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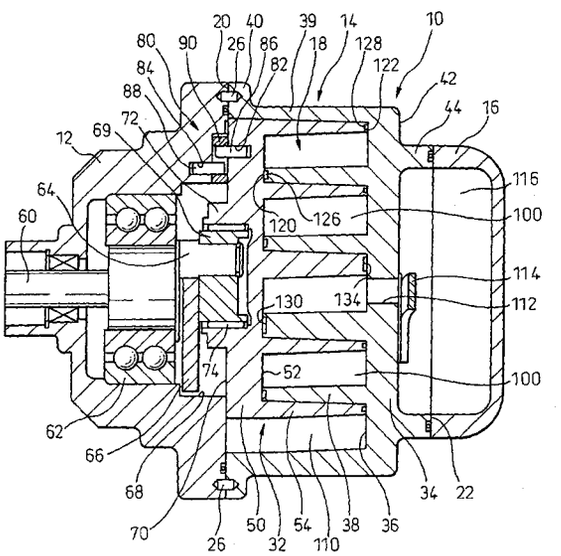
(54) Scroll-type compressor

(57) A scroll material 160 for the production of a scroll is cast, a scroll portion 54 thereof is left as cast, and the portions other than the scroll portion 54 are machine-worked. Positioning portions 168, 169, and 170 and an engagement hole 172 are cast together with the scroll portion 54 of the scroll material 160, etc., in a die-casting process. In a machine working process, an engagement portion 248 of a holding jaw 234 is engaged with the engagement hole 172 of the positioning portion 168 and at the same time the positioning portions 168, 169, and 170 are held with the holding jaws 234, 236 and 238 of a chuck 230. In this state, the outer side surface of the base 162 opposite to the scroll portion 54, etc., are cutting-worked with work tools. Using the positioning portions 168, 169, and 170 as the work basis is almost equal to using the scroll portion 54 as the work basis, and a movable scroll, having a high relative positioning accuracy between the scroll portion 54 and other portions, can be manufactured.

Fig.1



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a scroll-type compressor, a scroll thereof, and a method of manufacturing the scroll.

2. Description of the Related Art

[0002] A scroll-type compressor comprises a fixed scroll and a movable scroll. A scroll has a structure in which a scroll portion (or scroll lap) is provided on a surface of a base (or an end plate portion or a mirror plate), and in a state in which the fixed scroll and the movable scroll are engaged with each other, a compression chamber, which is a crescent-shaped and substantially closed space, is formed between the outer side surface and the inner side surface of the scroll portions of both scrolls. When the movable scroll is revolved, the compression chamber moves from the peripheral portion of the scrolls to the central portion thereof and the volume of the compression chamber decreases as it moves in. The gas enclosed in the compression chamber is compressed thereby and discharged from a discharge port formed in the central portion.

[0003] Therefore, it is required that the inner side surface and the outer side surface of the scroll portions, and the front end surface and the inner side surface of the base of the scroll portions of the fixed scroll and the movable scroll come into contact with each other or come very close in with each other to prevent the gas in the compression chamber from flowing to the outside with all possible effort. For example, the movable scroll is revolved with the scroll portion thereof being kept in contact with the scroll portion of the fixed scroll. In this case, both the scroll portions of the fixed scroll and the movable scroll are made to come into contact with each other at both the ends in the circumferential direction of each compression chamber, and it is preferable that as many points as possible, in plural points to be contacted, are made to come into contact and the degree of contour (when the actual contour is within +/- Hμm from the true contour, the degree of contour is said to be 2Hμm) of the outer side surfaces and the inner side surfaces of the both scroll portions is, for example, 70μm or less, or more preferably, 40μm or less, so that clearances are as small as possible even if there exist portions not in contact with each other. It may be the case in which a revolving mechanism, which revolves the movable scroll, has a function to maintain the posture of the movable scroll (self-rotation preventing function), independently (without the help of the fixed scroll) and the scroll of the movable scroll is revolved without the scroll portion thereof being in contact with the scroll portion of the fixed scroll. In this case, the measure of the clearances between the inner side surface and the outer side surface of the scroll portion is required to be within the specified range, and it is necessary that the degree of contour of the inner side surface and the outer side surface of the scroll portion is, for example, 40μm or less to meet the requirement. It is also required that the height from the inner side surfaces of the base to the front end surfaces of the scroll portion is within the specified range and in such a case, the flatness thereof and the parallelism therebetween are need to be, for example, 20μm or less.

