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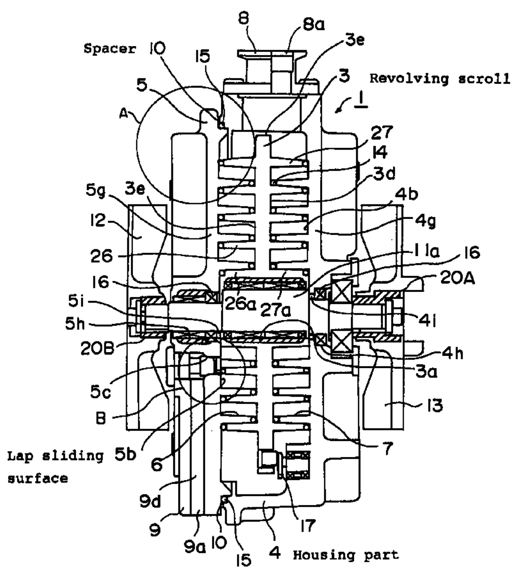
(54) Scroll fluid apparatus

(57) In a scroll fluid apparatus comprising at least one stationary scroll and a revolving scroll 3 used in combination therewith, the scrolls have laps 6 and 26 with the thickness thereof reducing from the scroll body mirror-finished surfaces 3e and 5b toward the tips as T1 > T2 and S1 > S2, elastic tip seals 14 being fitted in tip seal grooves formed in the tips of the laps. The lap 26 is engaged with the lap 6 in a state deviated by a predetermined angle. The revolving scroll 3 is disposed in an inner space of a housing 4 such that it is pushed thereby toward the mirror-finished surface 5b of the stationary scroll. The housing 4 is mounted on the stationary scroll via a spacer 10 such that the gap between the laps facing each other can be adjusted according to the thickness of the spacer.

Fig. 1



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Description

BACKGROUND OF THE INVENTION

Field of the invention

This invention relates to scroll fluid apparatuses, which comprise at least one stationary scroll and a revolving scroll for compressing gas and discharging the compressed gas to the outside, and also to a method of adjusting scroll position in the same.

Description of the Prior Art

Stationary scrolls and revolving scrolls, which have laps with the thickness thereof reducing from the stem on the scroll body mirror-finished surface toward the tip, are well known in the art as disclosed in Japanese Laid-Open Patent Publication No. 59-79090.

In this technique, since the thickness of the laps of the stationary and revolving scrolls are greater at the stem of the laps than at the tip thereof, the mechanical strength is improved, and deformation of the laps during the operation and machine processing can be eliminated.

Usually, in such a scroll fluid apparatus gas taken therein from the outer side is progressively compressed in a sealed space formed by the stationary and revolving scroll laps until it is brought to a central part of the apparatus and discharged as the compressed gas from the central part.

According to this prior art, when the facing laps forming the sealed space is excessively spaced apart, the volume of the sealed space may be insufficiently small. To obtain a desired fluid compression ratio, therefore, the lap turns number has to be increased, thus leading to an increased apparatus size.

When the gap of the sealed space is insufficiently small, on the other hand, the facing laps may strike each other while a revolving scroll is revolved, thus generating noise, increasing the load, requiring increased drive power and reducing the durability.

As a variety of scroll fluid apparatuses, scroll vacuum pumps are well known in the art, in which gas sucked from a vessel to be evacuated is taken in from the outer side of laps of stationary and revolving scrolls, and compressed in a progressively reducing the volume of sealed space formed by the laps one another, the compressed gas being discharged from a discharge port provided in a central part of the pump.

Examples of this prior art scroll vacuum pumps will now be described with reference to Figs. 5(a) and 5(b). In the example shown in Fig. 5(a), a stationary scroll 50A comprises a scroll body 50Aa with a stationary lap 50Ab provided on the inner side. A tip seal 54 which is fitted in the lap 50Ab is held in frictional contact with an inner mirror-finished surface of an opposed scroll body. The stationary scroll 50A has a suction hole 50Ac, which is provided on the outer side of the lap 50Ab and communicated with a vessel (not shown) to be evacuated, and also has a discharge hole 50Ad provided in the center of the scroll body 50Aa for discharging compressed gas.

A revolving scroll 51A comprises a scroll body 51Aa having a revolving lap 51Ab with a tip seal 54 fitted at the tip of lap 51Ab provided on the inner side and held in frictional contact with the opposed scroll body mirror-finished surface, and a revolving lap 51Ae with a revolving seal 53 fitted at the tip of 51Ae provided at the outside of revolving lap 51Ab and held in frictional contact with the scroll body 50Aa mirror-finished surface. The scroll body 51Aa has a central integral shaft 51Ac, which is eccentrically coupled to a shaft 51Ad coupled to a motor (not shown). The lap 51Ab is in mesh with the lap 50Ab of the stationary scroll 50A, and the revolving scroll 51A can be revolved relative to the stationary scroll 50A, whereby gas sucked through the suction hole 50Ac is progressively compressed in a sealed space formed by the laps 50Ab and 51Ab and discharged through the discharge hole 50Ad.

In the technique shown in Fig. 5(b), a stationary scroll 50B comprises a scroll body 50Ba with a lap 50Bb provided on the inner side, a tip seal 54 being fitted in the lap 50Bb and held in frictional contact with an opposed scroll body mirror-finished surface. The stationary scroll 50B has a suction hole 50Bc, which is provided on the outer periphery of the scroll body 50Ba and communicated with a vessel (not shown) to be evacuated, and also has a discharge hole 50Bd provided in the center of the scroll body 50Ba for discharging compressed gas.

A revolving scroll 51B comprises a scroll body 51Ba with a lap 51Bb provided on the inner side, a tip seal 54 being fitted in the tip of lap 51Bb and held in frictional contact with the opposed scroll body mirror-finished surface. The scroll body 51Ba has a central integral shaft 51Bc which is eccentrically coupled to a shaft 51Bd coupled to a motor (not shown). The lap 51Bb is in mesh with the lap 50Bb of the stationary scroll 50B, and the revolving scroll 51B can be revolved relative to the stationary scroll 50B.

A housing 52 which is coupled to the scroll body 50Ba of the stationary scroll 50B, provides an inner space 56 accommodating the revolving scroll 51B. The housing 52 has a central opening 52a, through which a drive shaft 51Bd of the revolving scroll 51B rotatably penetrates via a rotational seal 57. Gas sucked through the suction hole 50Bc is progressively compressed in a sealed space formed by the laps 50Bb and 51Bb and discharged through the discharge hole 50Bd.

The above prior art techniques are applications of a scroll compressor, in which the externally taken-in gas is under the same pressure as atmospheric air 58 when it has just taken in. In other words, in the case of Fig. 5(a) atmospheric air 58 and the taken-in gas in the space 59 on the outer side of the stationary scroll lap, exert equal pressures on the outer and inner sides of the revolving seal 53.

Likewise, in the case of Fig. 5(b) atmospheric air 58 and the taken-in gas in the space 56 on the outer side of the stationary scroll lap, exert equal pressures on the outer and inner sides of the rotating seal 57.

The scroll compressor sucks substantially the same pressure during its operation, leading to no substantial pressure difference between the pressures on the outer and inner sides of the revolving seal 53 or rotating seal 57, i.e., to no substantial gas leakage problem.

