baked, the films 32, 33 are obtained.

[0044] The second embodiment has the following advantages.

(2-1) The operation by which the coating roller 47 is brought into sliding contact with the intaglio 44 at the same peripheral speed as the travel speed of the coating roller 47 causes the lubrication paint 373 of uniform thickness in the holding groove 441 to be transferred to the peripheral surface of the coating roller 47 with a uniform thickness. The coating operation in which the coating roller 47 is rotated with respect to the swash plate 15 at the same peripheral speed as the travel speed of the coating roller 47 causes the coating film 374 formed in a uniform thickness on the peripheral surface of the coating roller 47 to be transferred to the swash plate 15 with a uniform thickness. Thus, the coating film 374 applied on the swash plate 15 has a uniform thickness. The coating film 374 having a uniform thickness is advantageous for securing a uniform thickness by removing the surplus portion by the centrifugal force.

(2-2) The coating roller 47 comes off from the intaglio 44 and the swash plate 15 at each coating session. Even in the case where particle attaches to the coating roller 47 while the paint is being applied to the coating roller 47 or particle attaches to the coating roller 47 while the swash plate 15 is being coated, therefore, the particular particle is not continuously attached to the coating roller 47. As a result, all of the films 32, 33 on the swash plates 15 are not damaged after particle is attached thereto.

[0045] The present invention may be additionally embodied in the following ways.

(1) With the piston 17 as a part to be formed with a film, the peripheral surface of the piston 17 in sliding contact with the peripheral surface of the cylinder bore 111 is defined as a film forming area.

(2) A fluid paint is attached to the film forming area of the part to be formed with a film, by the roll coating

method disclosed in Kokai No. 10-26081, and then the surplus portion of the paint in the film forming area is removed by centrifugal force.

(3) A fluid paint is attached to the film forming area of the part to be formed with a film, by the pad method disclosed in Kokai No. 11-173263, and then the surplus portion of the paint in the film forming area is removed by centrifugal force.

(4) A fluid paint is attached to the film forming area of the part to be formed with a film, by the spray method, and then the surplus portion of the paint in the film forming area is removed by centrifugal force.

(5) A fluid paint is attached to the film forming area of the part to be formed with a film, by the dipping method, and then the extraneous portion of the paint in the film forming area is removed by centrifugal force.

(6) As disclosed in Kokai No. 11-193780, a metal slide contact layer having a superior slidability is formed on the base surface of a part to be formed with a film in the film forming area, and a film according to the invention is formed on the slide contact layer. The film provides a protective film for the slide contact layer.

(7) A fluid paint is attached to a part of a film forming area of a part to be formed with a film, and then the part to be formed with a film is rotated thereby to spread the paint over the entire film forming area by centrifugal force. Further, the surplus portion of the paint in the film forming area may be removed by the centrifugal force.

[0046] As described in detail above, according to the present invention, a fluid paint is attached to a film forming area of a part to be formed with a film, and the surplus portion of the fluid paint attached to the film forming area is removed by centrifugal force thereby to form a film. Therefore, the invention has a great advantage that a film of high quality can be formed on a part of the compressor to be formed with a film.

[0047] While the invention has been described by reference to specific embodiments chosen for purposes of illustration, it should be apparent that numerous modifications could be made thereto by those skilled in the art without departing from the basic concept and scope of the invention.

Claims

1. A film forming method, for a part of a compressor to be formed with a film by attaching a fluid paint to a film forming area, comprising the steps of:

attaching said fluid paint to said film forming area; and

removing by centrifugal force the surplus portion of said fluid paint attached to said film forming area thereby to form said film.

2. A film forming method for a part of a compressor to be formed with a film according to claim 1, wherein said paint is a resin containing a solid lubricant.

3. A film forming method for a part of a compressor to be formed with a film according to claim 1, comprising the step of forming a film by dripping and attaching said paint on said film forming area.

4. A film forming method for a part of a compressor to be formed with a film according to claim 2, comprising the step of forming a film by dripping and attaching said paint on said film forming area.

5. A film forming method for a part of a compressor to be formed with a film according claim 1, comprising the step of spreading said paint on the flat surface of said film forming area due to the centrifugal force.

