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Description

BACKGROUND OF THE INVENTION

[Field of the Invention]

This invention relates to a scroll-type fluid machine that function as a compressor, and more particularly to an oilless scroll-type fluid machine wherein a chip seal is fitted into a seal groove rectangular in cross section formed in a helical wrap end surface opposed to a slide surface of an associated scroll so that the surrounded space between said slide surface and the wrap is sealed with the chip seal.

[Description of the Prior Art]

Scroll-type compressors are known in the art which comprises a stationary scroll having a first wrap formed in an involute spiral located within a casing enclosed by circumferential walls, a suction port and a discharge port formed in the circumferential wall and in the central region respectively and an orbiting scroll having a second wrap formed in an involute spiral capable of mating with the first wrap, wherein the orbiting scroll is orbited without spinning to introduce a gas into the casing from the suction port and to take the gas into a closed space formed between the first wrap and the second wrap, as the orbiting scroll is orbited, the volume of the gas is gradually reduced with the gas being moved toward the center, and the thus compressed high-pressure air can be discharged outside from the discharge port.

As the above scroll-type fluid machine, a single unit scroll-type machine for expanding, compressing, or pumping fluid with a stationery scroll and an orbiting scroll interfitting each other is disclosed, for example, in U.S. Patent No. 4,192,152 and a twin unit scroll-type machine for expanding, compressing, or pumping fluid with a pair of stationary scroll having respectively a wrap inside and with an orbiting scroll having each wrap on both surfaces which are interfitted with the stationary scrolls mating with the wraps is suggested in Japanese Patent Publication 63-42081.

However, in either of the above scroll-type fluid machines, since the wraps of the scrolls have approximately the same number of turns and are mated with each other with the phase displaced 180 degrees, problems described below arise at the suction side as well as the discharge side.

That is, on the suction side, the wrap starting ends situated on the scroll outer circumferential side come in contact with the other wrap side wall surface at the position where the phases are displaced 180 degrees to form a compression chamber, and therefore it is necessary that a suction port is formed at each wrap starting end position, or a semicircular detour in communication with the suction port positioned 180 degrees away is formed on the wrap outer circumferential side, resulting in that the apparatus is made large and the number of steps of producing it increases.

The arrangement of a number of suction ports as described above means that a number of compression chambers with the phases displaced 180 degrees carry out simultaneously the compression step, which makes difficult the high compression, and small the volume of the gas to be taken into the closed space enclosed by the wraps, so that the suction efficiency is not improved.

On the other hand, on the discharge side, since it is necessary to arrange a bearing section where a main shaft (crank shaft) is inserted so as to orbit the orbiting scroll at the central part of the scroll, a wrap terminal end and a discharge port must be disposed on the bearing section outer circumferential side in the involute spiral, and the arrangement of the wrap starting ends with the phases displaced 180 degrees makes short the involute spiral that can form a closed space (compression chamber), which results in that the volume of the final compression chamber remains large to be opened to the discharge port and therefore the compression ratio becomes small.

The large volume of the final compression chamber makes the seal line longer and as a result the sealability lowers and leakage is liable to occur, thereby lowering the compression efficiency.

To solve the above problems, in the so-called single unit scroll-type fluid machine, a main shaft of the orbiting scroll is disposed on the wrap back side so that a discharge port is arranged at the stationary scroll central section, while in the twin unit scroll-type fluid machine, as shown in the embodiment below, since an orbiting scroll is disposed between a pair of stationary scrolls, a main shaft must be extended through the stationary scroll central section, and therefore a defect inevitably arises that a wrap terminal end and a discharge port have to be disposed on the bearing section outer circumferential side in the middle of the involute spiral in the fluid machine adopting the above constitution.

Particularly in a compressor out of these fluid machines, in order to obtain a clean compressed gas, a groove section is formed in a wrap end surface opposed to the associated scroll specular surface and a self-lubricating seal member (hereinafter referred to as chip seal) is fitted into said groove section, thereby an oilless compressor is suggested wherein the wrap end surface is allowed to come slidably in contact with the associated scroll not directly but through said chip seal

so that oilless sealing becomes possible without using an oil seal (see, for example, German Patent DE No. 3,538,522).

However, in a twin unit scroll-type fluid machine, since a bearing section wherein a rotating shaft and others are inserted is situated at the scroll central section, a wrap terminal end and a discharge port are required to be disposed halfway of the helical curve on the bearing section outer circumferential side and in this state the wraps of the scrolls are mated with each other with the numbers of the turns being the same and with the phases being displaced 180 degrees.

Therefore, the gas is released to the discharge port while the volume of the final compressed chamber remains large on the discharge side, so that the compression ratio becomes small.

Further, since the large volume of the final compression chamber makes the seal line longer, the sealability lowers and a backward flow is liable to occur, leading to lowering of the compression efficiency.

In the scroll-type fluid machine using said chip seal, as shown in the above-mentioned German Patent and EPC patent No. 029,8315, a resilient backup member is disposed in the interior of the groove section on the chip seal back side and an floating effect is increased through the backup member to increase the sealing effect.

However, the chip seal groove is not easy to be made deeper, since the machining tools have a limit and the number of steps of cutting for making the groove deeper increases.

Further, if the groove is too deep, when the wraps are orbited, a force is exerted transversely of the chip by the sliding engagement with the scroll specular surface, and the collapse will occur, which is unfavorable in view of the strength. If the width of the wrap is increased to solve this problem, the width of the wrap does not contribute to the compression efficiency at all, and problems arise that a dead space increases and that the compression efficiency and the amount of the air decrease.

Therefore, a backup member is disposed in the interior of the groove section on the chip seal back side without making the groove of the chip seal deep and the chip seal upper section is extended out of the groove section, but in that constitution, the amount of the chip seal in the groove decreases and the chip seal subjects to an energized force due to the small spring constant of the backup member, resulting in a problem that the assembling of the chip seal becomes impossible because the chip seal attached in an involute fashion is disengaged from the seal groove unless the assembling is carried out very carefully.

SUMMARY OF THE INVENTION

[Object of the Invention]

The present invention dissolves the above various defects of a twin unit scroll-type compressor and makes the twin unit scroll-type compressor easily possible to be used in practice.

Other object of the present invention is to provide a scroll-type fluid machine which can be made small-sized, can improve the suction/discharge efficiency, and can attain a high compression ratio.

Another object of the present invention is to provide a scroll-type fluid machine which improves the sealability between wraps and compression ratio or expansion ratio.

Another object of the present invention is to provide a twin unit scroll-type fluid machine wherein the assembling accuracy and the machining accuracy of the scrolls are not required to be so high, and if there is a mechanical error, the error can be absorbed, and the sealability between the wrap end surface and the associated specular surface can be kept to obtain a desired compression ratio or expansion ratio.

A still another object of the present invention is to provide a scroll-type fluid machine having a resilient backup member disposed in the interior of a groove section on the chip seal back side, wherein the above problems associated with the assembling described above can be easily dissolved.

Following in the order of the claims, constitutions to achieve the above objects of the present invention will be described hereinafter.

[Constitution]

The present invention relates particularly to an oilless scroll-type fluid machine out of twin unit scroll compressors having an orbiting scroll and a pair of stationary scrolls positioned on the opposite sides of the orbiting scroll, wherein a chip seal is fitted into a seal groove rectangular in cross section formed in a helical wrap end surface opposed to a slide surface of an associated scroll and a surrounded space between the slide surface and the wrap is sealed with the chip seal.

The stationary scroll has a central shaft hole through which a main shaft is inserted to allow the orbiting scroll to be orbited, a discharge port is formed in a land section surrounding said central shaft hole, the discharge port is made in communication with an inner circumferential end in an involute groove region (an involute groove region between the wrap and the land section outer circumference) positioned on the land section circumferential side through a through-hole, a seal groove

extended from the wrap inner circumferential end is formed on the upper surface side of the land section formed with said through-hole, and the discharge port and the involute groove region inner circumferential end can be sealed with a chip seal fitted in said seal groove.

That is, where the present invention is to be applied to a compressor, as shown in Fig. 6, without causing a wrap inner circumferential end 15a of an orbiting scroll 1 to face to a discharge port 7, a discharge port 7 is formed through a through-hole 31 in a land section 4 of a central shaft hole 1a situated in the interior of an inner circumferential end 21a of the scroll groove 21, so that when the volume of the final compression chamber becomes the smallest, the discharge is carried out, and therefore the compression efficiency is improved.