In the vacuum pump applications, however, the pressure of the gap taken in through the suction hole 50Ac (in the case of Fig. 5(a)) or 50Bc (in the case of Fig. 5(b)) which is communicated to the vessel to be evacuated, although initially the same as the atmospheric air pressure, is progressively reduced with the progress of the evacuation, thus producing a progressively increasing difference between the pressures of atmospheric air 58 and the taker-in gas in the peripheral inner space 56 or 59 of the scroll lap on the outer and inner sides of the revolving seal 53 or rotating seal 57, the pressure difference becoming maximum at the end of the evacuation of the vessel.

As described above, the revolving seal 53 is revolved with the revolving of the revolving scroll 51A, while the rotating seal 57 is rotated with the rotation of the shaft 51Bd of the revolving scroll 51B. As the seal 53 or 57 is worn out, the sealing pressures between it and the associated scroll body mirrors-finished surface, and also between it and the associated revolving scroll shaft outer periphery are reduced. In consequence, the seal is pushed inward by the atmospheric air pressure, resulting the formation of a clearance, through which atmospheric air is forced into the scroll mechanism to reduce the pumping efficiency of the vacuum pump.

OBJECT AND SUMMARY OF THE INVENTION

In view of the above background, it is an object of the invention to provide a scroll fluid apparatus and method of adjusting scroll position in the same, which permits setting an adequate gap between the facing laps.

Another object of the invention is to provide a scroll fluid apparatus, which is free from any increase of the difference between gas pressures on the inner and outer sides of the scroll mechanism, i.e., on the inner and outer sides of dynamic seals of a rotating drive part.

A further object of the invention is to provide a scroll fluid apparatus, which is reduced in size and improved in durability.

According to a first aspect of the invention, it is featured a scroll fluid apparatus, which comprises a stationary scroll and a revolving scroll, these scrolls having laps reducing in thickness from the stem on the scroll body mirror-finished surface toward the tip thereof, fluid taken in through a suction port provided on the outer side of the apparatus being compressed while being forced removing gradually through a sealed space formed in order by the laps in mesh with each other toward a discharge port provided in the neighborhood of the center of the apparatus and then discharged through the discharge port.

In the stationary and revolving scrolls, elastic tip seals are fitted in tip seal grooves formed in the tip of the laps such as to form the sealed space together with laps in frictional contact with opposed mirror-finished surface of scroll body each other, and a housing defining an inner space is coupled via a spacer to the stationary scroll, in which the revolving scroll is disposed such as to be pushed by the inner surface of the housing toward the stationary scroll body mirror-finished surface, gap between the facing laps being adjustable by appropriately selecting the spacer.

As shown in Fig. 1, with the above construction appropriate selection of the thickness of the spacer 10 permits the revolving scroll 3 to be pushed by the inner surface 4b of a housing part 4 to cause the tip seal 14, which is fitted in the tip seal groove 26e (Fig. 2) provided in the revolving scroll lap tip, to be elastically deformed and held in gas-tight frictional contact with the opposed mirror-finished surface. The distance between the lap sliding surfaces (i.e., mirror-finished surfaces) 4b and 5b of housing parts 4 and 5, and hence the distance between the mirror-finished surface 3e of the revolving scroll 3 and the mirror-finished surface 4b of the housing part 4, thus those both distances can be varied according to the thickness of the spacer 10.

As shown in Fig. 2(b), by appropriately selecting the spacer 10 the position of the inclined surface 26a of the lap 26 of the revolving scroll 3, as shown by the solid line, can be adjusted to the position as shown by the dashed line 26a'. That is, the distance L1 between the laps 26 and 6 with the inclined surface 26a at the position R1, can be reduced to the distance L2 by the position adjustment to the position R2 shown on the dashed line 26a'. In this way, the gap between the facing laps can be adjusted by appropriately selecting the spacer 10.

According to a second aspect of the invention, it is featured a method of adjusting the scroll position in a scroll fluid apparatus by:

preparing a stationary scroll and a revolving scroll, these scrolls having laps with the thickness thereof reducing from the stem on the scroll body mirror-finished surface toward the tip, elastic tip seals being fitted in the tip seal grooves formed in the tip of the laps and being each other in frictional contact with opposed scroll body mirror-finished surface, the laps being in mesh with each other, and also a housing having an inner space for accommodating the revolving scroll therein;

disposing the revolving scroll in the inner space of the housing such as to be pushed by the inner surface thereof toward the stationary scroll body mirror-finished surface; and

mounting the housing on the stationary scroll via a spacer such as to permit adjusting the gap between the facing laps according to the thickness of the spacer.

With this construction, appropriate selection of the spacer permits the revolving scroll to be pushed by the inner surface of housing toward the stationary scroll body mirror-finished surface to cause the tip seal fitted in the revolving scroll lap tip seal groove to be elastically compressed and held in gas-tight frictional contact with the opposed mirror-finished surface. In this way, the scroll position adjustment can be obtained.

Suitably, in the above adjustment method the revolving scroll, the stationary scroll and the housing may be prepared in different sizes in predetermined ranges, and their sizes may be selected to be in pertinent ranges to be mounted respectively.

By so doing, it is possible to assemble the apparatus such as to meet a required performance range without need of measuring the torque of the apparatus, fluid discharge rate in unit time, etc at the time of assembling.

According to a third aspect of the invention, it is featured a scroll vacuum pump comprising at least one stationary scroll and a revolving scroll, wherein the stationary scroll has a scroll body with a central bore, the revolving scroll having a scroll body with a shaft, which is fitted for rotation in the central bore of the stationary scroll via a dynamic seal.

Suitably, the stationary scroll is constituted by a housing having the central bore, in which the shaft of the revolving scroll is fitted, a stationary scroll lap extending spirally with above central bore as the center from the vicinity of the central bore toward the outer periphery and being in mesh with a revolving scroll lap, a suction port provided on the outer side of the stationary scroll lap for sucking gas, and a discharge port provided near the central bore for discharging the gas taken in from the outer side of the stationary scroll lap after the gas has been compressed, the revolving scroll being disposed in an inner space defined by the housing and revolved relative to the stationary scroll, the shaft of the revolving scroll being fitted for rotation in the central bore of the stationary scroll via a dynamic seal.

It is further suitable to construct a scroll vacuum pump, which comprises a double lap revolving scroll having a scroll body with laps each on each side, and a stationary scroll having a first housing part with a stationary lap in frictional contact with one of the laps of the revolving scroll and a second housing part with a stationary lap in frictional contact with the other lap of the revolving scroll, the first and second housing parts each constituting a stationary scroll body with a central bore, in which a shaft of the revolving scroll is fitted for rotating in the both central bores via a dynamic seal, the first and second housing parts being coupled to each other via a static seal in the vacuum scroll pump outer periphery other than a region thereof to be in frictional contact with the outer periphery of the revolving scroll.

As shown in Fig. 1, housing parts 4 and 5 form stationary scrolls with scroll bodies 4g and 5g. The scroll body 4g has a bore 4i and a greater diameter bore 4h, and the scroll body 5g has a bore 5h and a greater diameter bore 5i. The revolving scroll has a shaft 11, which is fitted for rotation in the greater diameter bores 4h and 5i via dynamic seals 16.