6. A part of a compressor to be formed with a film in a film forming area, wherein said film is formed according to the method described in any one of claims 1 to 5.

7. A part of a compressor to be formed with a film according to claim 6, wherein said compressor is a swash plate compressor having at least a shoe interposed between a piston and a swash plate integrally rotated with a rotary shaft in such a manner that the shoe is in sliding contact with both said swash plate and said piston, the rotation of said swash plate is transmitted to said piston through said shoe thereby to reciprocate said piston, said part to be formed with a film is said swash plate, and the slide contact area of said swash plate in sliding contact with said shoe constitutes said film forming area.

Fig.1A

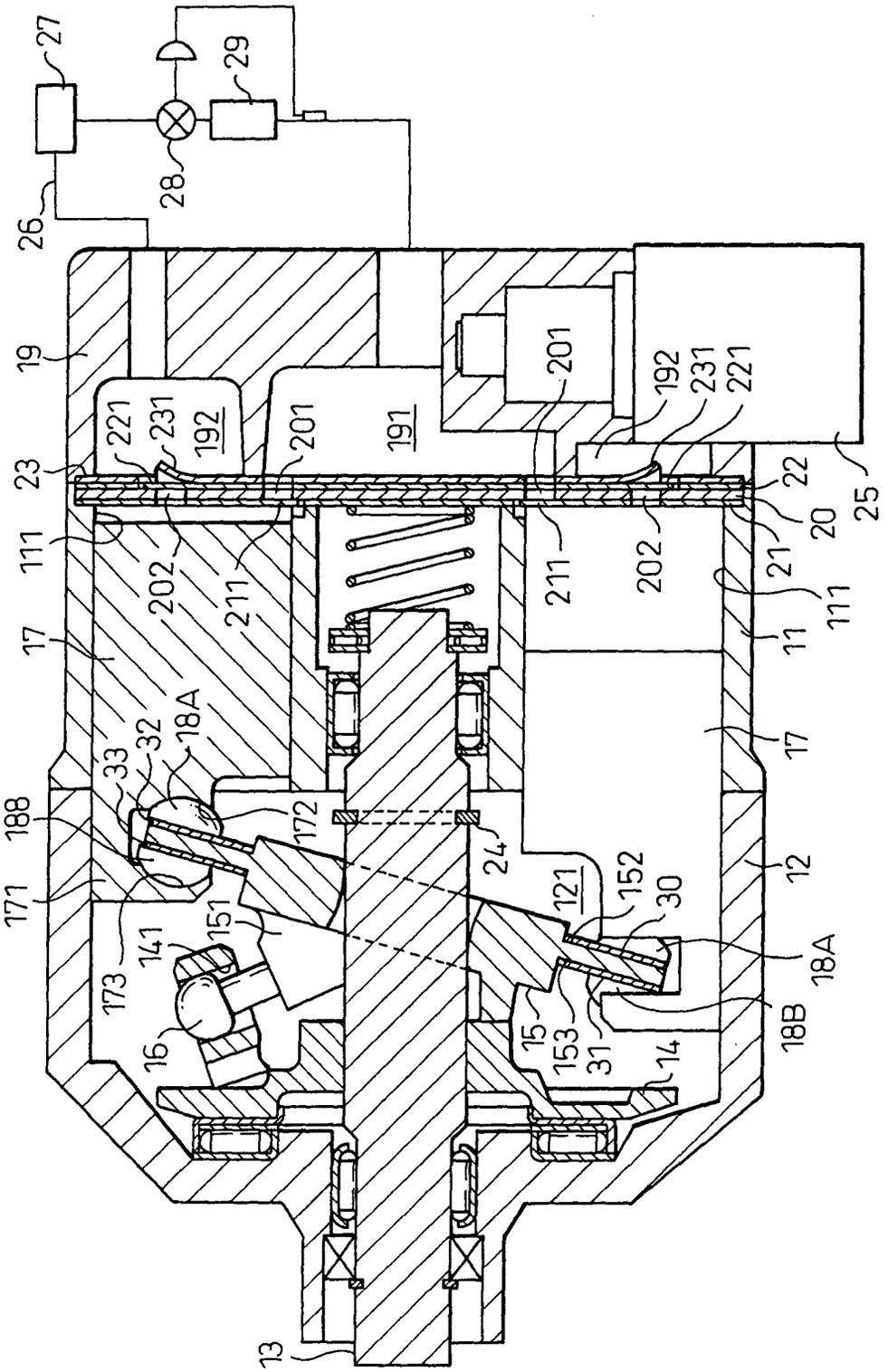
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Fig.1B