As described above, the attained small volume of the final compression chamber makes the seal line short, and as a result the sealability is improved and the backward flow can be prevented, so that the compression efficiency is further improved.

In this case, when the discharge port 7 and the involute groove region inner circumferential end 21a are in communication through the land section 4, if the discharge port 7 is disposed on the side of the land 4 as described above, the air-tightness will fail between them and the above-mentioned objects cannot be attained fully.

Therefore, in the present invention, the discharge port 7 and the involute groove region 21a are made in communication through the through-hole 31, a seal groove 901 extended from the wrap inner circumferential end is formed on the upper surface side of the land section 4 where the through-hole 31 is drilled, and the discharge port 7 and the inner circumferential end of the involute groove region 210 are sealed with the chip seal 96 fitted in the seal groove 901.

According to the above technique, the gas highly compressed by the involute groove region inner circumferential end 21a can be prevented from leaking along the upper surface of the land section 4 to the discharge port 7, and accordingly the discharge efficiency can be improved and the compression ratio can be increased.

In this case, if the seal groove 90 is extended to allow all the circumference of the central shaft hole formed in the land section 4 to be surrounded by the seal groove 90 and the central shaft hole, the discharge port 7, and the involute groove region inner circumferential end 21a are made sealable with the chip seals 9 to 9d inserted into the seal groove 90, even when a seal means is used in the bearing 65 fitted in the central shaft hole 6, the highly compressed gas can be prevented from leaking along the shaft hole 6 and the above effect can be further enhanced.

In this case, by opening the through-hole 31 at a position nearer to the inside displaced from the central involute of the involute groove region 21a (on the land section outer circumferential side), the discharge port 7 and the involute groove region 21 can favorably be made in communication at a position where the gas is compressed most highly.

As shown in Fig. 7, the through-hole 31 is indeed required to be positioned below the seal groove 90b with it being out of communication therewith.

Further, the chip seal 9 used in the present invention is formed by integrating several different beltlike members one on the other without interposing a backup member therebetween on the back side and it is recommended that the member positioned in the interior of the seal groove is formed of a resilient member 91 and the member positioned on the upper side thereof is formed of a self-lubricating member 92.

Thus, if the chip seal groove 901 is not made deep, the assembling of the chip seal 9 is made easy and since the backup member and the chip seal are integrated, a fear is obviated that the ship seal will be displaced if the width of the chip grove is made narrow, further the fact that the width of the chip can be made narrow, which does not contribute to the compression efficiency, leads to the lowering of the dead space, and therefore the compression efficiency and the amount of the air can be further increased.

Further, in accordance with a preferred embodiment, as shown in Fig. 5, even on the discharge side, by extending the wrap inner circumferential end 10a on the side of the stationary scroll 1 toward the inner circumferential end by half a turn in comparison with the wrap inner circumferential end 15a on the side of the orbiting scroll 2, the inner circumferential ends 10a and 15a of the wraps are made approximately to coincide at a prescribed position of the phases upon the orbiting movement of the orbiting scroll 1, so that the volume of the final compression chamber can be made smallest and correspondingly the discharge efficiency can be improved and the compression ratio can be increased.

In this case, by forming the involute groove region inner circumferential end 21a into a semicircle, and allowing the wrap inner circumferential end 15a on the side of the orbiting scroll 1 to slide along the wall surface of the involute groove inner circumferential end 21a, the above-mentioned effect as well as the sealability on the side of the wrap inner circumferential end 15a on the side of the orbiting scroll 1 is improved.

In this case, it is recommended that the radius X of the semicircle of the circumferential wall sur-

face is to be set approximately equal to the eccentricity between the the shaft hole center 1a of the orbiting scroll and the center of the shaft hole 2a of the stationary scroll 2, in other words, approximately equal to the orbiting radius x.

Additionally, although an improvement in the compression efficiency and an increase in the compression ratio can be attained by taking the above constitution, in the case of twin unit scroll-type fluid machine, unless the retention of the parallelism between the opposed scrolls and the adjustment of the thrust are attained precisely and easily, the practical use thereof is difficult.

Therefore, in the twin unit scroll-type fluid machine in the present invention, as shown in Fig. 1, the orbiting scroll 1 is born on the main shaft 6 movably slightly in the thrust direction in association with the stationary scrolls 2A and 2B, each of chip seals 9 which are resiliently energized approximately to the same extent is fitted into at least each of the wrap end surfaces 101 and 151 of the orbiting scroll 1 opposed to the specular surfaces 11a and 21a of the stationary scrolls 2A and 2B so that the specular surfaces and the wrap end surfaces 101 and 105 can be sealed with said chip seals, the chip seal is formed by integrating several different beltlike members one on the other, the member positioned in the interior of the seal groove is made of a resilient material, preferably a soft resilient material having a small spring constant, and the member positioned on its upper side is made of a self-lubricating material.

According to the present invention, the orbiting scroll can be moved in the thrust direction, and since the chip seal 9 fitted in each of the wrap surfaces 101 and 151 of the orbiting scroll 1 has an energized resilient force, even if an uneven thrust force is exerted in the orbiting scroll 1 due to an assembling error or a machining error, the position of the orbiting scroll 1 can be automatically corrected by the resilient force and the thrust force can be obviated.

In other words, if there is an assembling error or a machining error, any particular thrust adjustment or parallelism adjustment is not required and the correction of the centering of the orbiting scroll 1 can be automatically effected.

Since the chip seal 9 is extendible (expandable) within the resilient limit, the oscillation of the axis of the orbiting scroll 1 can be easily absorbed.

The orbiting scroll 1 is not supported rigidly in association with the stationary scrolls 2A and 2B but is supported resiliently through the chip seals, so that the axial power is not uselessly increased.

Therefore, according to the present invention, by taking the above constitution, since the wrap circumferential surfaces on the suction side, the discharge side, and the intermediate part between them retain high sealability between them and the associated scrolls highly accurately with a simple constitution and a high compression efficiency can be secured, the present twin unit scroll-type compressor can be used in practice.

The use of the chip seal formed by integrating several different beltlike members one on the other is not restricted to the twin unit type but also can be applied to a scroll-type fluid machine having one orbiting scroll and one stationary scroll.

The chip seal can be formed by integrating a resilient member and a self-lubricating member through an adhesive, bonding agent, adsorption, or chemical bonding or by applying a viscous member of a self-lubricating material thickly on the resilient member and solidifying the viscous member to integrate them.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an overall sectional view of a scroll-type compressor according to the present invention, wherein (a) and (b) are enlarged sectional views of chip seals.

Fig. 2 is an enlarged sectional view of the central shaft section.

Fig. 3 is an enlarged sectional view of the vicinity of an eccentric rotating shaft.

Figs. 4 (a), (b), (c), and (d) are views showing processes of producing chip seals used in the present invention.

Fig. 5 is schematic views showing the shape and the arranged state of wraps of an embodiment of the present invention with the chip seal omitted, wherein (a) shows the final compression state and (b) shows the intermediate compression state.

Fig. 6 is an essential view of the central region of wraps, showing the shape of a chip seal on the side of the stationary scroll.

Fig. 7 is a sectional view taken along line A-A of Fig. 6.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Preferable embodiments of the present invention will be illustratively described in detail with reference to the drawings. It is, however, not intended to restrict the scope of the present invention within the dimensions, materials, shapes, relative positions, etc. of the constitutional parts in the embodiments, but merely aimed to an illustrative purpose, unless otherwise specified.

Figs. 1 through 3 show an oilless scroll-type compressor of an embodiment according to the present invention which comprises an orbiting scroll 1 provided with a pair of orbiting wraps 15A and 15B at both surfaces axially parallel to a main

shaft 5 of which central crank section 5a supports the orbiting scroll 1, a pair of stationary scrolls 2A and 2B formed with stationary wraps 10 mated with the orbiting wraps 15A and 15B, and three slave crank shafts 6 for restriction of a spin disposed in a 120 degree apart at outer circumferential sides 24 in a space enclosing the wraps which are for connecting said stationary scroll 2A and the orbiting scroll 1.

The stationary scrolls 2A and 2B are in the shape of circular caps, their circumferential walls 24 serving as a casing are abutted against each other with a seal member 29 between them so that a closed space may be formed therein and the main shaft 5 is passed through their central shaft holes 6 and through bearings 25 so that the main shaft 5 may be rotatably supported at two sections.