The rotation of the shaft 11 thus causes wear of the dynamic seals 16 intervening between the housing parts 4 and 5 and the shaft 11, and eventually produces clearances between the shaft 11 and the dynamic seals 16. Since the pressure of atmospheric air 58 is higher than the pressure inside the scroll mechanism, it causes gas to enter through the clearances between the seals 16 and the drive shaft 11, the clearances between the stationary scroll laps and the revolving scroll laps and the clearances between the tip seals and the opposed sliding surfaces as shown by arrows 20A and 20B in Fig. 4.

However, the gas that is discharged through a discharge port 5c after being compressed in the scroll mechanism, is under a higher pressure than the atmospheric air pressure. This means that the pressure in a central part of the inner space 21A, 21B, 22A and 22B in the scroll mechanism is far higher than in a peripheral part of the inner space, specifically close to the atmospheric air pressure, during the operation of the mechanism.

Thus, atmospheric air enters inner space of the scroll mechanism only slightly, if any, through the clearances formed by the dynamic seals 16. The gas entering the scroll mechanism may progressively flow through the clearances, or between the scroll laps and the clearances between the tip seals and the opposed mirror-finished surfaces towards the peripheral part of the mechanism. However, the numbers of turns of the laps have an effect of a labyrinth to interfere with the flow of the gas toward the peripheral part of the mechanism.

Atmospheric gas entering into a central part of the scroll mechanism inner space only slightly, if any, through the clearances formed by the dynamic seals 16, is thus compressed in that central part of the inner space together with preceding stage compressed gas being compressed in a preceding stage sealed space to be sent out toward the outside through a discharge port 5C.

The dynamic seals 16 are located at positions near the discharge port, at which positions the pressure of the inner compressed gas does not substantially differ from the atmospheric air pressure before the compressed gas is discharged to the outside. These seals thus can prevent the efficiency of the scroll mechanism from being reduced by externally introduced gas as a result of their wear, thus improving the durability of the scroll mechanism.

Suitably, said housing is constituted by a plurality of separate housing parts as noted above, two of which are coupled to each other via a static seal provided in the outer periphery of the scroll mechanism other than a region in frictional contact with the outer periphery of said revolving scroll.

The adjacent housing parts, i.e., the housing parts 4 and 5 (Fig. 1), are assembled together by inserting the shaft 11 into the central bore of one of them, i.e., the housing part 4, then disposing the revolving scroll therein by fitting a central bore of the revolving scroll on a portion 11a of the shaft 11, then engaging the other housing part 5 with the housing part 4, and then securing the two housings 4 and 5 to each other with bolts and nuts (not shown).

The housing which comprises these separate parts, can be assembled orderly and, if necessary, it is possible to adjust the housing inner space dimension in the axial direction of the shaft by appropriately selecting the spacer between the adjacent housing parts.

The assembling of the scroll vacuum pump may be facilitated by preliminarily measuring dimensions of the housing parts and the revolving scroll and grouping these components of eventual products in suitable dimension ranges together with pertinent spacer dimension ranges.

With the adjacent housing parts coupled to each other via the static seal 15 provided in the scroll vacuum pump outer periphery other than the region thereof in frictional contact with the revolving scroll outer periphery 3e, the static seal 15 is held stationary without possibility of producing any clearance while the gas sucked through a suction port 8 is reduced in pressure with the progress of the evacuation of the vessel.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic view showing a scroll fluid apparatus embodying the invention;

Fig. 2(a) is an enlarged-scale view showing a part A shown in Fig. 1;

Fig. 2(b) is a view for describing a function when adjusting an inter-lap gap;

Fig. 3 is an enlarged-scale view showing a part B shown in Fig. 1;

Fig. 4 is a view for describing a function when atmospheric air is introduced;

Fig. 5(a) is a view showing a pertaining prior art scroll fluid apparatus; and

Fig. 5(b) is a view showing a different pertaining prior art scroll fluid apparatus.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The invention will now be described in detail in conjunction with an embodiment thereof illustrated in the drawings. Unless otherwise specified, the sizes, materials, shapes, relative dispositions, etc. of the components described in the embodiment, have no sense of limiting the scope of the invention to them alone but are merely exemplary.

Fig. 1 is a schematic view showing an embodiment of the scroll fluid apparatus according to the invention. Fig. 2(a) is an enlarged-scale view showing a part A shown in Fig. 1. Fig. 2(b) is a view for describing a function when adjusting an inter-lap gap. Fig. 3 is an enlarged scale view showing a part B shown in Fig. 1.

Referring to Fig. 1, the scroll vacuum pump designated at 1 has a shaft 11, which has its right end coupled to a drive shaft of a motor (not shown) and able to be driven by the torque thereof. The shaft 11 has a central eccentric portion 11a with an increased outer diameter, which has its ends supported for rotation in bearings and dynamic seals 16 provided in housing parts 4 and 5.

The dynamic seals 16 serve to prevent intrusion of external particles and also prevent gas leaks to and from the outside of the scroll vacuum pump. They are desirably excellent in wear resistance. As for the sealing property, however, they need provide only the usual mechanical seal since they are located at positions subject to less pressure difference between the inside and outside of the scroll mechanism.

The housing parts 4 and 5 form stationary scrolls. They are cup-like in shape, and their outer peripheral walls which function as casings are sealed to each other via a spacer 10 and an O-ring 15 as a static seal, thus forming an inner sealed space.

The housing part 4 has a lap sliding surface (i.e., a mirror-finished surface) 4b perpendicular to its axis. Its central portion has a bore 4i, which is open to the lap sliding surface 4b and in which a non-eccentric portion of the shaft 11 other than the eccentric portion 11a thereof is fitted for rotation, and an increased diameter bore 4h, in which the dynamic seal 16 noted above is fitted. The lap sliding surface 4b has a lap 7 extending spirally outward from the neighborhood of the bores. A tip seal 14 is fitted in a tip seal groove formed in the top of the lap 7. The tip seal 14 is made of a fluorine type resin or like self-lubricating material and in contact with the opposed lap sliding surface to provide a perfectly seal.

The peripheral wall of the housing part 4 has three elements of a revolving mechanism 17, radially spaced apart at an interval of 120 degrees.

The revolving mechanism 17 is coupled to a revolving scroll to be described later.

The housing part 4 has a suction port 8, which is formed in the outer periphery and communicated with a vessel (not shown) to be evacuated for sucking gas therefrom through it.

The housing part 5 has a lap sliding surface 5b perpendicular to its axis. It's central portion has a bore 5h, which is open to the lap sliding surface 5b and in which a non-eccentric portion of the shaft 11 other than the eccentric portion 11a thereof is fitted for rotation, and an increased diameter bore 5i, in which the dynamic seal 16 is fitted. The lap sliding surface 5b has a lap 6 extending spirally outward from the neighborhood of the bores. A tip seal 14 is fitted in a tip seal groove formed in the tip of the lap 6 and in contact with the opposed lap sliding surface to provide a perfect seal.

A revolving scroll 3 is disposed for revolving in the inner space formed by the housing parts 4 and 5.

The revolving scroll 3 has a disc-like scroll body having opposite side lap sliding surfaces 3d and 3e with laps 26 and 27 thereon, which are able to engage with the stationary scroll laps.

