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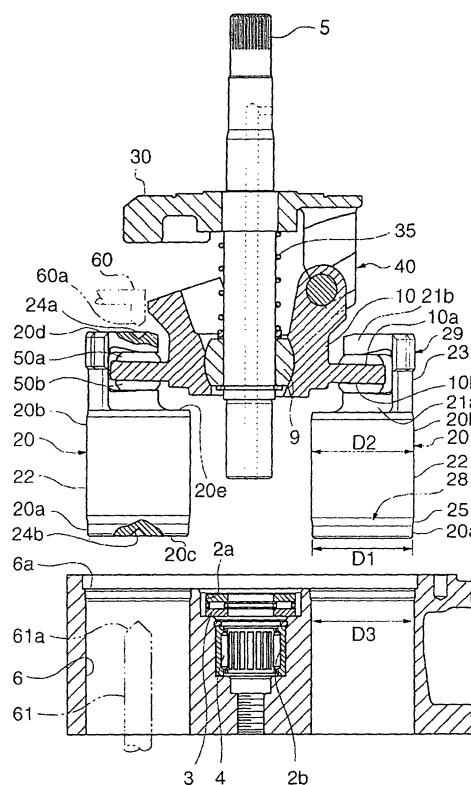
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(54) **VARIABLE DISPLACEMENT TYPE COMPRESSOR**

(57) In a variable capacity compressor including a cylinder block 1 having a plurality of cylinder bores 6, a shaft 5 rotatably supported in a central portion of the cylinder block 1, a swash plate 10 mounted on the shaft 5, for rotation in unison with the shaft 5, and a plurality of pistons 20 connected to the swash plate 10, for performing linear reciprocating motion within the cylinder bore 6 by rotation of the swash plate 10, a guide portion 28 for guiding the piston 20 into the cylinder bore 6 when the piston 20 is assembled in the cylinder bore 6, is formed on a top face-side end 20a of the hollow cylindrical portion 22 of the piston 20.

FIG. 1



EP 1 264 987 A1

Description

Technical Field

[0001] This invention relates to a variable capacity compressor whose delivery quantity varies with changes in the inclination angle of a swash plate thereof, such as a variable capacity swash plate compressor.

Background Art

[0002] A conventional variable capacity swash plate compressor includes a cylinder block having a plurality of cylinder bores, a shaft rotatably supported in a central portion of the cylinder block, a swash plate mounted on the shaft, for rotation in unison with the shaft, and a plurality of pistons connected to the swash plate, for reciprocation within the respective cylinder bores by rotation of the swash plate.

[0003] FIG. 5 is a side view of a piston of the conventional variable capacity swash plate compressor.

[0004] The piston 520 has a hollow cylindrical portion 522, shoe support portions 521a, 521b formed on the side of a bottom face 520e of the hollow cylindrical portion 522, and a bridge portion 523 connecting the shoe support portions 521a, 521b.

[0005] When the shaft rotates, the swash plate also rotates in unison with the shaft. As the swash plate rotates, the swash plate applies a load to the piston 520 via shoes to cause the piston 520 to slide within the cylinder bore 506.

[0006] During operation of the compressor, oil contained in the refrigerant is attached to the inner peripheral surface of the cylinder bore 506. This oil is uniformly attached to the outer peripheral surface of the hollow cylindrical portion 522, when the opposite ends of the piston 520 (top face 520c and bottom face 520e) are perpendicular to the axis of the cylinder bore 506.

[0007] However, the problem is that when the axis of the piston 520 is inclined relative to the axis of the cylinder bore 506, the slidability of the piston 520 is lowered, which makes so-called galling liable to occur.

[0008] To prevent the galling, a top face-side end 522a and a bottom face-side end 522b of the hollow cylindrical portion 522 are chamfered. Further, as for the cylinder block 501, a bottom dead center-side opening 506a of the cylinder bore 506 is chamfered.

[0009] By the way, when the piston 520 is assembled with the cylinder block 501, the cylinder block 501 is placed below the piston 520, and then the piston 520 is inserted into the cylinder bore 506 with the top face 520c inside.

[0010] However, the center of gravity of the piston 520 suspended from the periphery of the swash plate via the shoes is toward the top face 520c, and hence when the piston 520 is being assembled with the cylinder block 501, a plurality of the pistons 520 are inclined such that the respective top faces 520c of the pistons 520 draw

nearer, so that the axis of the piston 520 and the axis of the cylinder bore do not agree with each other.

[0011] This makes it necessary to perform centering operation to cause the axis of the piston 520 and that of the cylinder bore 506 to agree with each other, and the assembly work takes much time.

[0012] Particularly with a swash plate compressor using single-headed pistons as shown in FIG. 5, it is required to insert a plurality of pistons 520 into the respective cylinder bores 506 at a time, which takes more time to carry out the assembly work, and makes the pistons 520 and the cylinder bores 506 liable to scoring and galling.

[0013] It is an object of the present invention to provide a variable capacity compressor whose pistons can be smoothly assembled in cylinder bores without causing scoring or galling of the pistons and the cylinder bores.

Disclosure of Invention

[0014] To attain the above object, the invention provides a variable capacity compressor including a cylinder block having a plurality of cylinder bores, a shaft rotatably supported in a central portion of the cylinder block, a rotational inclined plate mounted on the shaft, for rotation in unison with the shaft, and a plurality of pistons each having a connecting portion connected to the rotational inclined plate, and a hollow cylindrical portion assembled in the cylinder bore, for performing linear reciprocating motion within the cylinder bore by rotation of the rotational inclined plate, wherein a guide portion for guiding the piston into the cylinder bore when the hollow cylindrical portion of the piston is assembled therein is provided on the hollow cylindrical portion of the piston.

[0015] As described above, a guide portion for guiding the piston into the cylinder bore when the hollow cylindrical portion of the piston is assembled therein is provided on the hollow cylindrical portion of the piston. Therefore, by the action of the guide portion, the hollow cylindrical portion is smoothly inserted into the cylinder bore. Therefore, it is possible to positively prevent the pistons and the cylinder bores from scoring or galling during assembly work, and reduce time for the assembly of the pistons with the cylinder block to improve the ease of assembly work.

[0016] Preferably, the guide portion has a top face-side end having a diameter smaller than a diameter of a bottom face-side end of the hollow cylindrical portion.

[0017] As described above, the guide portion has a top face-side end having a diameter smaller than a diameter of a bottom face-side end of the hollow cylindrical portion. Therefore, during assembly, the hollow cylindrical portion can be easily inserted into the cylinder bore.