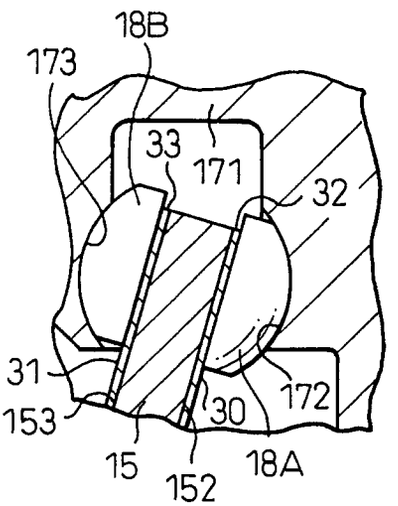

Fig.2A

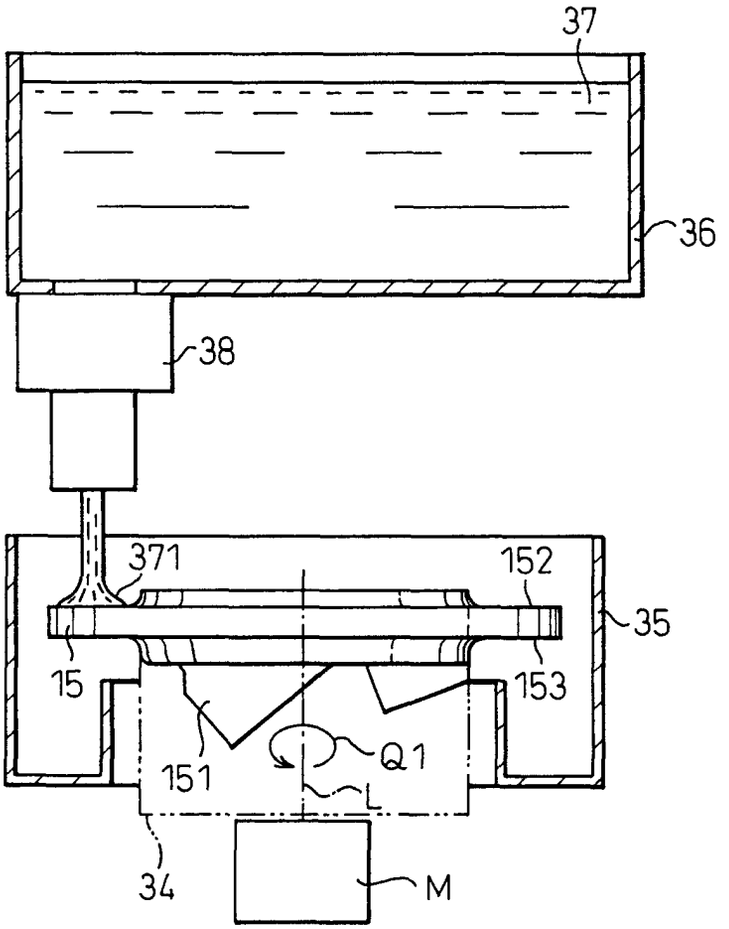

Fig.2B