The revolving scroll 3 has a central bore 3a which is fitted on the eccentric portion 11a of the shaft 11. The bore 3a is surrounded over the entire length of the eccentric portion of the shaft 11 by laps 26a and 27a.

The housing part 5 has a discharge port 5c, which is open to the lap sliding surface 5b at a position thereof near the end of the lap 6. As shown in Fig. 3, a check valve 18 is provided in the discharge port 5c. The check valve 18 has a head 18a to be forced into sealing contact with the wall surface of the discharge port 5c, and a stem 18b for pushing the head 18a with a predetermined pressure. When the pressure of the gas having been compressed in the sealed space formed by the stationary and revolving scroll laps 6 and 26 exceeds the gas pressure in a discharge passage 9d, the valve head 18a is pushed open as shown by the phantom line 18a' to produce a clearance, allowing the compressed gas to be discharged through a discharge opening 5d, the discharge port 5c and the discharge passage 9d, and thence through a discharge opening 9a provided in the outer peripheral wall of the housing part 4 to the outside.

For the compressed gas in the sealed space formed by the stationary and revolving scroll laps 7 and 27, the lap sliding surface 4b has a discharge port, a check valve, a discharge passage, etc. like the discharge port 5c, the check valve 18, the discharge passage 9d, etc. being disposed on the lap sliding surface 5b (not shown), respectively.

Cooling fans 12 and 13 for cooling the scroll vacuum pump, are mounted on end portions of the shaft 11 outside the housing parts 5 and 4.

The three elements of the revolving mechanism 17, which are provided at a radial interval of 120 degrees on the outer periphery of the revolving scroll as described before, are supported at one end on the housing part 4 and at the other end on the outer periphery of the revolving scroll 3. Via the revolving mechanism 17, the revolving scroll 3 is revolved relative to the stationary scrolls, that is, the outer periphery 3e of its scroll body is revolved in the housing inner space about an eccentric axis to the stationary scrolls.

In the scroll vacuum pump 1 having the above construction, with the rotation of the shaft 11 the eccentric portion 11a thereof causes revolution of the revolving scroll 3.

With the driving of the revolving scroll 3, gas sucked from an opening 8a of the suction port 8 is taken into the scroll mechanism by the revolving scroll laps 26 and 27 and progressively compressed in the sealed spaced formed by these laps and the stationary scroll laps 6 and 7 to be sent to the central portion. The compressed gas is discharged through the discharge port 5c and thence through the discharge passage 9d and the discharge opening 9a.

As shown, this embodiment related to the scroll type vacuum pump which comprises at least one stationary scroll and a revolving scroll, the revolving scroll having a shaft fitted for rotation in a central bore formed in the scroll body of each stationary scroll via a dynamic seal.

Suitably, either stationary scroll as a housing having the central bore penetrated by the shaft supporting the revolving scroll thereon, has a lap extending spirally outward from the neighborhood of the central bore toward the outer periphery and in mesh with a revolving scroll lap, either stationary scroll lap has a suction port provided on the outer side of its lap for sucking gas, and either stationary scroll has a discharge port provided near the central bore for discharging gas that has been compressed after being taken in from the outer side of the scroll mechanism, the revolving scroll being disposed in a housing inner space for revolution relative to each stationary scroll, the shaft supporting the revolving scroll being fitted for rotation in the central bore of each stationary scroll via a dynamic seal.

The rotation of the shaft 11 causes wear of the dynamic seals 16 intervening between the housing parts 4 and 5 and the shaft 11, and eventually produces clearances between the shaft 11 and the dynamic seals 16. Since the pressure of the atmospheric air 58 is higher than the pressure inside the scroll mechanism, it causes gas to enter through the clearances between the seals 16 and the drive shaft 11, the clearances between the stationary scroll laps and the revolving scroll laps and the clearances between the tip seals and the opposed sliding surfaces as shown by arrows 20A and 20B in Fig. 4.

However, the gas that is discharged through the discharge port 5c after being compressed in the scroll mechanism, is under a high pressure than the atmospheric air pressure. This means that the pressure in a central part of the inner space 21A, 21B, 22A and 22B in the scroll mechanism is far higher than in a peripheral part of the inner space, specifically close to the atmospheric air pressure, during the operation of the mechanism.

Thus, atmospheric air enters inner space of the scroll mechanism only slightly, if any, through the clearances formed by the dynamic seals 16. The gas entering the scroll mechanism may progressively flow through the clearances between the scroll laps and the clearances, or between the tip seals and the opposed mirror-finished surfaces towards the peripheral part of the mechanism. However, the numbers of turns of the laps have an effect of a labyrinth to interfere with the flow of the gas toward the peripheral part of the mechanism.

Atmospheric gas entering into a central part of the scroll mechanism inner space only slightly, if any, through the clearances formed by the dynamic seals 16, is thus compressed in that central part of the inner space together with preceding stage compressed gas being compressed in a preceding stage sealed space to be sent out toward the outside through a discharge port 5C.

The dynamic seals are located at positions near the discharge ports, at which positions the pressure of the inner compressed gas does not substantially differ from the atmospheric air pressure. These seals thus can prevent the efficiency of the scroll mechanism from being reduced by externally introduced gas as a result of their wear, thus improving the durability of the scroll mechanism.

In this embodiment, a plurality of housing parts are used with adjacent ones thereof coupled to each other via a static seal provided in the outer periphery of the assembled housing other than a region thereof in frictional contact with the outer periphery of the revolving scroll.

The adjacent housing parts, i.e., the housing parts 4 and 5 (Fig. 1), can be readily assembled together by inserting the shaft 11 into the central bore of one of them, i.e., the housing part 4, then disposing the revolving scroll therein by fitting the central bore of the revolving scroll on the portion 11a of the shaft 11, then engaging the other housing part 5 with the housing part 4, and then securing the two housings 4 and 5 to each other with bolts and nuts (not shown).

Besides, the revolving scroll can be readily positioned because the shaft supporting it is supported by the two housing parts 4 and 5, and thus it can be driven accurately.

In this embodiment, the gap between the facing laps of the stationary and revolving scrolls, i.e., the distance between the mirror-finished surfaces 5b and 4b, can be adjusted by appropriately selecting the thickness of the spacer 10 as shown Fig. 1.

When the revolving scroll 3 is pushed by the inner surface, i.e., the mirror-finished surface 4b of the housing part 4 via the tip seal 14, the tip seals 14 fitted in the tip seal grooves formed in the tip of its Laps 27 and 26 are elastically deformed to be in gas-tight frictional contact with the opposed mirror-finished surfaces 5b and 4b, while permitting the distance between the lap sliding surfaces (i.e., mirror-finished surfaces) 4b and 5b of the housing parts 4 and 5 to be varied.

The distance between the mirror-finished surface 3e of the revolving scroll 3 and the mirror-finished surface 4b of the housing part 4 thus can be varied according to the thickness of the spacer 10.

A shown in Fig. 2(a), the lap 26 of the revolving scroll 3 is formed such that its inclined surface 26a extending from its stem 26c to its tip 26d has an equal inclination angle to the inclination angle of the inclined surface 6b of the lap 6.