[0018] Preferably, the guide portion is formed between the bottom face-side end and the top face-side

end, and has a tapered surface portion gently sloping down from the bottom face-side end to the top face-side end.

[0019] As described above, the guide portion is formed between the bottom face-side end and the top face-side end, and has a tapered surface portion gently sloping down from the bottom face-side end to the top face-side end. Therefore, the hollow cylindrical portion enters the cylinder bore following the slope of the tapered surface portion. This makes it possible to smoothly insert the hollow cylindrical portion into the cylinder bore.

[0020] Preferably, the guide portion has a top face-side end having a diameter smaller than a diameter of a bottom face-side end of the hollow cylindrical portion, and the guide portion is formed between the bottom face-side end and the top face-side end, and has a tapered surface portion gently sloping down from the bottom face-side end to the top face-side end.

[0021] Preferably, the guide portion is positioned within the cylinder bore when the piston is at a maximum stroke and at a bottom dead center position and at a bottom dead center position.

[0022] As described above, the guide portion is positioned within the cylinder bore when the piston is at a maximum stroke and at a bottom dead center position. Therefore, even when the piston is at the maximum stroke and at the bottom dead center position, the piston is not liable to be inclined with respect to the central axis of the cylinder bore. Therefore, it is possible to prevent the piston from being inclined.

[0023] Preferably, the guide portion has a top face-side end having a diameter smaller than a diameter of a bottom face-side end of the hollow cylindrical portion, and the guide portion is positioned within the cylinder bore when the piston is at a maximum stroke and at a bottom dead center position.

[0024] Preferably, the guide portion is formed between the bottom face-side end and the top face-side end, and has a tapered surface portion gently sloping down from the bottom face-side end to the top face-side end, and the guide portion is positioned within the cylinder bore when the piston is at a maximum stroke and at a bottom dead center position.

[0025] Preferably, the guide portion has a top face-side end having a diameter smaller than a diameter of a bottom face-side end of the hollow cylindrical portion, and the guide portion is formed between the bottom face-side end and the top face-side end, and has a tapered surface portion gently sloping down from the bottom face-side end to the top face-side end, the guide portion being positioned within the cylinder bore when the piston is at a maximum stroke and at a bottom dead center position..

[0026] Particularly, the invention is effective for a variable capacity compressor wherein a piston ring is fitted on the hollow cylindrical portion.

[0027] When the hollow cylindrical portion is assembled with the cylinder block, first, the top face-side end of the hollow cylindrical portion is inserted into a bottom dead center-side opening of the cylinder bore, and thereafter, the hollow cylindrical portion can be inserted until the bottom face-side end is within the cylinder bore while forcing the piston ring into a ring groove against the resilience of the piston ring. Therefore, even if the piston ring is fitted on the hollow cylindrical portion, it is possible to more positively prevent the piston and the cylinder bore from galling, and at the same time reduce the time for assembling the piston and the cylinder block to improve the ease of assembly work.

[0028] Particularly, the invention is effective for a variable capacity compressor wherein the guide portion has a top face-side end having a diameter smaller than a diameter of a bottom face-side end of the hollow cylindrical portion, and wherein a piston ring is fitted on the hollow cylindrical portion.

[0029] Particularly, the invention is effective for a variable capacity compressor wherein the guide portion is formed between the bottom face-side end and the top face-side end, and has a tapered surface portion gently sloping down from the bottom face-side end to the top face-side end, and wherein a piston ring is fitted on the hollow cylindrical portion.

[0030] Particularly, the invention is effective for a variable capacity compressor wherein the guide portion is positioned within the cylinder bore when the piston is at a maximum stroke and at a bottom dead center position, and wherein a piston ring is fitted on the hollow cylindrical portion.

[0031] Particularly, the invention is effective for a variable capacity compressor wherein the guide portion has a top face-side end having a diameter smaller than a diameter of a bottom face-side end of the hollow cylindrical portion, and wherein the guide portion is formed between the bottom face-side end and the top face-side end, and has a tapered surface portion gently sloping down from the bottom face-side end to the top face-side end, and wherein a piston ring is fitted on the hollow cylindrical portion.

[0032] Particularly, the invention is effective for a variable capacity compressor, and wherein the guide portion is formed between the bottom face-side end and the top face-side end, and has a tapered surface portion gently sloping down from the bottom face-side end to the top face-side end, and wherein the guide portion is positioned within the cylinder bore when the piston is at a maximum stroke and at a bottom dead center position, and wherein a piston ring is fitted on the hollow cylindrical portion.

[0033] Particularly, the invention is effective for a variable capacity compressor wherein the guide portion has a top face-side end having a diameter smaller than a diameter of a bottom face-side end of the hollow cylindrical portion, and wherein the guide portion is positioned within the cylinder bore when the piston is at a maximum stroke and at a bottom dead center position,

and wherein a piston ring is fitted on the hollow cylindrical portion.

and wherein a piston ring is fitted on the hollow cylindrical portion.

[0034] Particularly, the invention is effective for a variable capacity compressor wherein the guide portion has a top face-side end having a diameter smaller than a diameter of a bottom face-side end of the hollow cylindrical portion, and wherein the guide portion is formed between the bottom face-side end and the top face-side end, and has a tapered surface portion gently sloping down from the bottom face-side end to the top face-side end, and wherein the guide portion is positioned within the cylinder bore when the piston is at a maximum stroke and at a bottom dead center position, and wherein a piston ring is fitted on the hollow cylindrical portion.

[0035] Preferably, a piston ring is fitted on the hollow cylindrical portion, and the piston ring is fitted on an axially central portion of the top face-side end of the hollow cylindrical portion.

[0036] As described above, a piston ring is fitted on the hollow cylindrical portion, and the piston ring is fitted on an axially central portion of the top face-side end of the hollow cylindrical portion. Therefore, the guide portion can be increased in size in an axial direction, and the piston can be smoothly inserted into the cylinder bore along the guide portion.

[0037] Preferably, the guide portion has a top face-side end having a diameter smaller than a diameter of a bottom face-side end of the hollow cylindrical portion, and a piston ring is fitted on the hollow cylindrical portion, the piston ring being fitted on an axially central portion of the top face-side end of the hollow cylindrical portion.

[0038] Preferably, a piston ring is fitted on the hollow cylindrical portion, and the piston ring is fitted on an axially central portion of the top face-side end of the hollow cylindrical portion.