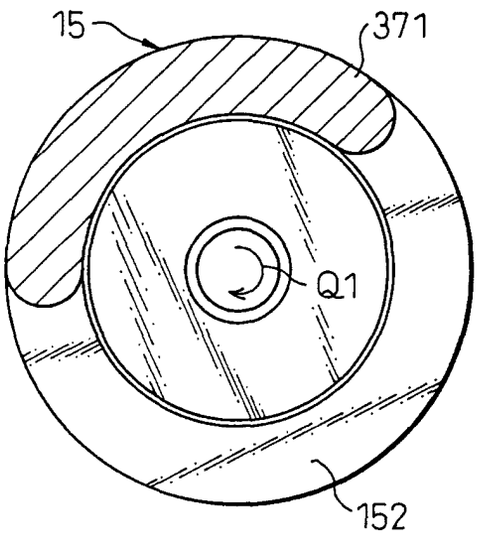

Fig.3A

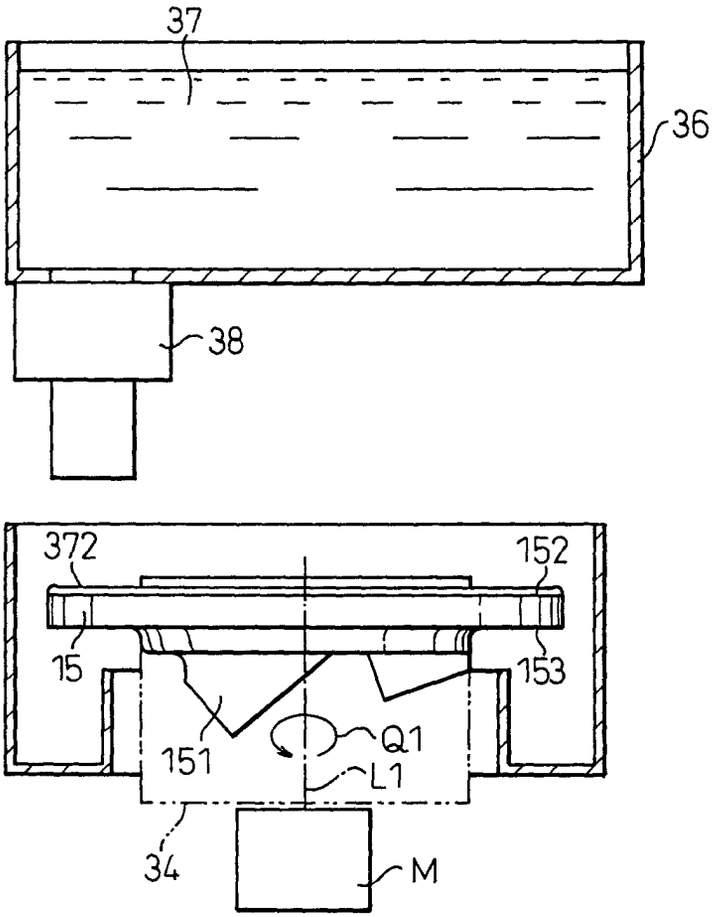

Fig.3B

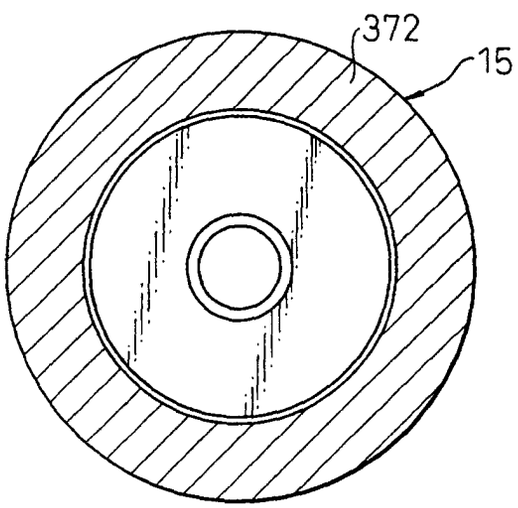