The stationary wraps 15A and 15B helical in shape are arranged around the bearings 25 and are opposed to each other symmetrically and a discharge port 7A and a suction port 8 are formed in a central region and an outer circumferential edge of the stationary scroll 2A respectively.

The orbiting scroll 1 and the stationary scroll 2B are formed respectively with discharge passages 7B and 7C for leading a compressed gas into the discharge port 7A.

As described above, the opposite surfaces of the orbiting scroll 1 are formed with orbiting wraps 15A and 15B axially parallelly, the orbiting wraps 15A and 15B can be mated with said stationary wraps 10, and support shafts 60a of the three slave crank shafts 60 are pivotally supported in a circumferential wall 14 on the circumferential side of the orbiting scroll 1.

That is, as known in the prior art, the slave crank shafts 60 are pivotally supported at positions (3 in number) displaced 120 degrees around the main shaft 5, the support shafts 60a of said crank shafts are born in bearings 63 of the orbiting scroll 1 and other support shafts 60b are born in bearings 64 of the stationary scroll 2A. As a result, when the main shaft 5 is rotationally driven, the slave crank shafts 60 follow that driven rotation to rotate eccentrically in line with the eccentricity X of the main shaft 5, thereby enabling the orbiting scroll 1 not to rotate on its own axis but to orbit with the fixed radius X about the center of the wraps of the stationary scrolls 2A and 2B.

The slave shafts 60 are born in a cantilever fashion only by the stationary scroll 2, thereby a slight tilting or axial misalignment of the orbiting scroll 1 can be absorbed to prevent the axial power from a useless increase.

That is, if the slave crank shafts 60 are supported by the stationary scrolls 2A and 2B with the orbiting scroll 1 between them, the axial movement of the orbiting scroll 1 can be allowed, but the occurrence of a tilting or axial misalignment of the orbiting scroll 1 cannot be allowed and the orbiting scroll 1 is supported rigidly, unfavorably leading to a problem that results in an increase of the axial power.

Referring to Figs. 2 and 3, the constitution of the above bearing sections are described. A bearing 65 fitted in the central crank shaft section 5a of the main shaft 5 is made up of a known needle roller bearing 65a having a number of needle bearings 65a1 supported in a housing 65a2 and a pair of oil seals 65b disposed on the opposite sides of the needle roller bearing 65a and the space defined between the oil seals 65b is filled with a grease. A bearing 63 between the support shaft 60a of each of the slave crank shafts 60 and the orbiting scroll 1 is made up of a housed needle roller bearing 63a and oil seals 63b and the space defined between the oil seals 65b is filled with a grease.

On the other hand, each of the bearings 66 fitted on the main shaft on the stationary scroll side is made up of a sealed angular bearing 66b, a housed needle roller bearing 66a, and an oil seal 66c stated from the outside and its closed space is filled with a grease. A bearing 64 fitted on the support shaft 60b of each of the slave crank shafts is made up of a pair of sealed angular bearings 64a and 64b and its closed space is filled with a grease.

According to the above constitution, the central eccentric shaft 5a of the main shaft 5 and the orbiting scroll 1, and the support shaft 60a of each of the slave crank shafts 60 and the orbiting scroll 1 are born by the housed needle roller bearings 63a and 65a wherein a number of the needle bearings 65a1 are born in the housing 65a2 (the needle bearing 65a1 itself has a slight clearance axially in the housing 65a2), so that said orbiting scroll 1 is constructed axially movably to a slight extent.

As is shown in Fig. 1, a wrap end surface 101 of each of the stationary wraps 10 opposed to each slide surface 11a of the orbiting scroll 1 and an end surface 151 of the slide wrap 15 (15A and 15B) opposed to each slide surface 21 of the stationary scroll 2 (2A and 2B) is recessed to form seal grooves 90 that extend helically along the length of the surfaces and have a rectangular cross-section, and a resilient chip seal 9 of a self-lubricating resin in the shape of a belt is fitted into each of the seal grooves 90 and thus the chip seals 9 are resiliently retained between the slide surface 11a of the orbiting scroll 1 and the slide surface 21 of the stationary scroll (2A and 2B).

The height H of each of the wraps is set to be slightly shorter than the distance L between the specular surfaces of the associated scrolls and the

distance R1 between the opposite surfaces of the orbiting scroll and the thickness R2 of the central crank section 5a of the main shaft are set to be slightly shorter than the distance M between the wrap end surfaces of the stationary scroll, in other words, the opposite surfaces of the orbiting scroll and the wrap end surfaces of the stationary scroll are opposed to have a slight clearance and the wrap end surfaces on the opposite surfaces of the orbiting scroll and specular surfaces of the stationary scrolls are opposed to have a slight clearance, and by interposing the chip seals between them, it is made secure that the orbiting scroll 1 can be slightly moved axially and can be resiliently retained.

The chip seals 9 used in this embodiment are not independently placed as backup members as in the above-mentioned prior art, but as is shown in Figs. 7 and 1, a backup member 91 and a self-lubricating seal member 92 are integrated so that the chip seal 9 itself may be resiliently energized.

The backup member 91 is made from a soft material which has a small spring constant and slightly restores the shape of the backup member 91 when the seal member 92 is forcibly brought in contact with the associated scroll specular surface (slide surface) such as a porous material of an ethylene tetrafluoride resin.

The self-lubricating seal member 92 is generally made from a copper containing resin (available under the trade name of Sunflon from Mitsubishi Densen Co.) or a fluororesin, but the present invention is not restricted to them.

The backup member 91 and the seal member 92 are in the shape of a belt and are smaller that the seal groove and when they are integrated, the top of the seal member extends out of the seal groove.

As is shown in Fig. 4 (a), the upper surface of the backup member 91 and the undersurface of the seal member 92 are integrated by using an adhesive or a bonding agent 93, or as is shown in Figs. 4 (b) and (c), the seal member 92 which is melted is applied thickly on the upper surface of the backup member 91 by using a spraying machine 95 or a flow coater 96 and then may be solidified thereafter, or as is shown Fig.4(d), the upper surface of the backup member 91 and the undersurface of the seal member 92 may be integrated by a deposition method or chemical bonding.

According to the embodiment, if a nonuniform or unparallel thrust occurs in the orbiting scroll due to an error of the assembling or the machining of the arrangement, the position can be automatically corrected by the resilient force of the chip seals 9, so that such a thrust can be obviated or the parallelism can be adjusted, and since the backup member 91 and the seal member 92 are integrated, the assembling to the seal groove 90 is made easy.

Now, the shape of the wraps used in the embodiment will be described based on Figs. 5 through 7.

For example, in Figs. 5 (a) and (b), reference numeral 10 indicates a wrap formed on the stationary scroll 2, the wrap 10 is formed in the shape of an involute starting from an outer circumferential wall 4a of a land section 4 of a central shaft hole 6 through which the main shaft 5 located at the central section extends and has about 7.5 x π turns (3.75 turns), and a semicircular wall is formed on the side of an involute groove starting end 21a between a second turn wrap 10c and a wrap starting end 10a formed to the outer circumferential wall 4a of the land section.

In this case, the shape of the circumferential wall surface is such that its radius is set to be approximately equal to the eccentricity x between an orbiting scroll shaft 1a and a stationary scroll shaft 2a, in other words, approximately equal to the scroll orbiting radius.

On the other hand, the wrap 15 on the side of the orbiting scroll 1 is extended in the shape of an involute whose turns are to be about 5.5 x π turns (2.75 turns) by making shorter by 180 degrees on the inner circumferential end side and on the outer circumferential end side than the wrap 10 on the side of the stationary scroll and its starting end 15a is brought in contact with the involute groove circumferential surface so that the wrap starting end 15a can be slid along the circumferential surface of the involute groove starting end 21a in conformity with the orbiting movement of the orbiting scroll, and the forward end of the wrap starting end 15a is formed into a semicircle in cross-section.

The stationary wrap 10 formed on the side of the stationary scroll 2 is formed into a helix having about 5.5 x π turns (about 2.75 turns) extending from a bearing shore 4 formed into an involute along the central shaft hole 6 through which the main shaft 5 located at the central section extends and an inner circumferential wall surface 21a at the inner circumferential end of a scroll groove 21 between the wrap inner circumferential end 10a and the wrap 10 c positioned on the outer circumferential side of the wrap inner circumferential end 10a is formed into a semicircle.