[0039] Preferably, the guide portion is formed between the bottom face-side end and the top face-side end, and has a tapered surface portion gently sloping down from the bottom face-side end to the top face-side end, and a piston ring is fitted on the hollow cylindrical portion, the piston ring being fitted on an axially central portion of the top face-side end of the hollow cylindrical portion.

[0040] Preferably, the guide portion is positioned within the cylinder bore when the piston is at a maximum stroke and at a bottom dead center position, and a piston ring is fitted on the hollow cylindrical portion, the piston ring being fitted on an axially central portion of the top face-side end of the hollow cylindrical portion.

[0041] Preferably, the guide portion has a top face-side end having a diameter smaller than a diameter of a bottom face-side end of the hollow cylindrical portion, and the guide portion is formed between the bottom face-side end and the top face-side end, and has a tapered surface portion gently sloping down from the bottom face-side end to the top face-side end, a piston ring being fitted on the hollow cylindrical portion, the piston

ring being fitted on an axially central portion of the top face-side end of the hollow cylindrical portion.

[0042] Preferably, the guide portion is formed between the bottom face-side end and the top face-side end, and has a tapered surface portion gently sloping down from the bottom face-side end to the top face-side end, the guide portion being positioned within the cylinder bore when the piston is at a maximum stroke and at a bottom dead center position, a piston ring being fitted on the hollow cylindrical portion, the piston ring being fitted on an axially central portion of the top face-side end of the hollow cylindrical portion.

[0043] Preferably, the guide portion has a top face-side end having a diameter smaller than a diameter of a bottom face-side end of the hollow cylindrical portion, and the guide portion is positioned within the cylinder bore when the piston is at a maximum stroke and at a bottom dead center position, a piston ring being fitted on the hollow cylindrical portion, the piston ring being fitted on an axially central portion of the top face-side end of the hollow cylindrical portion.

[0044] Preferably, the guide portion has a top face-side end having a diameter smaller than a diameter of a bottom face-side end of the hollow cylindrical portion, and the guide portion is formed between the bottom face-side end and the top face-side end, and has a tapered surface portion gently sloping down from the bottom face-side end to the top face-side end, the guide portion being positioned within the cylinder bore when the piston is at maximum stroke and at a bottom dead center position during, a piston ring being fitted on the hollow cylindrical portion, the piston ring being fitted on an axially central portion of the top face-side end of the hollow cylindrical portion.

[0045] A variable capacity compressor according to the invention includes a cylinder block having a plurality of cylinder bores, a shaft rotatably supported in a central portion of the cylinder block, a rotational inclined plate mounted on the shaft, for rotation in unison with the shaft, and a plurality of pistons each connected to the rotational inclined plate, for performing linear reciprocating motion within the cylinder bore by rotation of the rotational inclined plate, wherein recesses for use in centering are formed in a top face of the piston and a bottom dead center-side end face of the piston, respectively.

[0046] The piston can be inserted into the cylinder bore by causing a jig to abut the recess in the top face of the piston, and the axis of the piston can be caused to agree with the axis of the cylinder bore by causing a jig to fit in and abut the recess in the bottom dead center-side end face of the piston. Therefore, when the piston is inserted into the cylinder bore, the axis of the piston accurately agrees with the axis of the cylinder bore, so that the piston can be smoothly inserted into the cylinder bore. Therefore, it is possible to positively prevent the pistons and the cylinder bores from scoring or galling during assembly work, and reduce time for the assembly

of the pistons with the cylinder block to improve the ease of assembly work.

[0047] A variable capacity compressor according to the invention includes a cylinder block having a plurality of cylinder bores, a shaft rotatably supported in a central portion of the cylinder block, a rotational inclined plate mounted on the shaft, for rotation in unison with the shaft, and a plurality of pistons each connected to the rotational inclined plate, for performing linear reciprocating motion within the cylinder bore by rotation of the rotational inclined plate, wherein a diameter of a downstream-side opening of the cylinder bore is made larger than a diameter of the piston.

[0048] When the piston is assembled with the cylinder block, the piston is inserted into a bottom dead center-side opening of the cylinder bore with the top face-side end thereof inside. At this time, since the diameter of the bottom dead center-side opening of the cylinder bore is larger than the diameter of the top face-side end of the piston, the piston can be inserted into the cylinder bore without difficulty. Therefore, it is possible to positively prevent the pistons and the cylinder bores from scoring or galling during assembly work, and reduce time for the assembly of the pistons with the cylinder block to improve the ease of assembly work. Further, it is possible to work the piston more easily.

Brief Description of Drawings

[0049]

FIG. 1 is a cross-sectional view for explaining assembly of a piston with a cylinder block of a variable capacity swash plate compressor according to a first embodiment of the present invention;

FIG. 2 is an enlarged side view of the piston of the variable capacity swash plate compressor according to the first embodiment of the present invention;

FIG. 3 is a side view of a piston of a variable capacity swash plate compressor according to a second embodiment of the present invention;

FIG. 4 is a side view of a piston according to a variation of the second embodiment of the present invention; and

FIG. 5 is a side view of a piston of a conventional variable capacity swash plate compressor.

Best Mode for Carrying Out the Invention

[0050] The invention will now be described in detail with reference to drawings showing a preferred embodiment thereof.

[0051] FIG. 1 is a cross-sectional view for explaining assembly of a piston with a cylinder block of a variable capacity swash plate compressor according to a first embodiment of the present invention, and FIG. 2 is an enlarged side view of the piston.

[0052] The variable capacity swash plate compressor

includes a cylinder block 1, a swash plate (rotational inclined plate) 10, and a plurality of pistons 20.

[0053] The cylinder block 1 has a large-diameter hole 2a and a small-diameter hole 2b extending along the center line of the cylinder block 1. The large-diameter hole 2a has a thrust bearing 3 received therein, and the small-diameter hole 2b has a radial bearing 4 received therein.

[0054] The cylinder block 1 has a plurality of cylinder bores 6 extending therethrough at predetermined circumferential intervals about the center line of the cylinder block 1 (only two cylinder bores 6 are shown in FIG. 1).

[0055] The shaft 5 is rotatably supported in the large-diameter hole 2a and the small-diameter hole 2b of the cylinder block 1. A thrust flange 30 is fixed to a front-side end of the shaft 5.

[0056] The swash plate 10 is rotatably mounted on the shaft 5 via a hinge ball 9, and at the same time, connected to the thrust flange 30 via a hinge mechanism 40.