As shown in Fig. 2(b), the capability of varying the distance between the mirror-finished surfaces of the housing parts 4 and 5, means that the position of the inclination surface 26a of the lap 26 of the revolving scroll 3 as shown by the solid line can be adjusted to, for instance, the position as shown by the dashed line 26a' by selecting the spacer. In this case, the gap L1 between the laps 26 and 6 with the inclined surface 26a at position R1 is reduced to a gap L2 with the inclined surface at position R2 as shown by the dashed line 26a'. In this way, it is possible to adjust the gap between the laps facing each other by appropriately selecting the spacer.

For permitting the scroll position adjustment, a stationary scroll and a revolving scroll are prepared, which have laps reducing in thickness from the mirror-finished surface toward the tip, i.e., T1 > T2 and S1 > S2, an elastic tip seal being fitted in the tip of each lap and in frictional contact with the opposed mirror-finished surface, and a housing having an inner space for accommodating the revolving scroll therein, are prepared, the revolving scroll lap is meshed with the stationary scroll lap in a state that it is deviated by a predetermined angle, the revolving scroll in this state is disposed in the housing inner surface such that it is pushed by the housing inner surface toward the mirror-surface of the stationary scroll, and then the housing is mounted on the stationary scroll via a spacer. With the revolving scroll pushed by the housing inner surface toward the mirror-finished surface of the stationary scroll, each tip seal fitted in the tip seal groove provided in each lap tip is elastically compressed to be in gas-tight frictional contact with the opposed mirror-finished surface. It is thus possible to adjust the scroll position through adjustment of the gap between the laps facing each other, which is made by appropriately selecting the spacer thickness.

The dimensions of the components, such as the dimension between the tips of the revolving scroll opposite side laps and the height dimension of the laps 6 and 7 of the housing parts 4 and 5 from the mirror-finished surfaces 5b and 4b to the tips, are not fixed but fluctuate within tolerances of each kind of component due to wear of cutting tools used in the process of manufacture and fluctuations of initial settings for each lot.

Therefore, when a component with a positive error from the predetermined dimension is fitted in a component with a negative error, the clearance between the two components may be insufficient and disable sliding. On the other hand, fitting a product with a negative error in a component with a positive error may result in increased rattling between the two components.

The more the number of the components that are assembled together, the greater are the fluctuations as accumulated errors, increasing cases of making adjustment by replacing components and repeating tests.

In this embodiment, the housing consists of a plurality of separate parts as noted above, with adjacent ones thereof coupled to each other via a static seal provided in outer periphery of the scroll vacuum pump other than a region thereof in frictional contact the revolving scroll outer periphery. More specifically, the adjacent housing parts, i.e., the housing parts 4 and 5 (Fig. 1) are assembled together by inserting the shaft 11 into the central bore of one of them, i.e., the housing part 4, then disposing the revolving scroll therein by fitting a central bore of the revolving shaft on a portion 11a of the shaft 11, then engaging the other housing part 5, and then securing the two housing parts 4 and 5 to each other with bolts and nuts (not shown).

To facilitate the assembling, the components may be grouped into groups of those with negative errors, those with small errors and those with positive errors, etc. by measuring errors of components after the manufacture. Doing so permits assembling of the scroll mechanism by using components with similar errors.

By grouping stationary scrolls, revolving scrolls and housings into groups of those with sizes in predetermined ranges and using components in pertinent size ranges for assembling, it is possible to assemble the apparatus in a required performance range without need of measuring the torque of the apparatus, fluid discharge rate, etc. in the assembling.

The separate housing parts thus permit orderly assembling. In addition, it is possible to adjust, if necessary, the dimension of the housing inner space in the axial direction of the shaft by appropriately selecting the spacer interposed between adjacent housing parts.

The assembling thus may be facilitated by preliminarily measuring the dimensions of the housing parts and the revolving scroll and grouping these components together with the spacer.

In this embodiment, with the adjacent housing parts coupled to each other via the static seal 15 provided in the scroll vacuum pump outer periphery other than the region thereof in frictional contact with the revolving scroll outer periphery 3e, the static seal 15 is held stationary without possibility of producing any clearance while the gas sucked through a suction port 8 is reduced in pressure with the progress of the evacuation of the vessel.

While the above embodiment concerned the case, in which the double lap revolving scroll with the opposite side laps on the scroll body is used in combination with stationary scrolls, this is by no means limitative; the invention is also applicable to a case, in which a combination with a single lap revolving scroll having a single revolving lap on the scroll body and a stationary scroll are used.

As has been described in the foregoing, according to the invention the shaft supporting the revolving scroll is fitted for rotation in the stationary scroll body central bores via the dynamic seals, which are located in the neighborhood of the discharge port for discharging compressed gas. Thus, the pressure difference between the scroll mechanism inner and outer gases on the inner and outer sides of the dynamic seals, which seal the shaft for driving the revolving scroll are not big, and atmospheric air enters only very slightly, if any, due to wear of the dynamic seals. It is thus possible to prevent reduction of the efficiency of the scroll mechanism and improve the durability thereof.

In addition, according to the invention a stationary scroll and a revolving scroll, with the laps thereof reducing in thickness from the scroll body mirror-finished surface toward the tip, elastic tips being fitted in the lap tips and in frictional contact with the opposed scroll body mirror-finished surfaces, and a housing having an inner space for accommodating the revolving scroll therein, are used, the revolving scroll being disposed in the housing inner space such as to be pushed by the housing inner surface toward the stationary scroll body mirror-finished surface, the housing being mounted on the stationary scroll via a spacer. It is thus possible to provide a scroll fluid apparatus, which permits setting an adequate gap between the laps facing each other according to the thickness of the spacer, as well as a method of scroll position adjustment in the same scroll fluid apparatus.

Claims

1. A scroll fluid apparatus comprising a stationary scroll and a revolving scroll (3), said scrolls having laps (6, 7, 26, 27) reducing in thickness from the stem on the scroll body mirror-finished surface (3e, 4b, 5b) toward the tip thereof, fluid taken in through a suction port (8) provided on the outer side of said apparatus being compressed while being forced moving gradually through a sealed space formed by said laps in mesh with each other toward a discharge port (5c) provided in the neighbourhood of the center of the apparatus and then discharged through said discharge port,

   in the stationary and revolving scrolls, elastic tip seals (14) being fitted in tip seal grooves formed in the tip of said laps such as to form said sealed space together with laps in frictional contact with opposed mirror-finished surface of scroll body,

   a housing (4, 5) defining an inner space being coupled via a spacer (10) to said stationary scroll,

   said revolving scroll being disposed such as to be pushed by the inner surface of said housing toward the stationary scroll body mirror-finished surface,

   the gap between said laps facing each other being adjustable by appropriately selecting the spacer.

2. A method of adjusting the scroll position in a scroll fluid apparatus by:

   preparing a stationary scroll and a revolving scroll (3), said scrolls having laps (6, 7, 26, 27) with the thickness thereof reducing from the stem on the scroll body mirror-finished surface (3e, 4b, 5b) toward the tip, elastic tip seals (14) being fitted in the tip seal grooves formed in the tip of said laps and being in frictional contact with the opposed scroll body mirror-finished surface, and also a housing (4, 5) having an inner space for accommodating said revolving scroll:

   said laps of said revolving and stationary scrolls being in mesh with each other;

disposing said revolving scroll (3) in said inner space of said housing (4, 5) such as to be pushed by the inner surface thereof toward the stationary scroll body mirror-finished surface (4b, 5b); and

mounting said housing on said stationary scroll via a spacer (10) such as to permit adjusting the gap between said laps facing each other according to the thickness of said spacer.