In this case, the shape of the scroll groove inner circumferential wall surface 21a is set such that its radius is approximately equal to the eccentricity X between the orbiting scroll shaft hole center 1a and the stationary scroll shaft hole center 2a, in other words, approximately equal to the orbiting radius.

As a result, when the orbiting scroll 1 is orbited about the stationary scroll shaft hole center 1a, the

wrap inner circumferential end 15a on the side of said orbiting scroll is slid along the scroll groove inner circumferential wall surface 21a, so that the smooth sliding movement becomes possible.

As shown in Fig. 7, a discharge port 7 is drilled in the land section 4 on the interior side of the scroll groove inner circumferential wall 21a and a through-hole 31 extending through the scroll groove inner circumferential wall surface 21a and the discharge port 7 is formed along the direction extended from the outer circumferential wall 4a of the land section 4.

According to the above constitution, since the final compression chamber 30A is not opened until the wrap inner circumferential end 15a of the orbiting scroll 1 comes near to the land section outer circumferential wall 4a, the final compression chamber 30A can be easily reduced, so that the compression efficiency can be improved further.

However, if the chip seal is not interposed on the upper side of the land section 4 between the scroll groove inner circumferential wall surface 21a and the discharge port 7, there is a fear that the high-pressure gas in the discharge port 7 will flow back into the final compression chamber 30A that has not yet been fully compressed along the upper surface of the land section 4.

Therefore, as shown in Figs. 6 and 7, the chip seal groove 90b fitted near to the inner circumferential end 10 a of the stationary wrap is further increased into a semicircle along the scroll groove inner circumferential wall surface 21a of the land section 4 and the chip seal 9b is integrated continuously with the chip seal 9 and is fitted into the seal groove.

Although the bearing 65 is inserted in the central shaft hole formed in the land section, if a chip seal is not placed on the upper side of the land section 4 between the shaft hole and the discharge port 7, there is a fear that the high-pressure gas in the discharge port 7 leaks into the central shaft hole along the upper surface of the land section 4.

Therefore, the seal groove is extended so that it can surround all the central shaft hole in the land section, and the chip seal 9c is fitted into the seal groove such that it is integrally continuous with the chip seal 9 and the chip seal 9b.

In this case, although it is possible that the bearing 66 of the stationary scroll is provided with a seal means capable of prevention of leakage, the chip seal 9c can make up the function of the seal means.

Since the outer circumferential side of the land section 4 functions as a wrap, indeed, the chip seal 9a is fitted integrally and continuously with the chip seals 9, 9b, and 9c into the seal groove.

It is desirable that any of the chip seals 9, 9a, 9b, and 9c are press molded integrally.

As a result, the circumference of the discharge port is not directly opposed to the central shaft hole or the involute groove region inner circumferential ends than the land upper surface, but since it is cut off by the chip seals 9a, 9b, and 9c, it is easily made air-tight, and the compression efficiency can be improved further.

Reference symbol 4b indicates a sink to be in communication with the adjacent discharge port 7 (7A, 7B, and 7C).

Consequently, according to the embodiment, the inner circumferential wall surface 21a of the scroll groove 21 is made into the shape of a semicircle, the radius of the semicircle is set to be approximately equal to the eccentricity X between the orbiting scroll shaft hole center 1a and the stationary scroll shaft hole center 2a, in other words, approximately equal to the orbiting radius, further, the wrap 15 on the side of orbiting scroll 1 is extended, and its inner end 15a can be opposed closely to the scroll groove inner circumferential wall surface 21a or can be slid on it in response to the orbiting movement, and further according to the embodiment, since the discharge port 7 is drilled in the shore section 4 in the interior of the scroll groove inner circumferential wall surface 21a and the through-hole 31 for making the scroll groove inner circumferential groove wall surface 21a in communication with the discharge port 7 is formed along the outer circumferential wall 4a of the shore section 4, the final compression chamber 30A is not opened until the wrap inner terminal end comes near the shore section outer circumferential wall 4a, so that the compression efficiency can be improved.

Further, in this embodiment, since the chip seal 9 is disposed to surround the discharge port 7 (7A and 7C) on the side of the stationary scroll 2 (2A and 2B), the backward flow from the discharge port 7 can be prevented completely, and therefore the compression efficiency can be improved further.

Although the above technique was described for stopping the leakage from the discharge port 7 (7A and 7C) on the side of the stationary scroll 2 (2A and 2B), the above technique can be similarly applied to the discharge port 7B on the side of the orbiting scroll 1.

Claims

1. An oilless scroll-type fluid machine comprising an orbiting scroll (1) having an axially projecting involute wrap (15A, 15B) on each of both sides of the orbiting scroll and a pair of stationary scrolls (2A, 2B) each having an involute wrap (10) mated with the former wrap of said orbiting scroll (1), a chip seal (9) being fitted in

a seal groove (90) rectangular in cross section formed in a helical wrap end surface opposed to a slide surface (11a, 21a) of the associated scroll (1, 2), and the enclosed space formed between said wrap and said slide surface being sealed with said chip seal (9), characterized in that a discharge port (7) is formed in a land section (4) surrounding a central shaft hole (6) in said stationary scroll (2A, 2B), a through-hole (31) is formed between said discharge port (7) and an inner circumferential end of an involute groove region positioned on the land section outer circumferential side so that said discharge port (7) and said inner circumferential end may be communicated, a seal groove (90b) is formed on the upper surface side of the land section (4) formed with said through-hole (31) to extend from the wrap inner circumferential end, and the discharge port (7) and the involute groove region inner circumferential end are sealed with a chip seal (9b) fitted in said seal groove (90b).

2. The machine of claim 1, wherein said seal groove (90b) is extended to allow all the circumference of said central shaft hole (6) formed in the land section (4) to be surrounded, and said central shaft hole (6), the discharge port (7), and the involute groove region inner circumferential end can be sealed with said chip seal (9b) fitted in said seal groove (90b).

3. The machine of claim 1 or 2, wherein the stationary scroll wrap has its inner circumferential end extended so as to be longer by half a turn toward the inner circumferential end than the orbiting scroll wrap circumferential line, by using the outer circumferential line of the land section (4) (the land part), so that the circumferential ends (10b, 15b) of the wraps (10, 15) may be approximately in agreement with each other at a prescribed position of the phases upon the orbiting movement of said orbiting scroll (1).

4. The machine of any of claims 1 to 3, wherein said through-hole (31) is opened at a position inner than the position of the central involute line of the involute groove region.

5. The machine of any claims 1 to 4, wherein said chip seal (9) is formed by integrating several different beltlike members one on the other with the member positioned inside of the seal groove (90, 90b) being a resilient member (91) and the member (92) positioned thereon being a self-lubricating member.

6. The machine of claim 1, wherein each of said orbiting scroll wrap (15) and said stationary scroll wrap (10) has a wrap turn of 720 degrees (two turns) or over and preferably of 1000 degrees.

7. The machine of any of the preceding claims, comprising a plurality of slave cranks (60) for supporting said stationary scrolls (2A, 2B) and said orbiting scroll (1), which is born on a main shaft (5), to allow said orbiting scroll (1) to be orbited by the rotation of said main shaft (5) without spinning, wherein housed needle roller bearings (65a) are each applied to the bearing section of the main shaft (5) of said orbiting scroll (1) and to the bearing section of each of the slave cranks (60) so that the stationary scrolls (2A, 2B) are born on the main shaft (5) and can be moved slightly in the thrust direction, said chip seals (9), which can be resiliently energized approximately to the same extent, are fitted respectively to wrap end surfaces of the orbiting scroll (1) opposed to specular surfaces of the stationary scrolls (2A, 2B) so that said specular surfaces and the wrap end surfaces can be sealed with said chip seals (9).

8. The machine of claim 7, wherein said chip seal (9b) is formed by integrating several different beltlike members (91, 92, 93) one on the other with the member positioned inside of the seal groove (90b) being a resilient member (91) and the member positioned thereon being a self-lubricating member (92).

9. The machine of claim 8, wherein said resilient member (91) and said self-lubricating member (92) are integrated with an adhesive (93), a bonding agent, adsorption, or a chemical bond.