[0057] Interposed between the thrust flange 30 and the swash plate 10 is a spring 35 for urging the swash plate 10 in a direction of decreasing the inclination angle of the swash plate 10.

[0058] Each piston 20 has a hollow cylindrical portion 22 and a connecting portion 29. The connecting portion 29 is provided on a bottom face 20e side of the hollow cylindrical portion 22. The hollow cylindrical portion 22 is slidable within the cylinder bore 6. The connecting portion 29 is comprised of shoe support portions 21a, 21b, and a bridge portion 23 connecting the shoe support portions 21a, 21b. Further, the connecting portion 29 is connected to the swash plate 10 via a pair of shoes 50a, 50b having a semispherical shape. The piston 20 performs linear reciprocating motion within the cylinder bore 6 by rotation of the swash plate 10.

[0059] The shoes 50a, 50b are supported by the shoe support portions 21a, 21b of the piston 20 such that they can relatively slide on a front-side sliding surface 10a and a rear-side sliding surface 10b of the swash plate 10.

[0060] The hollow cylindrical portion 22 of the piston 20 is formed with a guide portion 28. The guide portion 28 guides the piston 20 into the cylinder bore 6 when the piston 20 is assembled in the cylinder bore 6. The guide portion 28 is formed between a bottom face-side end 20b and a top face-side end 20a of the hollow cylinder 22, and has a tapered surface portion 25 which gently slopes down from the bottom face-side end 20b to the top face-side end 20a. The guide portion 28 (top face-side end 20a) has a diameter D1 which is smaller than a diameter D2 of the bottom face-side end 20b of the hollow cylindrical portion 22. The top face-side end 20a and the bottom face-side end 20b of the hollow cylindrical portion 20 are divided e.g. by the tapered surface portion 25 as a border. Assuming that the cylinder bore 6 has a diameter D3, the relationship between the diameter D1 of the guide portion 28 of the hollow cylin-

dricial portion 20, the diameter D2 of the bottom face-side end 20b, and the diameter D3 of the cylinder bore 6 is defined as:

$$D3 - D2 < D3 - D1$$

[0061] The piston 20 is not liable to be inclined with respect to the central axis of the cylinder bore 6, since the guide portion 28 is positioned within the cylinder bore 6 even when the piston is at maximum stroke and at the bottom dead center position.

[0062] The top face 20c of the piston 20 and the bottom dead center-side end face 20d of the same are formed with recesses 24b, 24a for use in centering, respectively. The recesses 24b, 24a have a shape of a cone, a hollow cylinder, or the like.

[0063] It should be noted that the extreme end of the top face-side end 20a and that of the bottom face-side end 20b of the hollow cylindrical portion are chamfered. Further, as for the cylinder block, the bottom dead center-side opening 6a of the cylinder bore 6 is chamfered.

[0064] Next, a procedure of assembling the piston 20 with the cylinder block 1 will be described with reference to FIG. 1. In the assembly work, movable guide jigs 60, 61 are used for centering.

[0065] First, members including the hinge ball 9, the swash plate 10, the shoes 50a, 50b, the pistons 20 and the thrust flange 30 are mounted on the shaft 5. At this time, as shown in FIG. 1, the pistons 20 are suspended from the swash plate 10.

[0066] Next, the pistons 20 etc. are placed above the cylinder block 1, to cause the respective top faces 20c of the pistons 20 to face the cylinder bores 6 of the cylinder block 1.

[0067] Next, an abutment portion 60a of the movable guide jig 60 positioned above is fitted in the recess 24a in the bottom dead center-side end face 20d, to cause the axis of each piston 20 to agree with the axis of the cylinder bore 6, and then the movable guide jig 60 is pushed downward. At this time, the guide portion 28 of the piston 20 acts as a guide, and the piston 20 is inserted into the cylinder bore 6.

[0068] Thereafter, an abutment portion 61a of the movable guide jig 61 positioned below is fitted in the recess 24b in the top face 20c of the piston 20 inserted into the cylinder bore 6, and the piston 20 is inserted into the cylinder bore 6 until the bottom face-side end 20b is within the cylinder bore 6 while preventing the piston 20 from being inclined with the help of the movable guide jig 61. As a result, the hollow cylindrical portion 22 is inserted into the cylinder bore 6 along the slope of the tapered surface portion 25b.

[0069] By the above procedure, the plurality of pistons are assembled with the cylinder block 1, at a time.

[0070] It should be noted that a rear-side end of the shaft 5 is supported by the thrust bearing 3 and the radial bearing 4.

[0071] According to this embodiment, the piston 20 can be smoothly inserted into the cylinder bore 6, whereby the time for assembly of the pistons 20 with cylinder block 1 is reduced and the ease of assembly work is improved.

[0072] Further, the piston 20 and the cylinder bore 6 can be assembled such that their axes accurately agree with each other. Therefore, it is possible to more positively prevent the pistons 20 and the cylinder bores 6 from scoring or galling.

[0073] Further, since the piston 20 is not liable to be inclined with respect to the central axis of the cylinder bore 6, it is possible to prevent the piston 20 from being inclined even when the piston is at maximum stroke and at the bottom dead center position.

[0074] FIG. 3 is a side view of a piston of a variable capacity swash plate compressor according to a second embodiment of the present invention. However, a piston 126 is shown as a cross section. Component parts similar to those of the first embodiment are designated by identical reference numerals, and description thereof will be omitted.

[0075] This embodiment is distinguished from the above embodiment in that a top face-side end 120a of a hollow cylindrical portion 122 has a piston ring 126 fitted thereon.

[0076] The piston ring 126 has an inner diameter equal to an inner diameter of a groove 127 formed in the outer peripheral surface of the top face-side end 120a of the hollow cylindrical portion 122, and is mounted in the groove 127 with opposed ends of a split thereof being separate from each other.

[0077] The piston 120 as well can be assembled with the cylinder block 1 in the same manner as described above.

[0078] It should be noted that although the diameter of the piston ring 126 assumed when the piston ring 126 is fitted in the groove 127 can be larger than that of the bottom face-side end 120b, in this case, it is only required to push the piston 120 into the cylinder bore 6 while forcing the piston ring 126 into the ring groove 127 against the resilience thereof.

[0079] According to this embodiment, even when the piston ring 126 is fitted on the hollow cylindrical portion 122, it is possible to prevent the piston 120 and the cylinder bore from scoring or galling during assembly work.