3. The method of adjusting the scroll position in a scroll fluid apparatus according to claim 2, wherein as said stationary scroll, said revolving scroll (3) and said housing (4, 5) are prepared those of different sizes in predetermined ranges for selecting those of given sizes in pertinent ranges to be mounted respectively.

4. A scroll fluid apparatus comprising at least one stationary scroll and a revolving scroll (3),

said revolving scroll being supported on a shaft (11) fitted for rotation in a central bore formed in the scroll body of each stationary scroll via a dynamic seal (16).

5. The scroll fluid apparatus according to claim 4, wherein:

said stationary scroll is constituted by a housing (4, 5) having said central hole, in which said shaft (11) of said revolving scroll (3) is fitted, said housing also having a stationary scroll lap (6, 7) extending spirally with above central bore as the center from the vicinity of said central bore toward the outer periphery and being in mesh with a revolving scroll lap (26, 27), a suction port (8) provided on the outer side of said stationary scroll lap for sucking gas, and a discharge port (5c) provided near said central bore for discharging the gas taken in from the outer side of said stationary scroll lap after said gas has been compressed,

said revolving scroll (3) being disposed in an inner space defined by said housing (4, 5) and revolved relative to said stationary scroll,

said shaft (11) of said revolving scroll (3) being fitted for rotation in said central bore of said stationary scroll via a dynamic seal (16).

6. The scroll fluid apparatus according to claim 5, wherein said housing (4, 5) is constituted by a plurality of parts, two of which are coupled to each other via a static seal (15) provided in the outer periphery of the scroll mechanism other than a region in frictional contact with the outer periphery of said revolving scroll (3).

7. A scroll fluid apparatus comprising a double lap revolving scroll (3) having a scroll body with laps (26, 27) each on each side, and a stationary scroll having a first housing part (4, 5) with a stationary lap in frictional contact with one of said laps of said revolving scroll and a second housing part (4, 5) with a stationary lap in frictional contact with the other lap of said revolving scroll,

said first and second housing parts (4, 5) each constituting a stationary scroll body with a central bore, in which a shaft (11) of said revolving scroll (3) is fitted for rotation in the both central bores via a dynamic seal (16),

said first and second housing parts (4, 5) being coupled to each other via a static seal (15) in the scroll build apparatus outer periphery other than a region thereof to be in frictional contact with the outer periphery of said revolving scroll (3).

Fig. 1

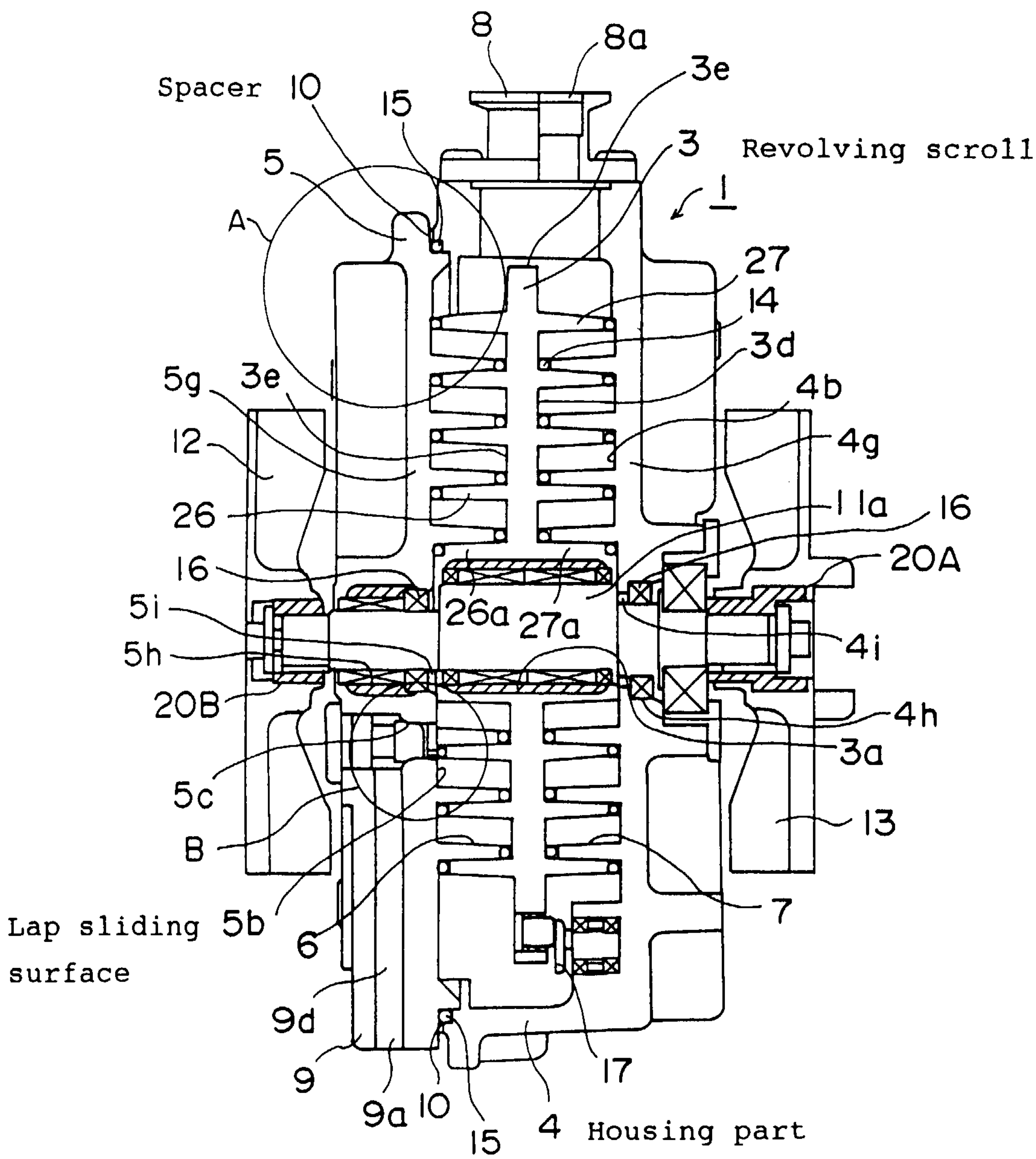

8
8a
3e
Spacer 10
15
3
Revolving scroll
5
1
A
27
14
3d
5g
3e
4b
12
4g
26
11a
16
20A
16
26a
27a
5i
4i
5h
20B
4h
3a
5c
13
B
7
Lap sliding surface
5b
6
9d
17
9
9a
10
15
4
Housing part