[0004] To satisfy the above-mentioned requirements, machine work such as cutting work, grinding work, and so on, using a complicated and expensive working machine such as the scroll form working machine disclosed in Japanese Unexamined Patent Publication (Kokai) No.6-99306 used to be performed conventionally. The work cost is, however, very high because it takes a considerable time for machine work and the cost of facilities is also high because a considerable number of working machines is required to produce a desired number of scrolls, and as a result it is unavoidable that the scroll-type compressor is expensive.

[0005] Therefore, it has been proposed, for example, in Japanese Unexamined Patent Publication (Kokai) No.62-255501 or Japanese Unexamined Patent Publication (Kokai) No.9-53577 to reduce the manufacturing cost of the scroll by abbreviating the machine work on the portions, of the fixed scroll and the movable scroll, other than those at which the fixed scroll and the movable scroll come into contact with each other or come very close in with each other for sealing performance. If the machine work on unnecessary portions is abbreviated, the time required for machine work, the work cost, and the required number of work machines are also reduced accordingly and as a result the cost of facilities is reduced. Reduction in work time, however, is limited because the portions on which work can be abbreviated are limited, and an expensive working machine such as the scroll form working machine is still required and the fact is that the cost of facilities has not been reduced sufficiently.

SUMMARY OF THE INVENTION

[0006] The present invention has been developed to reduce the manufacturing cost of the scroll further than before, with the fact mentioned above being the background, and the present invention can provide the following scroll-type compressors, scrolls for them, and the scroll manufacturing methods, which will be described in each aspect below. The individual aspects are classified into sections, each section is numbered, and if necessary, other aspects are quoted in description. This is only to facilitate understanding of the present invention, and it should not be considered that the technical characteristics described in the present specifications and the combination of these characteristics are restrict-

ed to those described in each section. If plural items are described in a section, it does not mean that the plural items should be always employed all together. It is also possible to select and employ only part of those items.

(1)

The first aspect of the method of manufacturing a scroll for a scroll-type compressor in the present invention comprises

a die-casting process, wherein a production scroll material, having a base and a scroll portion which is erected thereon, and having such a shape that the thickness of the scroll portion gradually decreases in the direction from the proximal end of the base side thereof to the front end thereof, is cast using a production metal mold that opens in the direction of thickness of the base, and wherein the production metal mold comprises a production first mold, having a cavity of a shape that corresponds to at least the entire scroll portion, and a production second mold, having a cavity of a shape that corresponds to at least a part of the base; and

a machine working process, wherein a scroll, as a product, can be obtained by machine-working the base of the production scroll material, which is cast in the die-casting process, and by at least the outer side surface and the inner side surface of the scroll portion of the production scroll material being left as cast.

Therefore, if at least the outer side surface and the inner side surface of the scroll portion are left as cast, the time for machine-working the scroll can be reduced considerably and the cost of facilities can also be reduced because an expensive machine such as the scroll form working machine is no longer necessary. Moreover, if the scroll portion is formed into such a shape that the thickness thereof gradually decreases in the direction from the proximal end thereof to the front end thereof, the shape can preferably provide a draft angle with which the cast scroll material is drawn from the metal mold, and when used as a product, the scroll can be preferably reduced in weight by increasing the thickness of the proximal end of the scroll portion where the bending moment is large and by thinning the front end thereof. The phrase "at least the outer side surface and the inner side surface of the scroll portion are left as cast and a scroll is obtained as a product" means that even when the scroll is installed in a compressor as a product, at least the outer side surface and the inner side surface of the scroll portion are left as a cast surface, and this does not exclude the case in which the cast surface of at least either the outer side surface or the inner side surface is processed with synthetic resin or metal coating as a product in order to improve the sliding characteristic, anti-abrasion characteristic, or airtightness, and so on. It is also preferable that the front end surface of the scroll portion is left as cast, but it is not indispensable to leave the surface as cast because the front end surfaces are located in a single plane, therefore, they can be worked with simple plane work.

(2)

In the second aspect of the present invention, the base is machine-worked with at least either the outer side surface or the inner side surface of the scroll portion left as cast being the work basis in the machine working process described in the first aspect.

Therefore, if the base is worked with at least either the outer side surface or the inner side surface of the scroll portion being the work basis, it is possible to accurately engage the scroll portion, at least the outer side surface and the inner side surface of which are left as cast, with the scroll portion of the target scroll, with the state in which the worked base is assembled to the scroll-type compressor.