[0080] Further, although the clearance between the guide portion 128 and the cylinder bore 6 is larger than that between the bottom face-side end 120b of the hollow cylindrical portion 122 and the cylinder bore 6, the piston ring 126 seals between the guide portion 128 and the cylinder bore 6, whereby it is possible to prevent leakage of refrigerant.

[0081] It should be noted that in the above second embodiment, description is given of a case in which the piston ring 128 is provided on the top face-side end 120a of the hollow cylindrical portion 22 of the piston 120, this is not limitative, but it may be provided on the bottom

face-side end 120b of the hollow cylindrical portion 22.

[0082] FIG. 4 is a side view of a piston according to a variation of the second embodiment. Component parts similar to those of the first embodiment are designated by identical reference numerals and description thereof will be omitted.

[0083] This variation is distinguished from the second embodiment in that a piston ring 226 is fitted on an axially central portion of a top face-side end 220 of a hollow cylindrical portion 220.

[0084] According to this variation, since the axial dimension of the top face-side end 220a is larger than that of the second embodiment, the time for assembly of the pistons with the cylinder block 1 is reduced, and the ease of assembly work is further improved.

[0085] Although not shown, instead of making the diameter of the top face-side end of the piston smaller than that of the bottom face-side end of the piston as in the above embodiments, the diameter of the bottom dead center-side opening of the cylinder bore may be made larger than that of the piston.

[0086] According to this configuration, the same effects as described above can be obtained, and at the same time, the piston can be worked more easily.

[0087] It should be noted that although in the above embodiments, description has been given of cases where the present invention is applied to a variable capacity swash plate compressor, this is not limitative, but the present invention can be applied to other variable capacity compressors, such as a wobble plate compressor.

Industrial Applicability

[0088] As described heretofore, the variable capacity compressor according to the present invention is useful as a refrigerant compressor for an automotive air conditioner, and according to the variable capacity compressor, it is possible to positively prevent pistons and cylinder bores from scoring or galling during assembly work, and reduce time for the assembly of the pistons with a cylinder block to improve the ease of assembly work.

Claims

1. A variable capacity compressor including:

a cylinder block having a plurality of cylinder bores,
a shaft rotatably supported in a central portion of said cylinder block,
a rotational inclined plate mounted on said shaft, for rotation in unison with said shaft, and
a plurality of pistons each having a connecting portion connected to said rotational inclined plate, and a hollow cylindrical portion assem-

bled in said cylinder bore, for performing linear reciprocating motion within said cylinder bore by rotation of said rotational inclined plate,

wherein a guide portion for guiding said piston into said cylinder bore when said hollow cylindrical portion of said piston is assembled therein is provided on said hollow cylindrical portion of said piston.

2. A variable capacity compressor according to claim 1, wherein said guide portion has a top face-side end having a diameter smaller than a diameter of a bottom face-side end of said hollow cylindrical portion.

3. A variable capacity compressor according to claim 1, wherein said guide portion is formed between said bottom face-side end and said top face-side end, and has a tapered surface portion gently sloping down from said bottom face-side end to said top face-side end.

4. A variable capacity compressor according to claim 1, wherein said guide portion has a top face-side end having a diameter smaller than a diameter of a bottom face-side end of said hollow cylindrical portion, and

wherein said guide portion is formed between said bottom face-side end and said top face-side end, and has a tapered surface portion gently sloping down from said bottom face-side end to said top face-side end.

5. A variable capacity compressor according to claim 1, wherein said guide portion is positioned within said cylinder bore when said piston is at a maximum stroke and at a bottom dead center position.

6. A variable capacity compressor according to claim 1, wherein said guide portion has a top face-side end having a diameter smaller than a diameter of a bottom face-side end of said hollow cylindrical portion, and

wherein said guide portion is positioned within said cylinder bore when said piston is at a maximum stroke and at a bottom dead center position.

7. A variable capacity compressor according to claim 1, wherein said guide portion is formed between said bottom face-side end and said top face-side end, and has a tapered surface portion gently sloping down from said bottom face-side end to said top face-side end, and

wherein said guide portion is positioned within said cylinder bore when said piston is at a maximum stroke and at a bottom dead center position.

8. A variable capacity compressor according to claim

- 1, wherein said guide portion has a top face-side end having a diameter smaller than a diameter of a bottom face-side end of said hollow cylindrical portion, and
- wherein said guide portion is formed between said bottom face-side end and said top face-side end, and has a tapered surface portion gently sloping down from said bottom face-side end to said top face-side end, and
- wherein said guide portion is positioned within said cylinder bore when said piston is at a maximum stroke and at a bottom dead center position.
9. A variable capacity compressor according to claim 1, wherein a piston ring is fitted on said hollow cylindrical portion.
10. A variable capacity compressor according to claim 1, wherein said guide portion has a top face-side end having a diameter smaller than a diameter of a bottom face-side end of said hollow cylindrical portion, and
- wherein a piston ring is fitted on said hollow cylindrical portion.
11. A variable capacity compressor according to claim 1, wherein said guide portion is formed between said bottom face-side end and said top face-side end, and has a tapered surface portion gently sloping down from said bottom face-side end to said top face-side end, and
- wherein a piston ring is fitted on said hollow cylindrical portion.
12. A variable capacity compressor according to claim 1, wherein said guide portion is positioned within said cylinder bore when said piston is at a maximum stroke and at a bottom dead center position, and
- wherein a piston ring is fitted on said hollow cylindrical portion.
13. A variable capacity compressor according to claim 1, wherein said guide portion has a top face-side end having a diameter smaller than a diameter of a bottom face-side end of said hollow cylindrical portion, and
- wherein said guide portion is formed between said bottom face-side end and said top face-side end, and has a tapered surface portion gently sloping down from said bottom face-side end to said top face-side end, and
- wherein a piston ring is fitted on said hollow cylindrical portion.
14. A variable capacity compressor according to claim 1, wherein said guide portion is formed between said bottom face-side end and said top face-side end, and has a tapered surface portion gently sloping down from said bottom face-side end to said top face-side end,
- wherein said guide portion is positioned within said cylinder bore when said piston is at a maximum stroke and at a bottom dead center position, and
- wherein a piston ring is fitted on said hollow cylindrical portion.
15. A variable capacity compressor according to claim 1, wherein said guide portion has a top face-side end having a diameter smaller than a diameter of a bottom face-side end of said hollow cylindrical portion, and
- wherein said guide portion is positioned within said cylinder bore when said piston is at a maximum stroke and at a bottom dead center position, and
- wherein a piston ring is fitted on said hollow cylindrical portion.
16. A variable capacity compressor according to claim 1, wherein said guide portion has a top face-side end having a diameter smaller than a diameter of a bottom face-side end of said hollow cylindrical portion, and
- wherein said guide portion is formed between said bottom face-side end and said top face-side end, and has a tapered surface portion gently sloping down from said bottom face-side end to said top face-side end, and
- wherein said guide portion is positioned within said cylinder bore when said piston is at a maximum stroke and at a bottom dead center position, and
- wherein a piston ring is fitted on said hollow cylindrical portion.
17. A variable capacity compressor according to claim 1, wherein a piston ring is fitted on said hollow cylindrical portion, and
- wherein said piston ring is fitted on an axially central portion of said top face-side end of said hollow cylindrical portion.
18. A variable capacity compressor according to claim 1, wherein said guide portion has a top face-side end having a diameter smaller than a diameter of a bottom face-side end of said hollow cylindrical portion, and
- wherein a piston ring is fitted on said hollow cylindrical portion, and
- wherein said piston ring is fitted on an axially central portion of said top face-side end of said hollow cylindrical portion.
19. A variable capacity compressor according to claim 1, wherein said guide portion is formed between said bottom face-side end and said top face-side end, and has a tapered surface portion gently sloping down from said bottom face-side end to said top