10. The machine of claim 8 or 9, wherein a viscous member of a self-lubricating material is applied thickly on said resilient member (91) and then is solidified to integrate the self-lubricating material (92) and the resilient member (91).

Patentansprüche

1. Ölfreie, spiralartige Fluidmaschine, aufweisend:

eine umlaufende Spirale (1) mit einer axial hervorstehenden Evolventen-Windung (15A, 15B) auf jeder ihrer zwei Seiten und

einem Paar stationärer Spiralen (2A, 2B) mit jeweils einer Evolventen-Windung (10), die zu der zuvorgennnanten Windung der umlaufenden Spirale (1) paßt,

wobei ein Dichtungsstreifen (9) in eine im Querschnitt rechteckige Dichtungsrinne (90) eingepaßt ist, die in einer einer Gleitfläche (11a, 21a) der zugeordneten Spirale (1, 2) gegenüberliegenden spiralförmigen Windungsendfläche ausgebildet ist, und wobei der zwischen der Windung und der Gleitfläche eingeschlossene Raum mit dem Dichtungsstreifen abgedichtet ist,

dadurch gekennzeichnet,

daß eine Auslaßöffnung (7) in einem eine mittlere Wellenbohrung (6) in der stationären Spirale (2A, 2B) umgebenden Inselabschnitt (4) ausgebildet ist,

daß zwischen der Auslaßöffnung (7) und einem inneren Umfangsende eines Evolventen-Rinnenbereichs, der an dem äußeren Umfang des Inselabschnitts angeordnet ist, eine Durchgangsöffnung (31) ausgebildet ist, so daß die Auslaßöffnung (7) und das innere Umfangsende miteinander in Verbindung stehen können,

daß auf der oberen Oberflächenseite des mit der Durchgangsöffnung (31) versehenen Inselabschnitts (4) ausgehend von dem inneren Umfangsende der Windung eine Dichtungsrinne (90b) ausgebildet ist, und

daß die Auslaßöffnung (7) und das innere Umfangsende des Evolventen-Rinnenbereichs mit einem in die genannte Dichtungsrinne (90b) eingepaßten Dichtungsstreifen (9b) abgedichtet sind.

2. Maschine nach Anspruch 1, wobei sich die Dichtungsrinne (90b) so erstreckt, daß der gesamte Umfang der in dem Inselabschnitt (4) gebildeten mittleren Wellenöffnung (6) umgeben und die mittlere Wellenöffnung (6), die Auslaßöffnung (7) und das innere Umfangsende des Evolventen-Rinnenbereichs mit dem in die Dichtungsrinne (90b) eingepaßten Dichtungssteifen (9b) abgedichtet werden können.

3. Maschine nach Anspruch 1 oder 2, wobei sich das innere Umfangsende der stationären Spiralenwindung unter Verwendung der äußeren Umfangslinie des Inselabschnitts (4) (des Inselteils) so weit erstreckt, daß die stationäre Spiralenwindung zum inneren Umfangsende hin um eine halbe Windung länger ist als die Umfangslinie der umlaufenden Spiralenwindung, so daß die Umfangsenden (10b, 15b) der Windungen (10, 15) an vorgeschriebenen Phasenpositionen bei der Umlaufbewegung der umlaufenden Spirale (1) näherungsweise miteinander übereinstimmen.

4. Maschine nach einem der Ansprüche 1 bis 3, wobei die Durchgangsöffnung (31) innnerhalb der mittleren Evolventen-Linie des Evolventen-Rinnenbereichs offen ist.

5. Maschine nach einem der Ansprüche 1 bis 4, wobei der Dichtungsstreifen (9) durch Zusammenfügen mehrerer unterschiedlicher bandförmiger Teile gebildet ist, wobei das innerhalb der Dichtungsrinne (90, 90b) angeordnete Teil ein Federteil (91) und das darauf angeordnete Teil (92) ein selbstschmierendes Teil ist.

6. Maschine nach Anspruch 1, wobei sowohl die umlaufende Spiralenwindung (15) als auch die stationäre Spiralenwindung (10) eine Windung von mindestens 720 Grad (zwei Umläufen) und vorzugsweise von 1000 Grad aufweisen.

7. Maschine nach einem der vorhergehenden Ansprüche, aufweisend:

eine Vielzahl von Nebennocken (60) zur Stützung der stationären Spiralen (2A, 2B) und der umlaufenden Spirale (1), die auf einer Hauptwelle (5) gelagert ist, so daß die umlaufende Spirale (1) bei Drehung der Hauptwelle (5) umlaufen kann, ohne sich zu verdrehen, wobei der Lagerabschnitt der Hauptwelle (5) der umlaufenden Spirale (1) und der Lagerabschnitt jeder der Nebennocken (60) jeweils mit eingesetzten Nadelrollenlagern (65a) versehen ist, so daß die stationären Spiralen (2A, 2B) auf der Hauptwelle (5) gelagert und in Schieberichtung geringfügig bewegbar sind, wobei die Dichtungsstreifen (9), die etwa im gleichen Ausmaß federnd gespannt werden können, jeweils an den Endflächen der Windungen der umlaufenden Spirale (1) gegenüber spiegelartigen Flächen der stationären Spiralen (2A, 2B) so befestigt sind, daß die spiegelartigen Flächen und die Endflächen der Windung mit den Dichtungsstreifen (9) abgedichtet werden können.

8. Maschine nach Anspruch 7, wobei der Dichtungssteifen (9b) durch Zusammenfügen mehrerer unterschiedlicher bandförmiger Teile (91, 92, 93) aufeinander gebildet ist, wobei das innerhalb der Dichtungsrinne (90b) befindliche Teil ein Federteil (91) und das darauf angeordnete Teil ein selbstschmierendes Teil (92) ist.

9. Maschine nach Anspruch 8, wobei das Federteil (91) und das selbstschmierende Teil (92) mittels eines Klebers (93), eines Bindemittels, mittels Haftung oder einer chemischen Bindung zusammengefügt sind.

10. Maschinen nach Anspruch 8 oder 9, wobei ein viskoses Element eines selbstschmierenden

Materials dick auf das Federteil (91) aufgebracht und dann verfestigt ist, um das selbstschmierende Material (92) und das Federteil (91) zu verbinden.

Revendications

1. Machine à fluide du type à volutes sans huile lubrifiante, comprenant une volute (1) à déplacement orbital ayant une spire en développante (15A, 15B) qui dépasse axialement de chacune des deux faces de la volute à déplacement orbital et une paire de volutes fixes (2A, 2B) ayant chacune une spire en développante (10) destinée à coopérer avec la spire de la volute à déplacement orbital (1), un joint autolubrifiant d'étanchéité (9) étant monté dans une gorge (90) d'étanchéité de section rectangulaire formée dans une surface d'extrémité de spire hélicoïdale opposée à une surface de glissement (11a, 21a) de la volute associée (1, 2), l'espace fermé réalisé entre la spire et la surface de glissement étant fermé de manière étanche par le joint autolubrifiant d'étanchéité (9), caractérisée en ce qu'un orifice de refoulement (7) est formé dans un tronçon (4) de portée entourant un trou central (6) de passage d'arbre de la volute fixe (2A, 2B), un trou débouchant (31) est formé entre l'orifice de refoulement (7) et une extrémité circonférentielle interne d'une région de gorge en développante placée du côté circonférentiel externe du tronçon de portée afin que l'orifice de refoulement (7) et l'extrémité circonférentielle interne puissent communiquer, une gorge (90b) d'étanchéité est formée du côté de la surface supérieure du tronçon de portée (4) réalisé avec le trou débouchant (31) partant de l'extrémité circonférentielle interne de la spire, et l'orifice de refoulement (7) et l'extrémité circonférentielle interne de la région de gorge en développante sont fermés de manière étanche par un joint autolubrifiant d'étanchéité (9b) logé dans la gorge d'étanchéité (90b).

2. Machine selon la revendication 1, dans laquelle la gorge d'étanchéité (90b) est prolongée afin que toute la circonférence du trou central (6) de passage d'arbre formé dans le tronçon (4) de portée soit entourée, et le trou central (6) de passage d'arbre, l'orifice de refoulement (7) et l'extrémité circonférentielle interne de la région de gorge en développante peuvent être fermés de manière étanche par le joint autolubrifiant d'étanchéité (9b) logé dans la gorge d'étanchéité (90b).