(3)

The third aspect of the present invention comprises, in addition to the first aspect: a trial die casting process that casts a trial scroll material using a trial metal mold equipped with a trial first mold having the same cavity as or a similar one to that of the production first mold; a measuring process including measuring first dimensions of at least the outer side surface and the inner side surface of the scroll portion of the trial scroll material, comparing the first dimensions with second dimensions of the corresponding portions of the cavity that has formed the scroll portion of the trial first mold and obtaining the dimensional difference between the first dimensions and the second dimensions; and a manufacturing process to manufacture the production first mold, to the cavity of which, having a shape corresponding to a scroll portion with the true shape and dimensions, modifications based on the dimensional difference obtained in the measuring process are made; and wherein the production first mold is used as a component of the production metal mold of the production scroll material.

It is preferable that the trial metal mold is designed so that the width of the cavity of the production first mold that forms the scroll portion is slightly narrower than the true one. This is because the first mold of the production metal mold can be obtained by applying additional work, including modifications (for example, a modification required to remove the dimensional difference) based on the dimensional difference obtained in the measuring process, to the trial metal mold. Not restricted to this, however, it is possible to employ a trial metal mold equipped with a trial first mold that has the cavity having the shape and dimensions, which are just in the complementary relationship with the scroll portion of a scroll as

a product. In this case, it will be almost always required to manufacture the production metal mold from scratch. It is also possible to obtain the data to be used to determine the shape and dimensions of the cavity of the metal mold to cast the scroll material of the present invention, the outer side surface and the inner side surface of the scroll portion of which are not machine-worked, by comparing the shape and dimensions of the cavity of the conventional metal mold, used to cast the scroll material, with those of the cast scroll material cast in the conventional art, in which the scroll used to be manufactured by machine-working the outer side surface and the inner side surface of the scroll portion. In this case, the conventional metal mold can be used as a trial metal mold of the present invention.

(4)

In the fourth aspect of the present invention, in addition to any one of the first through the third aspects, the production first mold and the trial first mold have a cavity corresponding to the base at least of the scroll portion side, as well as the cavity corresponding to the scroll portion.

In this aspect, it is possible to easily obtain a scroll material, the dimension from the inner side surface of the base to the front end surface of the scroll portion, that is, the height of the scroll portion, which is accurate.

(5)

In the fifth aspect of the present invention, in addition to the third or the fourth aspect, the measuring process includes a measuring process to measure the dimensions of the inner side surface and the outer side surface of the scroll portion of the trial scroll material.

It is possible to manufacture a production scroll material equipped with a scroll portion, the dimensional accuracy of the inner side surface and the outer side surface of which is high, by measuring the dimensions of the inner side surface and the outer side surface of the scroll portion of the trial scroll material to obtain the dimensional difference from the corresponding portions of the cavity and by making modifications corresponding to the dimensional difference to the cavity with the shape to be fitted to the scroll portion having the true shape and dimensions to obtain the shape and dimensions of the cavity of the production first mold.

(6)

In the sixth aspect of the present invention, in addition to the fifth aspect, the measuring process includes a process to measure the flatness of the inner side surface of the base of the trial scroll material,. and a process to measure the flatness of the front end surface of the scroll portion of the trial scroll material and the height thereto from the inner side surface of the base of the scroll portion thereof.

When the amount of distortion of the inner side surface of the base or the front end surface of the scroll portion is small, the measurement can be abbreviated, but even when the amount of distortion is large, it is possible to obtain a scroll material, the height accuracy of the scroll portion of which is high, and to abbreviate the machine work to the front end surface of the scroll portion according to the present aspect.

(7)

In the seventh aspect of the present invention, in addition to any one of the first aspect or the third through the sixth aspects, a positioning portion, which has a relative position specified in advance with respect to the scroll portion, is formed on the base in the die-casting process and, in the machine working process the scroll material is positioned by utilizing the positioning portion and thereby the base is machine-worked.

When at least the outer side surface and the inner side surface of the scroll portion are not machine-worked but the base is machine-worked, it is preferable that at least either the outer side surface or the inner side surface of the scroll portion is used as the work basis, but they have shapes not appropriate for the work basis. If, therefore, a positioning portion is formed at the same time as the scroll portion is formed in the die-casting process and machine work is performed with the basis of the positioning portion, it will be easy to position the scroll material and a scroll, which has a dimensional accuracy almost the same as that of one which is machine-worked with the basis of at least either the outer side surface or the inner side surface of the scroll portion, can be obtained.