Fig. 2

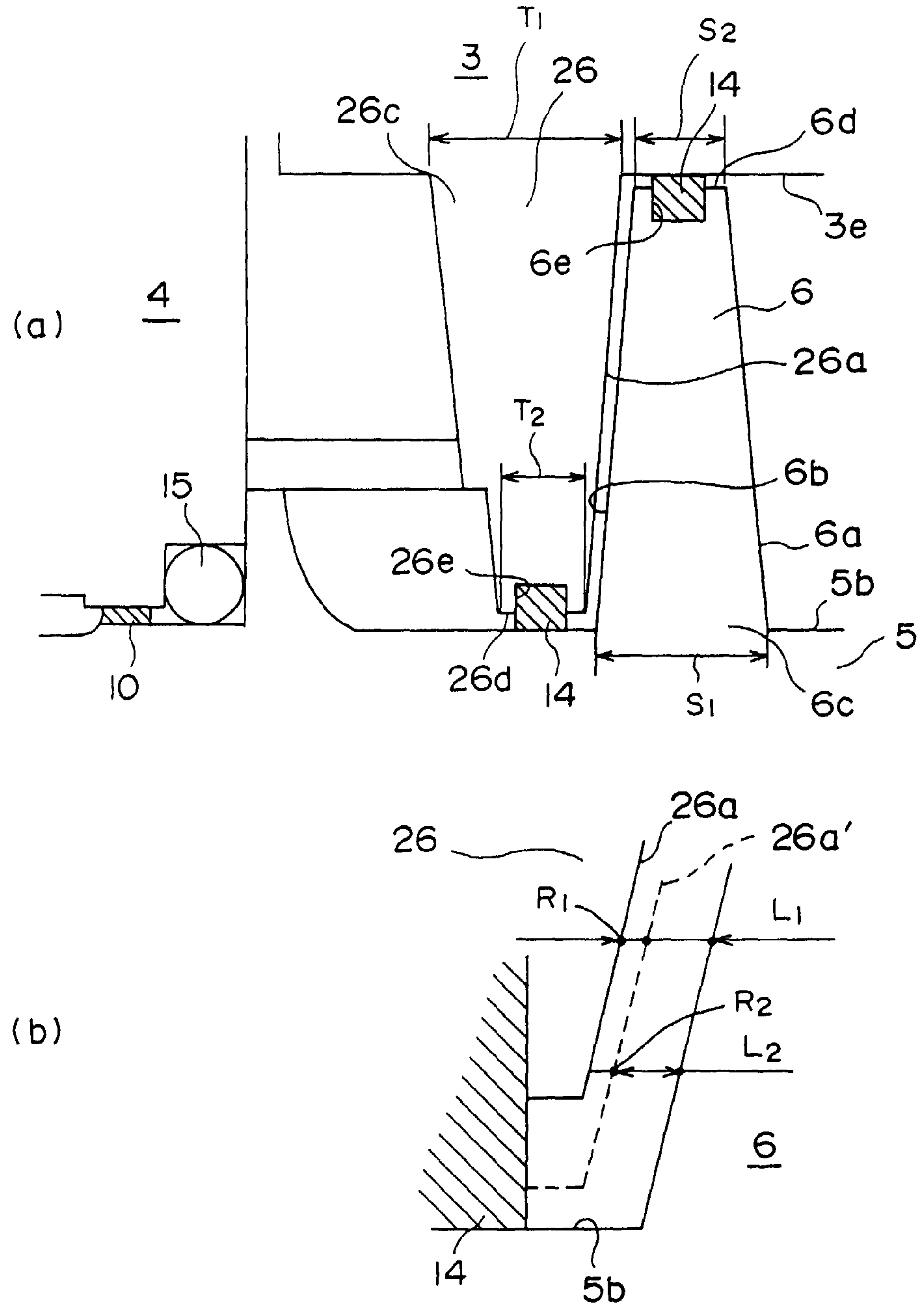

(a)
4
3
T1
26
26c
S2
14
6d
3e
6e
6
26a
T2
6b
15
6a
26e
5b
5
10
26d
14
S1
6c
(b)
26
26a
26a'
R1
L1
R2
L2
6
14
5b