3. Machine selon la revendication 1 ou 2, dans laquelle la spire de la volute fixe a son extrémité circonférentielle interne qui se prolonge de manière qu'elle soit plus grande d'un demi-tour vers l'extrémité circonférentielle interne que la courbe circonférentielle de la spire de la volute à déplacement orbital, par utilisation de la courbe circonférentielle externe du tronçon de portée (4) (partie de portée), si bien que les extrémités circonférentielles (10b, 15b) des spires (10, 15) peuvent se correspondre approximativement à une position prédéterminée des phases lors du mouvement orbital de la spire (1) à déplacement orbital.

4. Machine selon l'une quelconque des revendications 1 à 3, dans laquelle le trou débouchant (31) débouche à une position qui se trouve plus à l'intérieur que la position de la courbe centrale en développante de la région de gorge en développante.

5. Machine selon l'une quelconque des revendications 1 à 4, dans laquelle le joint autolubrifiant d'étanchéité (9) est formé par intégration de plusieurs organes différents en forme de sangle les uns sur les autres, l'organe placé à l'intérieur de la gorge d'étanchéité (90, 90b) étant un organe élastique (91) et l'organe placé sur lui (92) étant un organe autolubrifiant.

6. Machine selon la revendication 1, dans laquelle chacune des spires (15) de volute orbitale et de spires (10) de volute fixe couvre au moins 720° (2 tr) ou plus et de préférence 1 000°.

7. Machine selon l'une quelconque des revendications précédentes, comprenant plusieurs vilebrequins asservis (60) de support des volutes fixes (2A, 2B) et de la volute orbitale (1), qui est portée par un arbre principal (5), afin que la volute orbitale (1) puisse présenter un déplacement orbital lors de la rotation de l'arbre principal (5) sans rotation de la volute elle-même, dans laquelle des paliers à aiguilles étanches (65a) sont appliqués chacun sur le tronçon de palier de l'arbre principal (5) de la volute orbitale (1) et sur le tronçon de palier de chacun des vilebrequins asservis (60) afin que les volutes fixes (2A, 2B) soient portées par l'arbre principal (5) et puissent être légèrement déplacées dans la direction de poussée, et les joints autolubrifiants d'étanchéité (9), qui peuvent être rappelés élastiquement approximativement de la même amplitude, sont logés aux surfaces d'extrémité de spire de la volute orbitale (1) opposée aux surfaces spéculaires des volutes fixes (2A, 2B) si bien que les surfaces

spéculaires et les surfaces d'extrémité de spires peuvent être fermées de manière étanche par les joints autolubrifiants d'étanchéité (9).

8. Machine selon la revendication 7, dans laquelle le joint autolubrifiant d'étanchéité (9b) est formé par intégration de plusieurs organes différents en forme de sangle (91, 92, 93) placés les uns sur les autres, l'organe placé à l'intérieur de la gorge d'étanchéité (90b) étant un organe élastique (91) et l'organe placé sur lui étant un organe autolubrifiant (92).

9. Machine selon la revendication 8, dans laquelle l'organe élastique (91) et l'organe autolubrifiant (92) sont rendus solidaires par un adhésif (93), par un agent de liaison, par absorption ou par liaison chimique.

10. Machine selon la revendication 8 ou 9, dans laquelle un organe visqueux d'un matériau autolubrifiant est appliqué sous forme épaisse sur l'organe élastique (91) puis est solidifié afin que le matériau autolubrifdant (92) et l'organe élastique (91) soient rendus solidaires.

FIG. 1

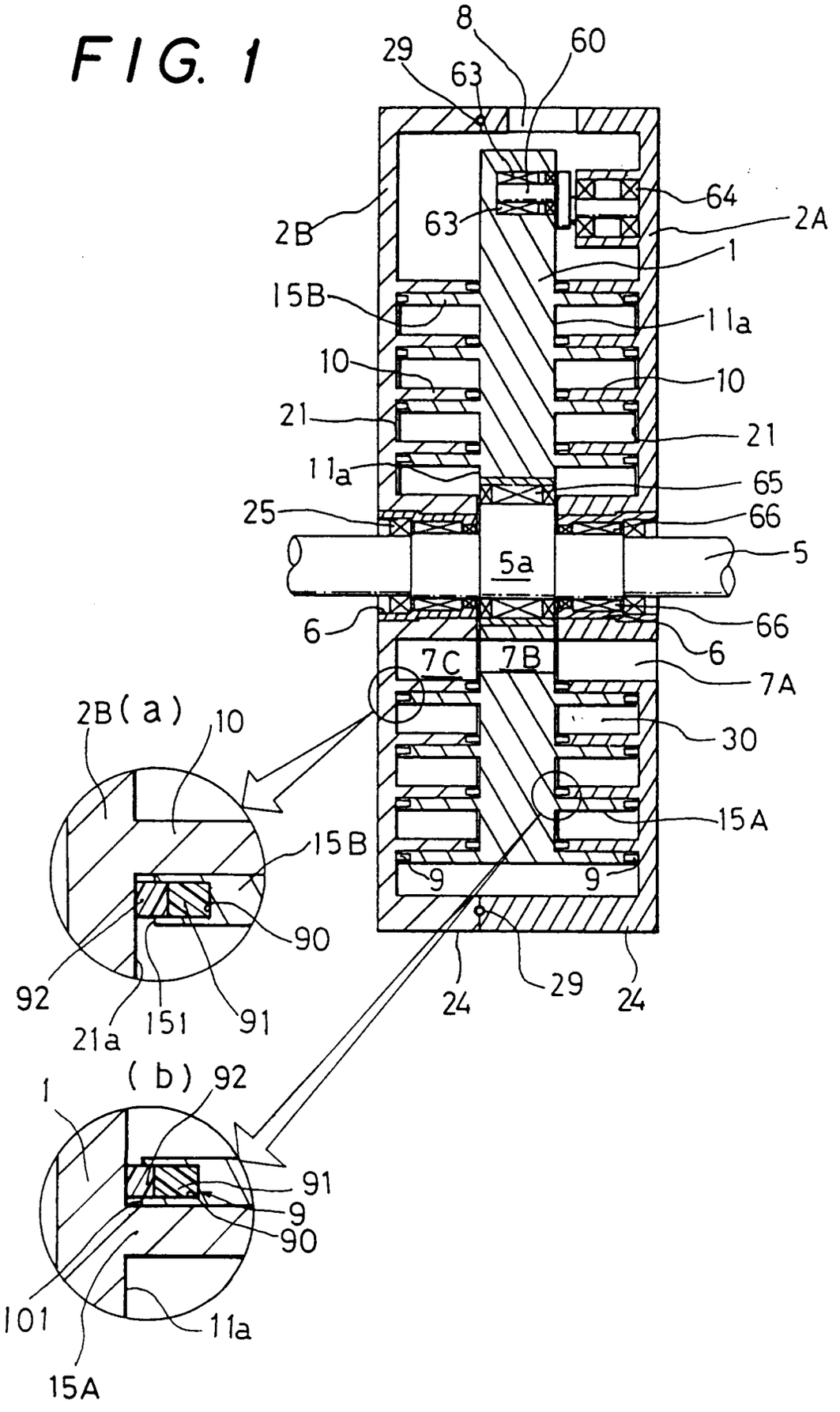

8
29
63
60
64
2B
63
2A
1
15B
11a
10
10
21
21
11a
65
25
66
5a
5
6
66
6
7C
7B
7A
2B(a)
10
30
15B
15A
90
9
9
92
21a
151
91
24
29
24
(b)
92
1
91
9
90
101
11a
15A