(8)

In the eighth aspect of the present invention, in addition to any one of the first through the sixth aspects, the machine working process includes a process, in which the scroll material is fixed by a fixture and the base is machine-worked after the scroll material is positioned with a positioning jig that is physically engaged with at least either the outer side surface or the inner side surface of the scroll portion of the scroll material.

As described later, it is also possible to hold at least either the outer side surface or the inner side surface of the scroll portion with a chuck and machine-work the base, but the outer side surface and the inner side surface of the scroll portion have a shape inappropriate for chuck holding. Contrary to this, it is easier to position using a positioning jig that is physically engaged with the outer side surface or the inner side surface of the scroll portion than to hold the outer side surface or the inner side surface thereof with a chuck, resulting in advantages if a positioning jig and a fixture are prepared separately.

(9)

In the ninth aspect of the present invention, in addition to the eighth aspect, the positioning jig has three or more engagement portions that are engaged with the scroll portion at three or more points and the three or more points of engagement are selected so that the location of center and the rotational phase around the center of the scroll material can be determined uniquely.

(10)

In the tenth aspect of the present invention, in addition to the ninth aspect, the positioning jig is of such a type that one of the three or more engagement portions comes into contact with either the inner end or the outer end of the scroll portion in the direction almost parallel to the longitudinal direction (direction along the scroll) of the scroll portion and the other two or more are engaged with either the inner side surface or the outer side surface of the scroll portion, respectively.

In a state in which one engagement portion and either the inner end or the outer end of the scroll portion are made to come into contact with each other in the direction almost parallel to the longitudinal direction of the scroll portion, and at the same time each of two engagement portions and either the inner side surface or the outer side surface of the scroll portion are engaged with each other, respectively, the location of center and the rotational phase around the center of the scroll can be determined uniquely. Any positioning jig can be used if it comprises engagement portions that can uniquely determine the location of center and the rotational phase of the scroll around the center thereof as long as at least either a rotational torque around the central line or a force in the specified direction perpendicular to the central line of the scroll material is applied to the scroll material by an operator or a robot. This aspect provides a preferable example of such a positioning jig.

(11)

In the eleventh aspect of the present invention, in addition to the ninth aspect, the positioning jig is of such a type that it has four or more engagement portions, one of the four or more engagement portions comes into contact with the inner end of the scroll portion in a direction almost parallel to the longitudinal direction of the scroll portion, and the other three or more engagement portions are engaged with the inner side surface of the scroll portion, with each central angle between two adjacent engagement portions of the three or more engagement portions being smaller than 180 degrees.

If one of the engagement portions and the inner end of the scroll portion are made to come into contact with each other in a direction almost parallel to the longitudinal direction of the scroll portion, the other three or more engagement portions are engaged with the inner side surface of the scroll portion, and at the same time the engagement points are selected so that each central angle between two adjacent engagement portions is smaller than 180 degrees, then the location of center of the scroll and the rotational phase around the center thereof can be determined uniquely and at the same time the relative rotations of the scroll with respect to the positioning jig in the normal or reverse direction are disabled. If the three or more engagement portions, which satisfy the above-mentioned condition, are engaged with the inner side surface of the scroll portion, the relative movement of the scroll portion with respect to the positioning jig in any radial direction is disabled unless the scroll is rotated. The relative rotation of the scroll with respect to the positioning jig in such a direction that the radius of the engagement point corresponding to each engagement portion of the scroll portion decreases is also disabled. With this state, if one of the engagement portions and the inner end of the scroll portion are made to come into contact with each other, the relative rotation of the scroll in such a direction that the radius of the engagement point corresponding to each engagement portion of the scroll portion increases is also disabled, therefore, the location of center of the scroll can be determined uniquely and the relative rotations of the scroll with respect to the positioning jig in the normal or reverse direction are also disabled simultaneously. In other words, the positioning jig of the present aspect can position the scroll with the state in which the relative movement of the scroll in any direction in a plane perpendicular to the central line of the scroll is disabled. It is preferable that the three or more engagement portions which come into contact with the inner side surface of the scroll portion are arranged so that each central angle between two adjacent engagement portions is almost equal to each other.

(12)

In the twelfth aspect of the present invention, in addition to the ninth aspect, the positioning jig is of such a type that it has four or more engagement portions, one of the four or more engagement portions is made to come into contact with the outer end of the scroll portion in a direction almost parallel to the longitudinal direction of the scroll portion, and the other three or more engagement portions are engaged with the outer side surface of the scroll portion, with each central angle between two adjacent engagement portions of the three or more engagement portions being smaller than 180 degrees.