face-side end, and

wherein a piston ring is fitted on said hollow cylindrical portion, and

wherein said piston ring is fitted on an axially central portion of said top face-side end of said hollow cylindrical portion.

20. A variable capacity compressor according to claim 1, wherein said guide portion is positioned within said cylinder bore when said piston is at a maximum stroke and at a bottom dead center position, and wherein a piston ring is fitted on said hollow cylindrical portion, and wherein said piston ring is fitted on an axially central portion of said top face-side end of said hollow cylindrical portion.
21. A variable capacity compressor according to claim 1, wherein said guide portion has a top face-side end having a diameter smaller than a diameter of a bottom face-side end of said hollow cylindrical portion, and wherein said guide portion is formed between said bottom face-side end and said top face-side end, and has a tapered surface portion gently sloping down from said bottom face-side end to said top face-side end, and wherein a piston ring is fitted on said hollow cylindrical portion, and wherein said piston ring is fitted on an axially central portion of said top face-side end of said hollow cylindrical portion.
22. A variable capacity compressor according to claim 1, wherein said guide portion is formed between said bottom face-side end and said top face-side end, and has a tapered surface portion gently sloping down from said bottom face-side end to said top face-side end, and wherein said guide portion is positioned within said cylinder bore when said piston is at a maximum stroke and at a bottom dead center position, and wherein a piston ring is fitted on said hollow cylindrical portion, and wherein said piston ring is fitted on an axially central portion of said top face-side end of said hollow cylindrical portion.
23. A variable capacity compressor according to claim 1, wherein said guide portion has a top face-side end having a diameter smaller than a diameter of a bottom face-side end of said hollow cylindrical portion, and wherein said guide portion is positioned within said cylinder bore when said piston is at a maximum stroke and at a bottom dead center position, and wherein a piston ring is fitted on said hollow cylindrical portion, and

wherein said piston ring is fitted on an axially central portion of said top face-side end of said hollow cylindrical portion.

24. A variable capacity compressor according to claim 1, wherein said guide portion has a top face-side end having a diameter smaller than a diameter of a bottom face-side end of said hollow cylindrical portion, and wherein said guide portion is formed between said bottom face-side end and said top face-side end, and has a tapered surface portion gently sloping down from said bottom face-side end to said top face-side end, and wherein said guide portion is positioned within said cylinder bore when said piston is at a maximum stroke and at a bottom dead center position, and wherein a piston ring is fitted on said hollow cylindrical portion, and wherein said piston ring is fitted on an axially central portion of said top face-side end of said hollow cylindrical portion.

25. A variable capacity compressor including:

a cylinder block having a plurality of cylinder bores,
a shaft rotatably supported in a central portion of said cylinder block,
a rotational inclined plate mounted on said shaft, for rotation in unison with said shaft, and
a plurality of pistons each connected to said rotational inclined plate, for performing linear reciprocating motion within said cylinder bore by rotation of said rotational inclined plate,

wherein recesses for use in centering are formed in a top face of said piston and a bottom dead center-side end face of said piston, respectively.

26. A variable capacity compressor including:

a cylinder block having a plurality of cylinder bores,
a shaft rotatably supported in a central portion of said cylinder block,
a rotational inclined plate mounted on said shaft, for rotation in unison with said shaft, and
a plurality of pistons each connected to said rotational inclined plate, for performing linear reciprocating motion within said cylinder bore by rotation of said rotational inclined plate,

wherein a diameter of a downstream-side opening of said cylinder bore is made larger than a diameter of said piston.