Fig.4

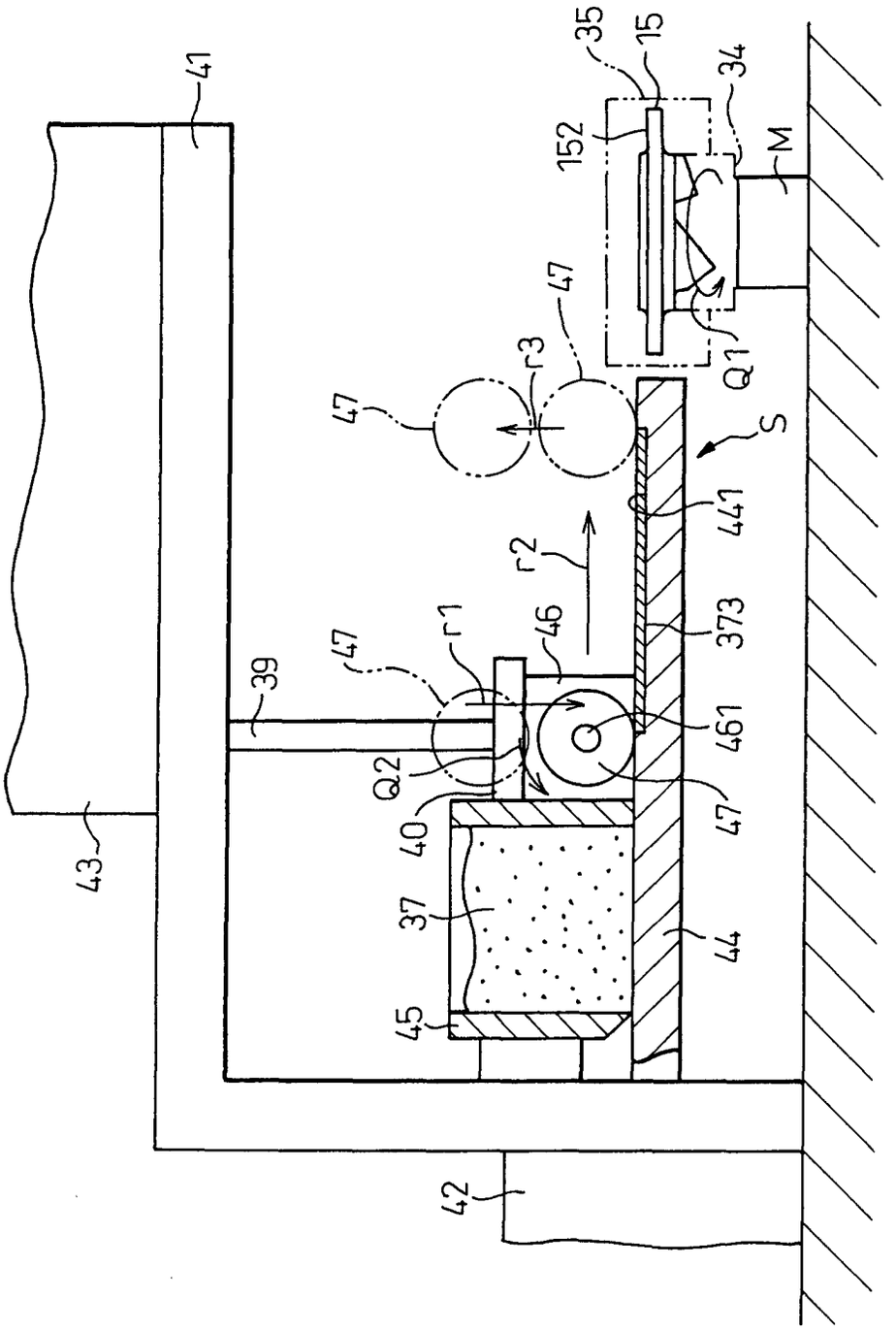
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Fig.5