The positioning jig of the present aspect can position the scroll in the state in which the relative movement of the scroll in any direction in a plane perpendicular to the central line of the scroll is disabled, for the same reason as that of the positioning jig described in the eleventh aspect. Similarly, it is

also preferable that the three or more engagement portions that come into contact with the outer side surface of the scroll portion are arranged so that each central angle between two adjacent engagement portions is almost equal to each other.

(13)

In the thirteenth aspect of the present invention, in addition to any one of the first through the sixth aspects, the machine working process includes such a process that the base is machine-worked with the state in which at least either the outer side surface or the inner side surface of the scroll portion of the scroll material is held with a chuck.

If the base is machine-worked in the state in which at least either the outer side surface or the inner side surface of the scroll portion is held with a chuck, the base can be machine-worked with the basis of the scroll portion, therefore, it will be possible to accurately engage the scroll portion, left as cast, with that of the target scroll with the worked base being assembled to a scroll-type compressor.

(14)

In the fourteenth aspect of the present invention, in addition to the thirteenth aspect, the chuck is such a type that it has three or more holding jaws that come into contact with the three or more points of the scroll portion in a direction almost perpendicular to each points, respectively, and the three or more contact points are selected so that the location of center of the scroll can be determined uniquely and the relative rotations of the scroll with respect to the chuck in both the normal or reverse direction are prevented.

If the chuck is equipped with a mechanism that can move the three or more holding jaws in synchronization with each other or by the same amount, it is possible to accurately fix the scroll to the specified place by letting the three or more holding jaws hold the three or more points, of the scroll portion, specified in advance. It is also applicable that one of the holding jaws may be disabled from moving, and the other holding jaws may be moved in synchronization with each other or by the same amount. This can also be applied to the chucks in the following aspects.

(15)

In the fifteenth aspect of the present invention, in addition to the thirteenth aspect, the scroll portion is designed so that the portion in the vicinity of the center of the scroll gradually increases in thickness along the curve toward the center and at the same time the chuck has at least three holding jaws, two among the at least three holding jaws pinching the scroll portion at the points on the inner side surface and the outer side surface thereof, where the thickness thereof gradually increases almost in the direction of thickness, and one of them being made to come to contact with the portion in the vicinity of the inner end, that is the end near the center of the scroll portion, in a direction almost perpendicular to that in which the two holding jaws pinch the scroll portion.

According to the present aspect of the invention, the structure of the chuck can be simplified. Moreover, since the three holding jaws are engaged with the portions near the center of the scroll portion, the positioning accuracy of the portion in the vicinity of the center becomes high. In a scroll-type compressor, the internal pressure of the compression chamber increases as it moves toward the center, therefore, it is preferable that the dimensional accuracy of the portion near the center of the scroll portion can be improved from the standpoint of effective prevention of leakage.

(16)

In the sixteenth aspect of the present invention, in addition to the fifteenth aspect, the chuck is such a type that it has, in addition to the three holding jaws, at least a holding jaw that almost perpendicularly comes into contact with at least either the inner side surface or the outer side surface of the portion, the radius of which is larger than those of the portions of the scroll portion with which the three holding jaws come into contact.

Although the structure of the chuck described in the fifteenth aspect is simple, there exists the possibility that the positioning accuracy of the circumferential portion of the scroll portion is degraded because the engagement points of the three holding jaws with the scroll portion are in the vicinity of the center. According to the invention of the present aspect, on the contrary, the dimensional accuracy of not only the portion in the vicinity of the center but also that of the circumferential portion can be improved.

(17)

In the seventeenth aspect of the present invention, in addition to the thirteenth aspect, the chuck is of such a type that it has at least four holding jaws, two of the at least four holding jaws are made to come into contact with two points on the outer side surface of the scroll portion separated each other almost in the direction of the first diameter of the scroll, and the other two are made to come into contact with two points on the inner side surface of the scroll portion separated each other almost in the direction of the second diameter, which is perpendicular to that of the first diameter.

(18)

In the eighteenth aspect of the present invention, in addition to the thirteenth aspect, the chuck is such a type that it has at least four or more holding jaws, one of the four or more holding jaws is made to come into contact with the inner end of the scroll portion in a direction almost parallel to the longitudinal direction of the scroll portion, and the other

three or more holding jaws are made to almost perpendicularly come into contact with the inner side surface of the scroll portion, with each central angle between two adjacent holding jaws among the three or more being smaller than 180 degrees.