FIG. 1

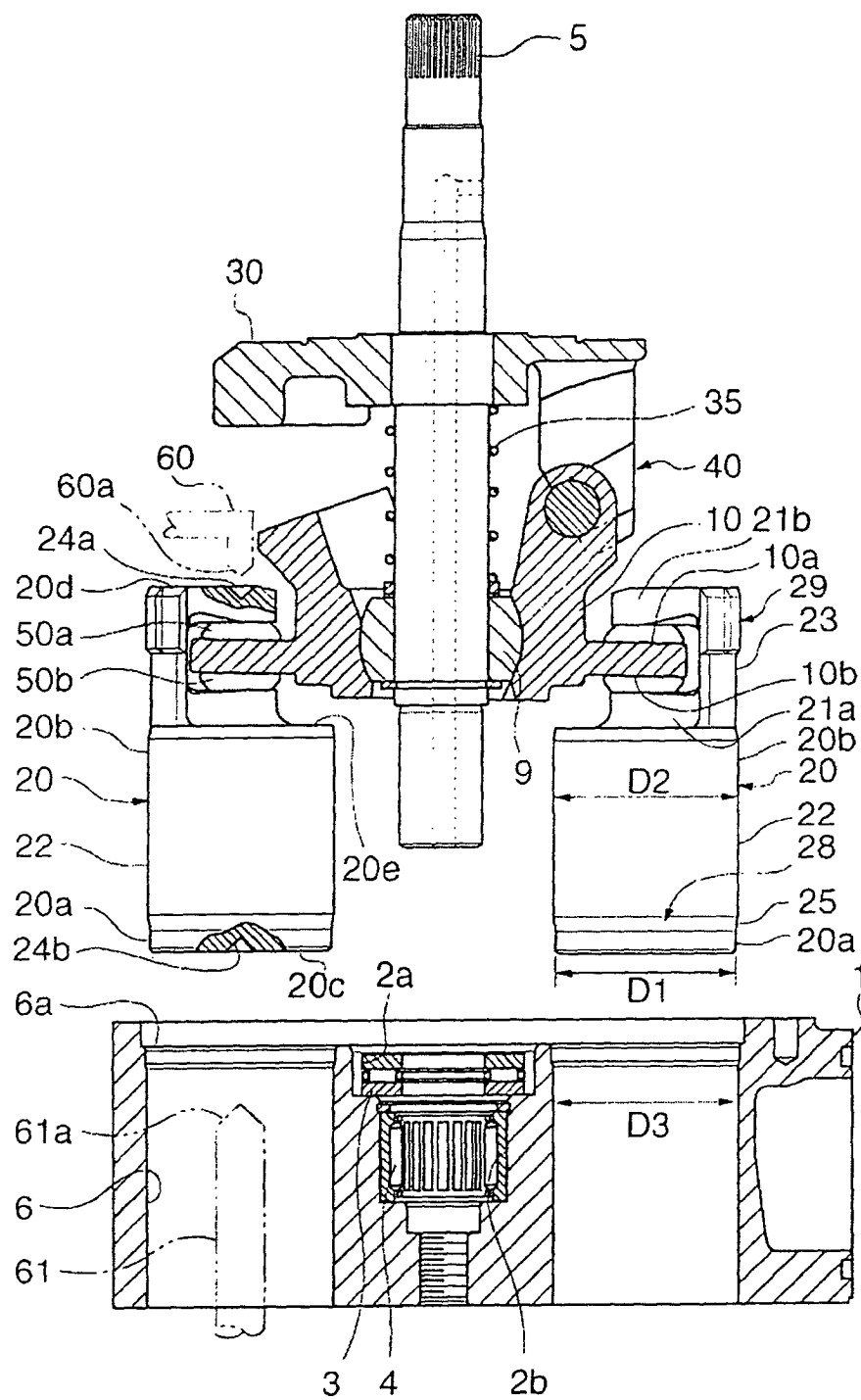


FIG. 2

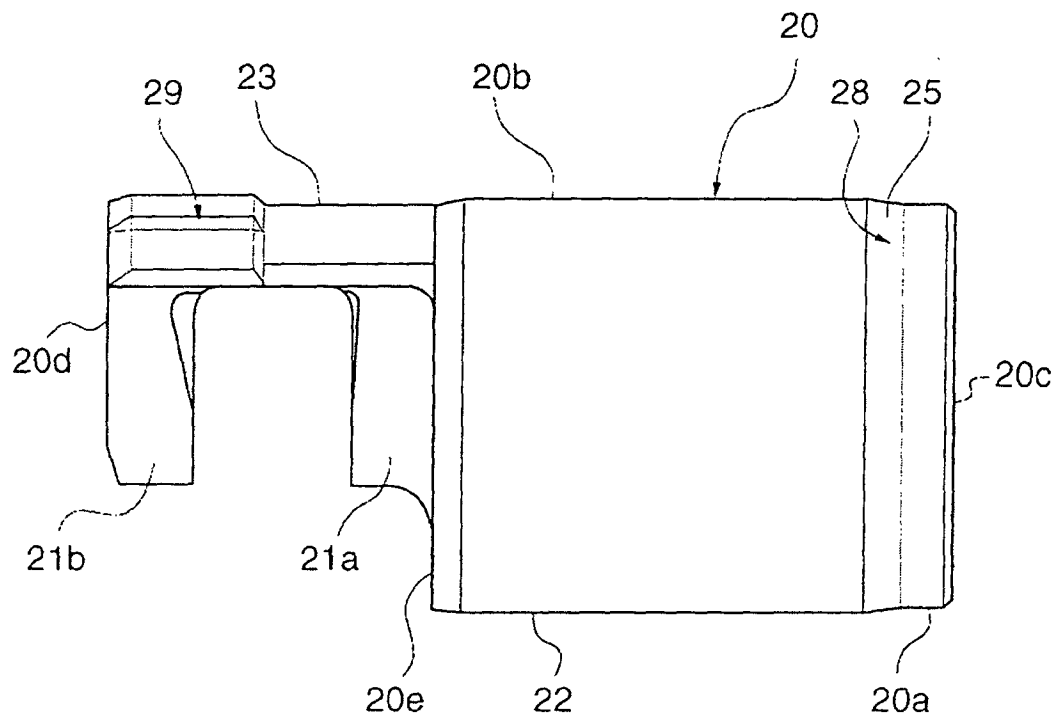


FIG. 3

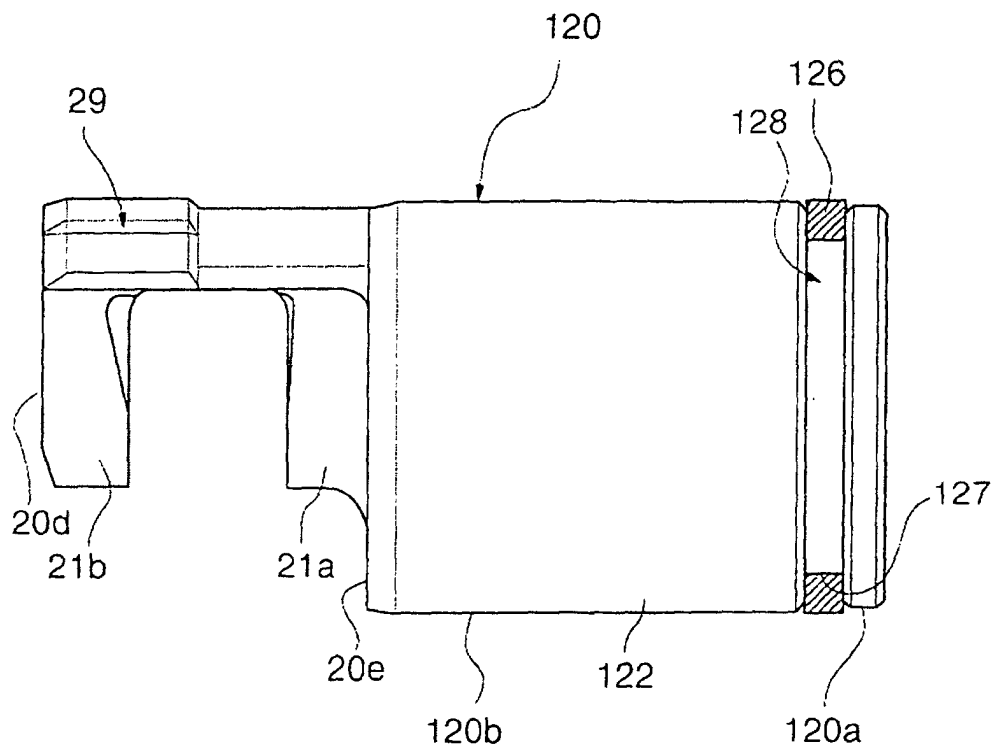


FIG. 4

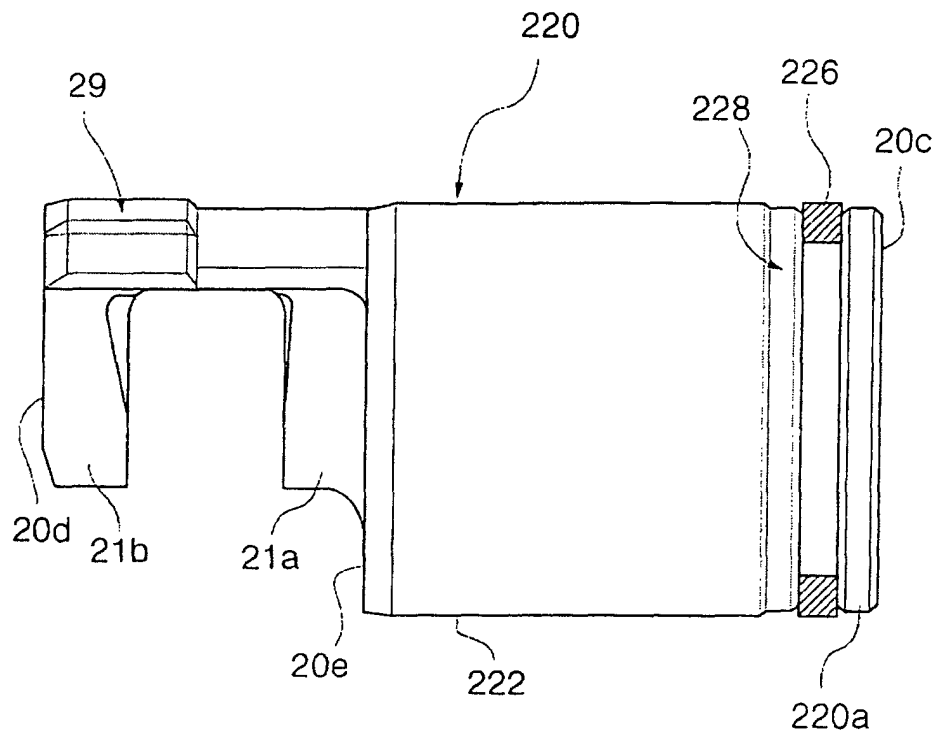
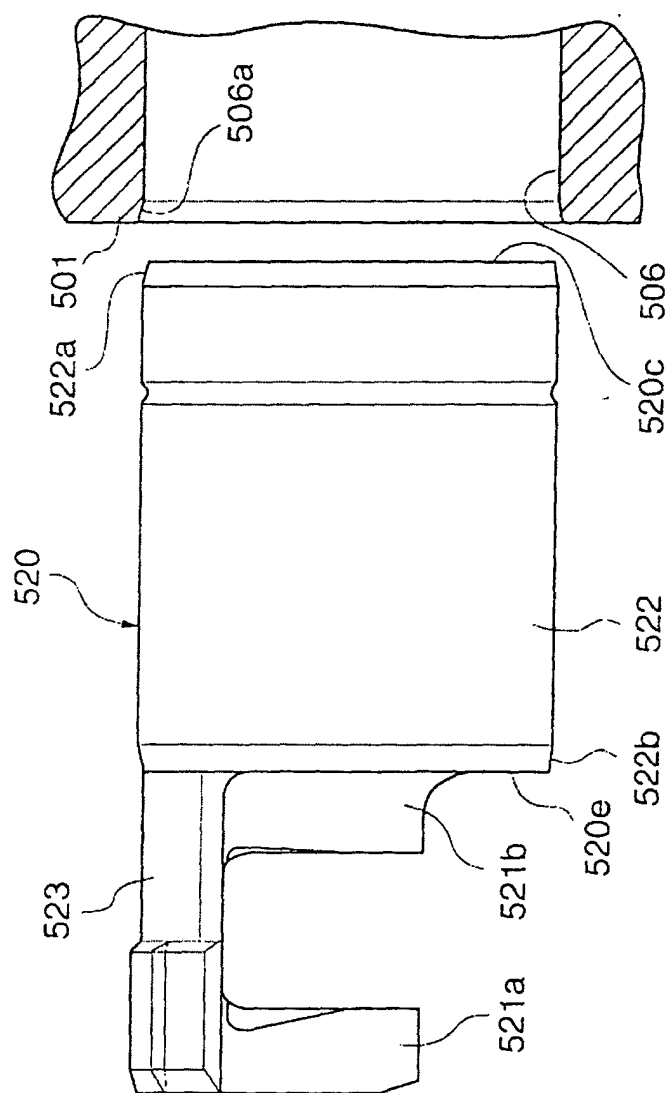


FIG. 5



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP00/06143

A. CLASSIFICATION OF SUBJECT MATTER Int.Cl. ⁷ F04B27/12		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) Int.Cl. ⁷ F04B27/08-27/12		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1922-1996 Toroku Jitsuyo Shinan Koho 1994-2000 Kokai Jitsuyo Shinan Koho 1971-2000 Jitsuyo Shinan Toroku Koho 1996-2000		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP, 9-203379, A (Toyoda Automatic Loom Works, Ltd.), 05 August, 1997 (05.08.97), Full text (Family: none)	1-26
Y	CD-ROM of the specification and drawings annexed to the request of Japanese Utility Model Application No.59459/1991 (Laid-open No.12673/1993) (Toyoda Automatic Loom Works, Ltd.), 19 February, 1993 (19.02.93), Full text (Family: none)	1
Y	JP, 63-25341, Y2 (Toyoda Automatic Loom Works, Ltd.), 11 July, 1988 (11.07.88), Full text (Family: none)	1
☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 05 December, 2000 (05.12.00)		Date of mailing of the international search report 12 December, 2000 (12.12.00)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
Facsimile No.		Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)