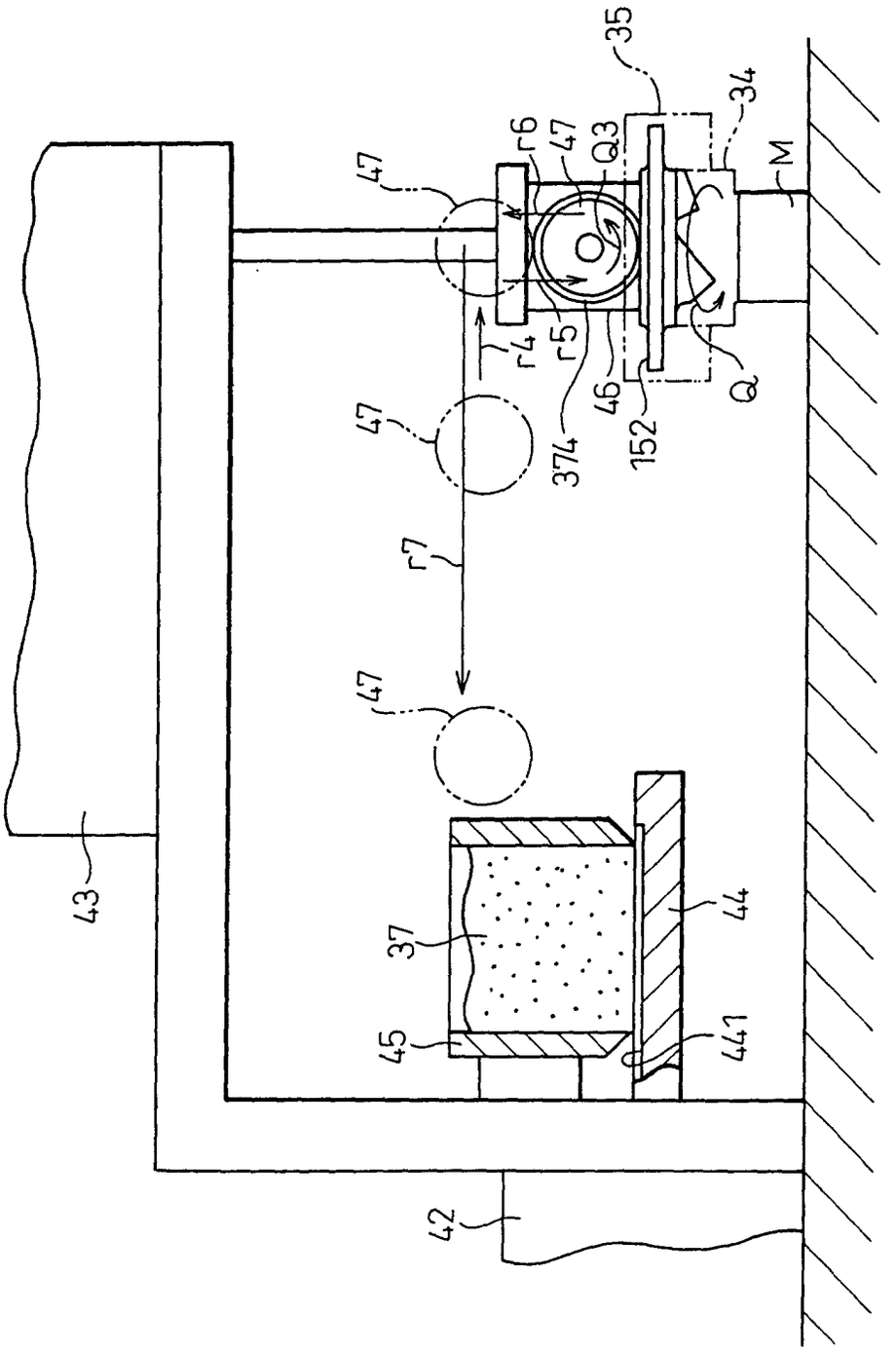

Fig.6A

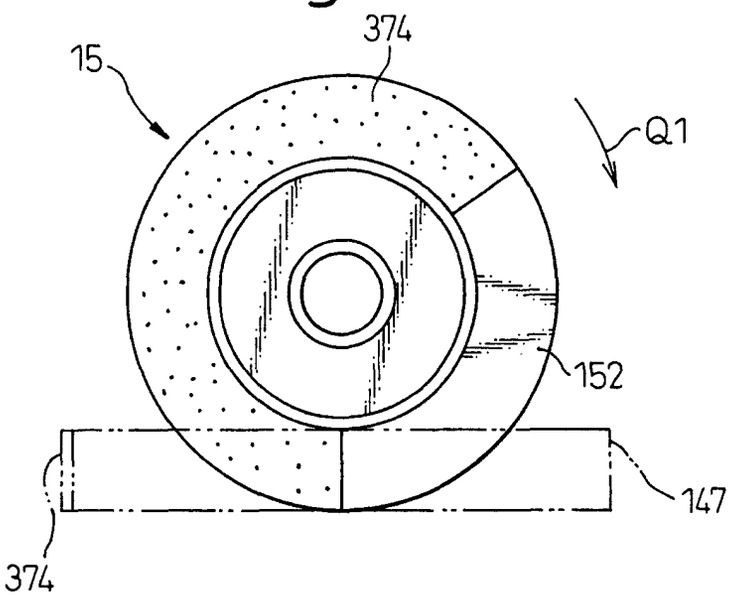

Fig.6B