FIG. 2

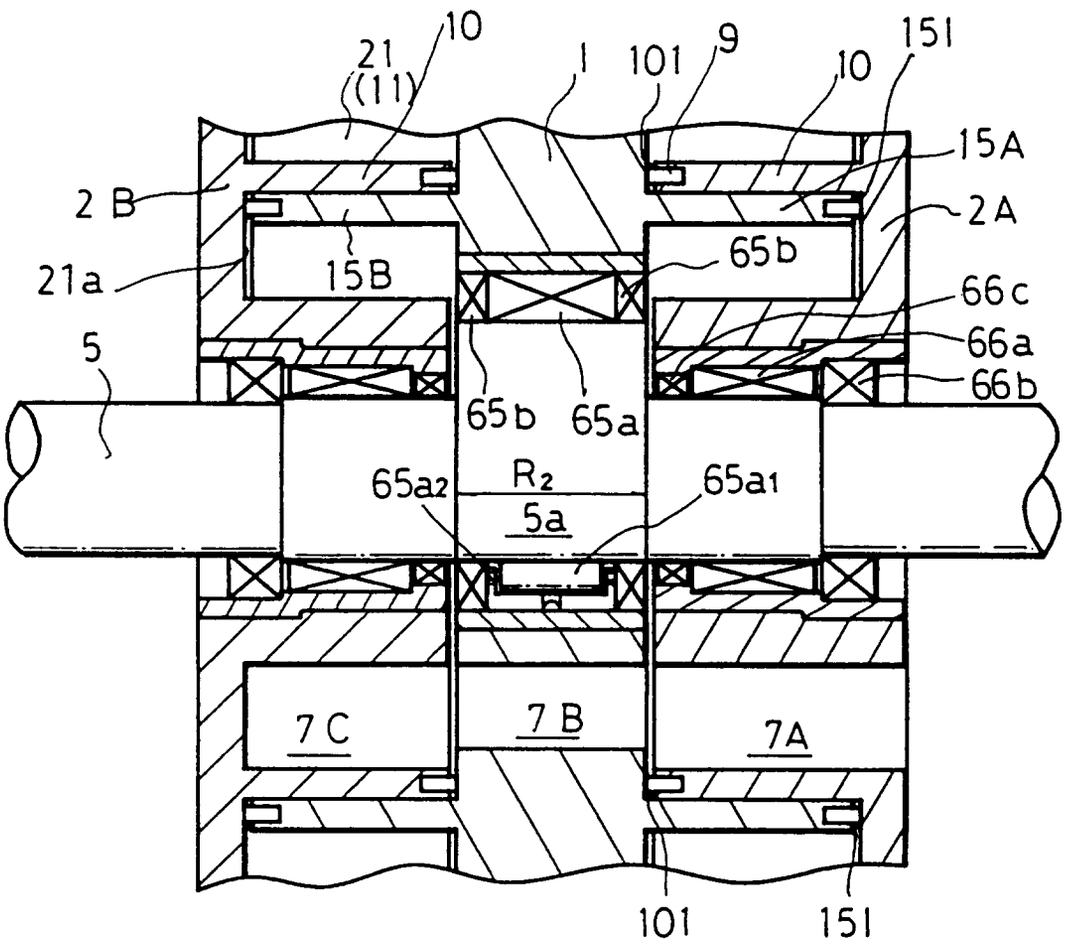

10
21
(11)
1
101
9
10
151
15A
2B
2A
21a
15B
65b
66c
66a
66b
5
65b
65a
65a2
R2
65a1
5a
7C
7B
7A
101
151

FIG. 3

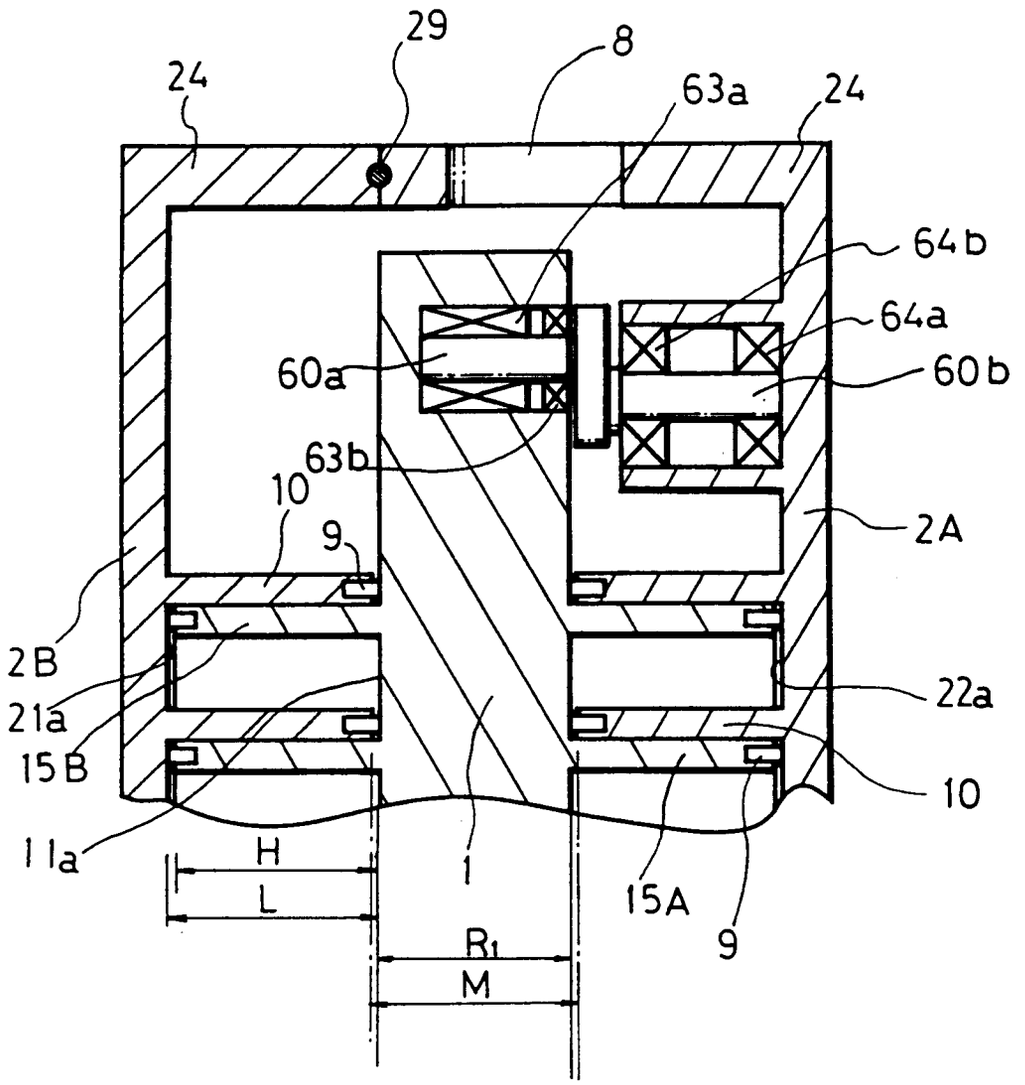

29
8
24
63a
24
64b
64a
60a
60b
63b
10
9
2A
2B
21a
15B
22a
10
11a
H
L
1
15A
9
R1
M

FIG. 4 (a)

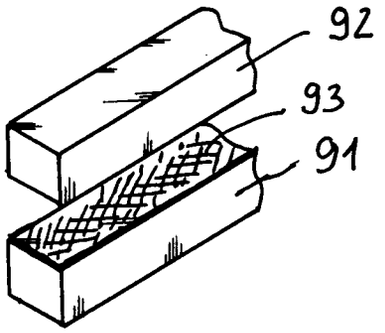


FIG. 4 (b)

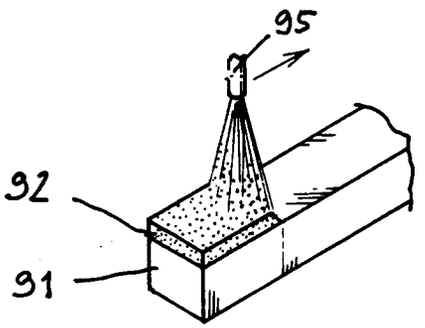


FIG. 4 (c)

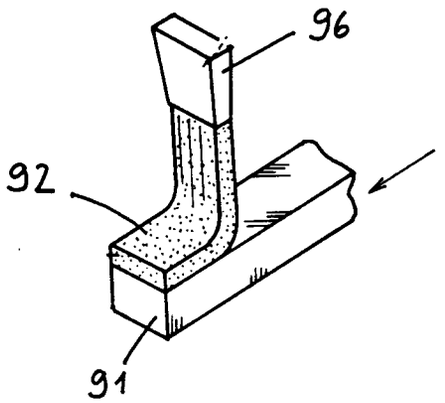


FIG. 4 (d)