Fig. 3

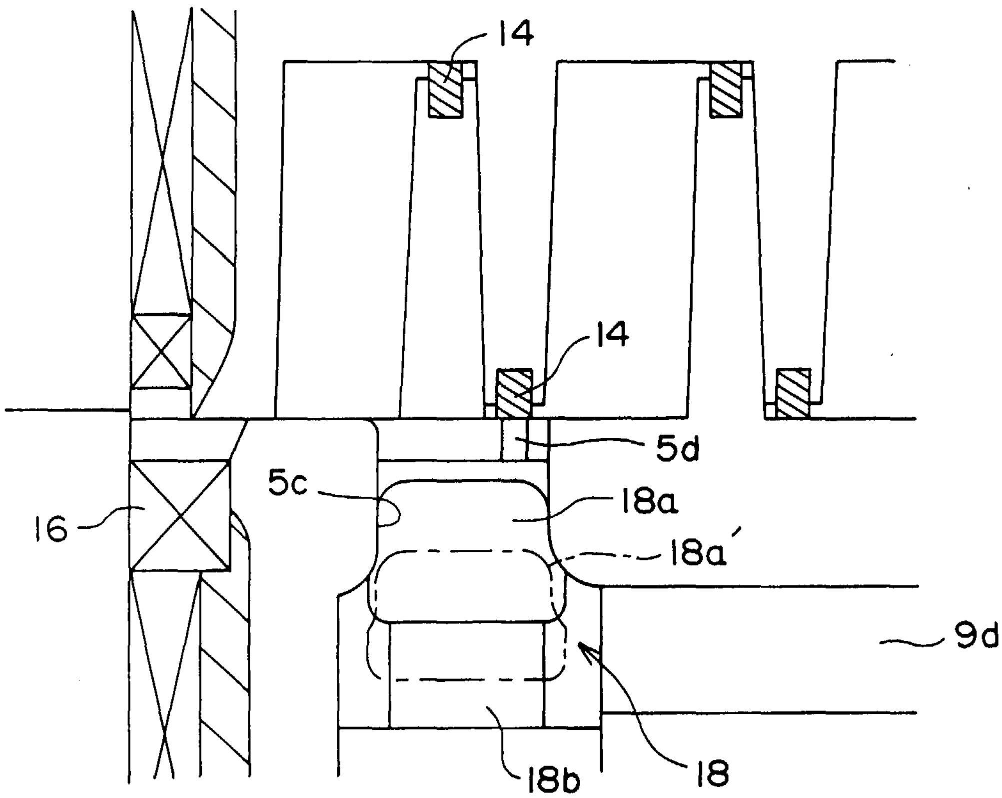


Fig. 4

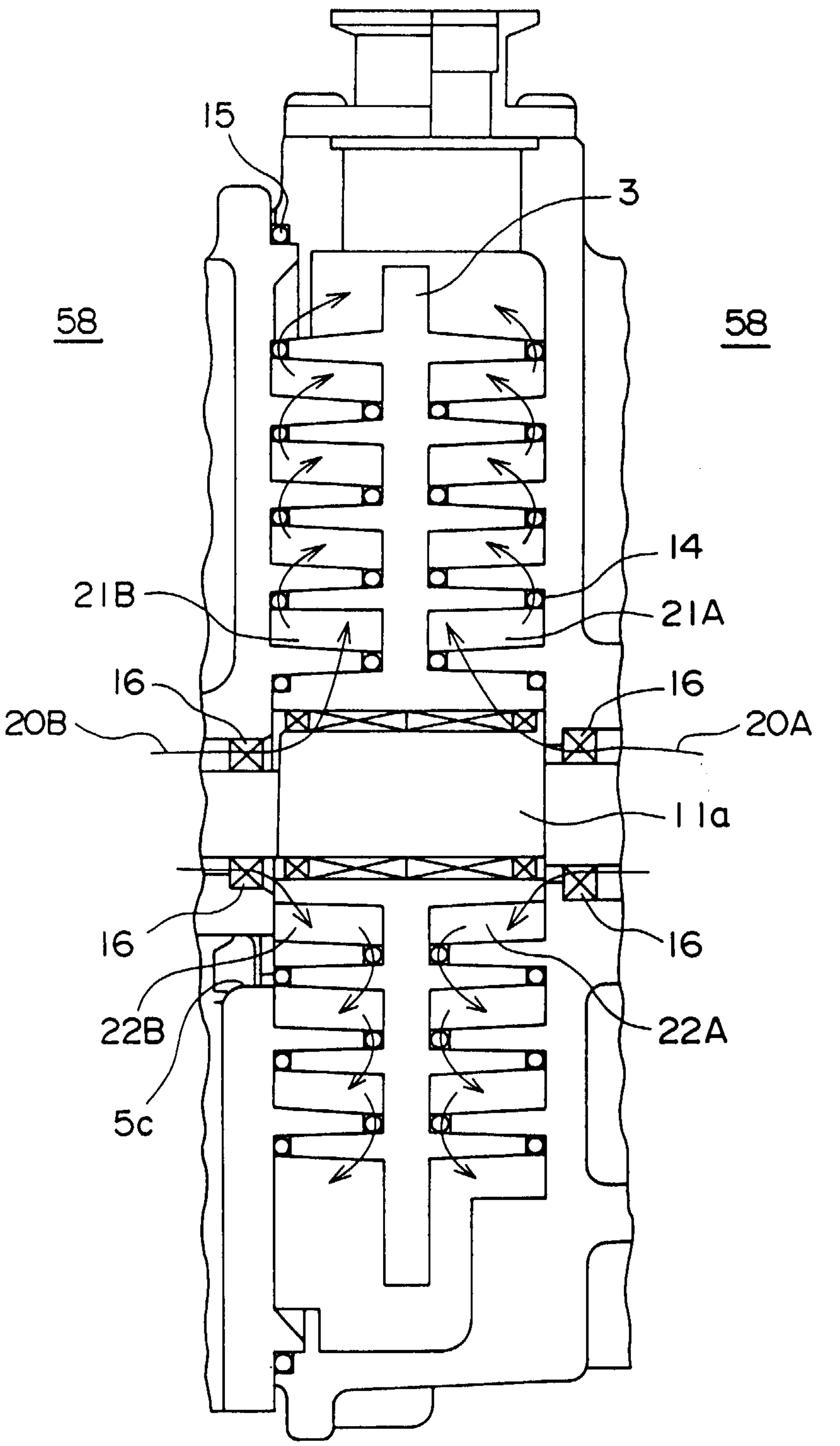
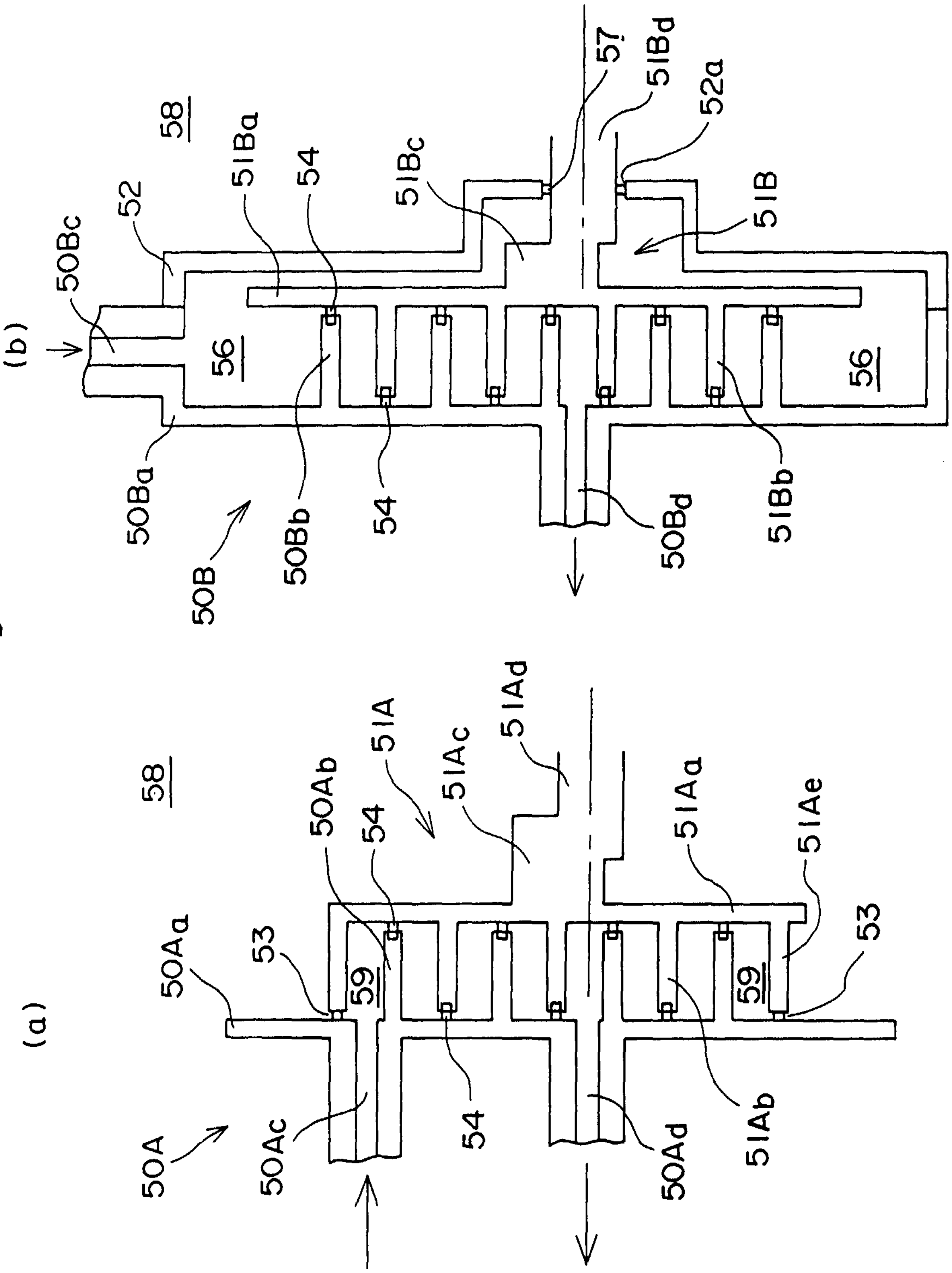


Fig. 5


(a)
(b)
50A
50Aa
50Ab
50Ac
50Ad
51A
51Aa
51Ab
51Ac
51Ad
51Ae
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54
58
59
50B
50Ba
50Bb
50Bc
50Bd
51B
51Ba
51Bb
51Bc
51Bd
52
52a
54
56
57