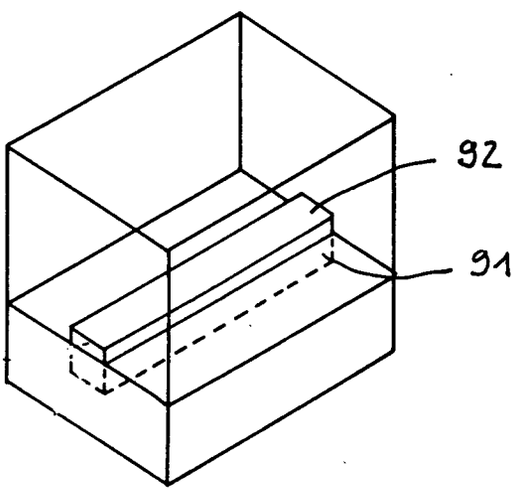


FIG. 5(a)

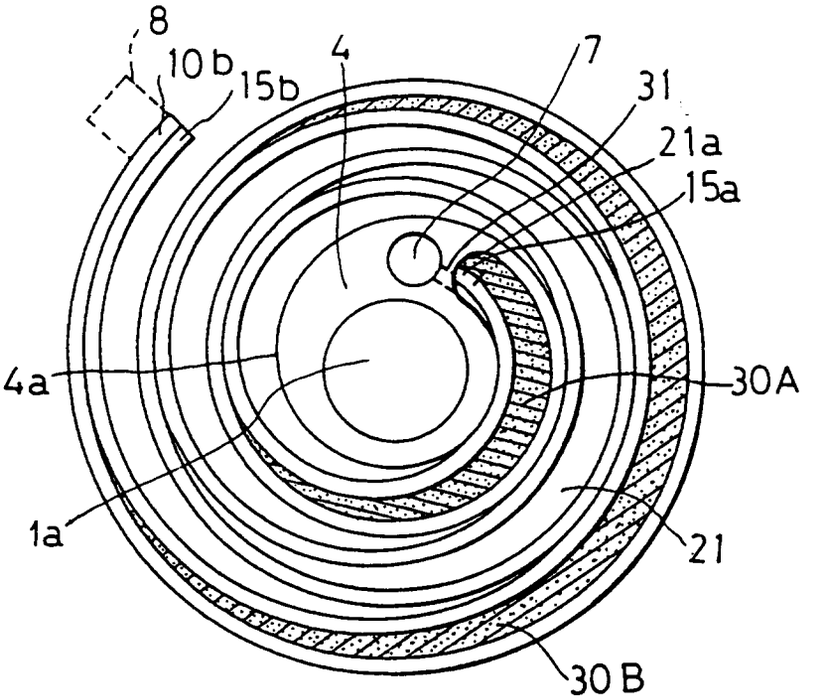

8
10b
15b
4
7
31
21a
15a
4a
30A
1a
21
30B

FIG. 5(b)

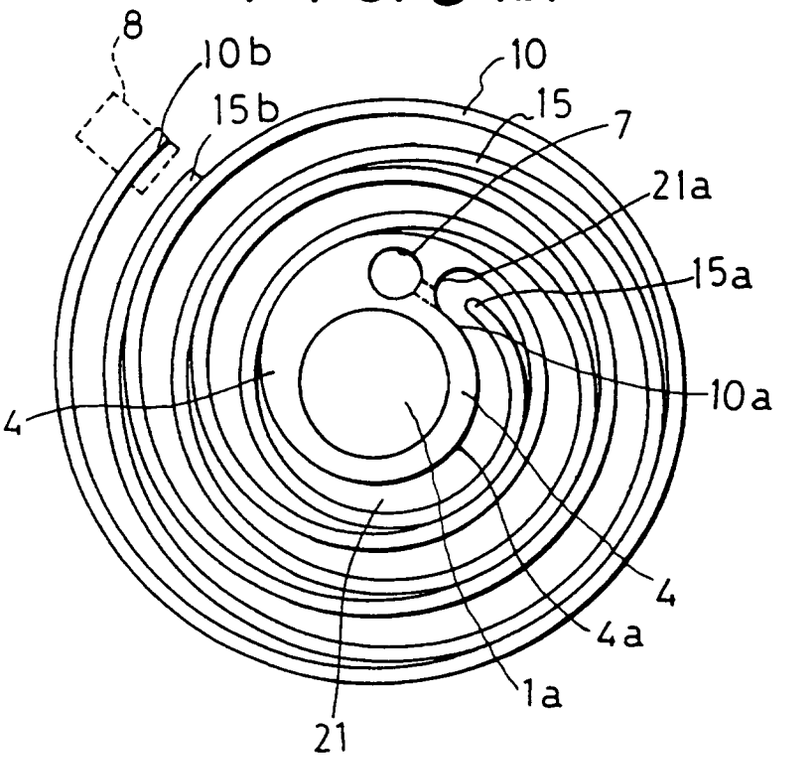

8
10b
15b
10
15
7
21a
15a
10a
4
4
4a
1a
21

FIG. 6

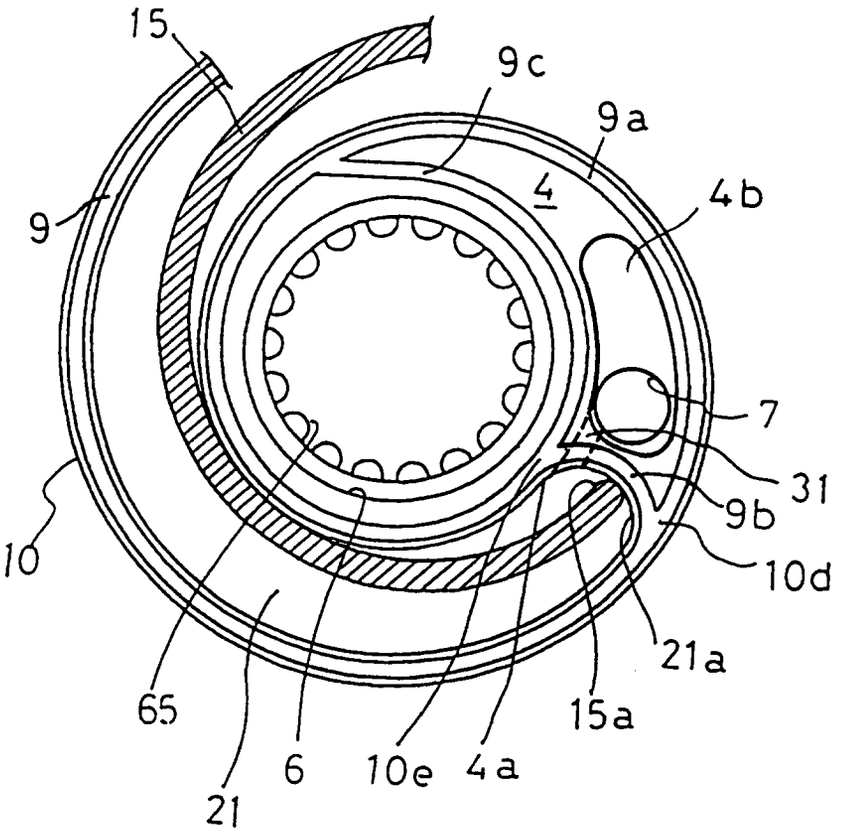
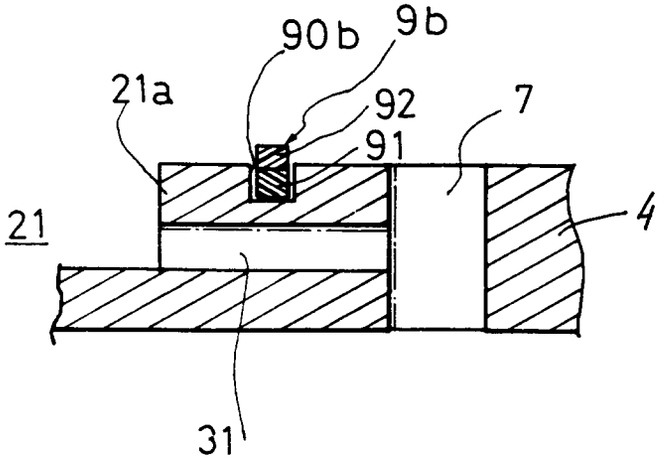

15
9c
9a
4
4b
9
7
31
9b
10
10d
21a
65
15a
21
6
10e
4a

FIG. 7


90b
9b
21a
92
7
91
21
4
31