When one of the holding jaws is disabled from moving, it is preferable to disable that which comes into contact with the inner end of the scroll portion.
(19)

In the nineteenth aspect of the present invention, in addition to the thirteenth aspect, the chuck is of such a type that it has four or more holding jaws, one of the four or more holding jaws is made to come into contact with the outer end of the scroll portion in a direction almost parallel to the longitudinal direction of the scroll portion, and the other three or more holding jaws are made to almost perpendicularly come into contact with the outer side surface of the scroll portion, with each central angle between two adjacent holding jaws of the three or more holding jaws being smaller than 180 degrees.

When one of the holding jaws is disabled from moving, it is preferable to disable that which comes into contact with the outer end of the scroll portion.
(20)

In the twentieth aspect of the present invention, in addition to the thirteenth aspect, the chuck is of such a type that it has four holding jaws, three of the four holding jaws are made to come into contact with either the outer side surface or the inner side surface of the scroll portion, the other one is made to come into contact with the other of the inner side surface or the outer side surface of the scroll portion, with which the three are not made to come into contact, and the three holding jaws and the one holding jaw are made to collaborate in preventing looseness due to the slight change of the radius of the scroll portion, when the normal directional relative rotational torque or the reverse relative rotational torque is applied to the scroll portion and the chuck.

If the three holding jaws are made to come into contact with either the outer side surface or the inner side surface of the scroll portion, the scroll cannot be moved in any radial direction unless the scroll is relatively rotated with respect to the chuck. Moreover, the scroll cannot be relatively rotated, with respect to the chuck either in the normal or reverse direction. Then, if the one holding jaw is made to come into contact with the other of the inner side surface or the outer side surface of the scroll portion, with which the three are not made to come into contact, the scroll cannot be relatively rotated, with respect to the chuck, in a direction other than that in which the scroll cannot be rotated as mentioned above. When the sum of the two central angles, between two adjacent holding jaws of the three that come into contact with the inner side surface (or outer side surface) of the scroll portion, is smaller than 180 degrees, it is preferable that the one holding jaw that comes into contact with the outer side surface (or the inner side surface) is arranged so as to almost oppose the middle holding jaw of the three.
(21)

In the twenty-first aspect of the present invention, in addition to any one of the first through the sixth aspects, the machine working process includes such a process in which, after the scroll material is positioned and fixed to the holding jig, the base is machine-worked with the holding jig being attached to the machine work equipment.

According to the invention of the present aspect, it is possible to position the scroll material outside of the work machine, resulting in the improvement of the availability of the work machine. It is also possible to use a precise measurement instrument or positioning jig for positioning because it can be performed, away from the machine, without sticking of cut chips or cutting oil to these equipment. The holding jig of the present aspect can employ the structure of the positioning jig or the chuck.
(22)

The scroll for a scroll-type compressor in the twenty-second aspect of the present invention comprises a base and a scroll portion erected thereupon, the scroll portion having such a shape that the thickness of the scroll portion gradually decreases in the direction from the proximal portion of the base side thereof to the front end thereof, and at least the outer side surface and the inner side surface of the scroll portion are left as cast. The effects described in the first aspect can be obtained.
(23)

In the twenty-third aspect of the present invention, in addition to the twenty-second aspect, a rounded portion is formed at the border between the scroll portion and the base and a rounded portion corresponding to the fore-mentioned rounded portion is also formed on the front end of the scroll portion.

It is effective to form a rounded portion on the proximal end of the scroll portion to alleviate stress concentration because a rather large bending moment is applied thereto. Even if the rounded portion is formed at the proximal end of the scroll portion, the leakage can be prevented from increasing by forming the corresponding rounded portion on the front end of the target scroll portion. In addition, it will be easier to work the corners to shape the front end of the scroll portion of the cavity for die-casting metal mold, and it is also possible to alleviate the stress concentration during casting.
(24)

In the twenty-fourth aspect of the present invention, in addition to the twenty-second or the twenty-third aspects, at least either the circumfer-

ential surface of the base or the end surface opposite to the scroll portion side thereof is machine-worked.

(25)

In the twenty-fifth aspect of the present invention, in addition to any one of the twenty-second through the twenty-fourth aspects, the front end surface, farthest from the base, of the scroll portion is machine-worked.

(26)

In the twenty-sixth aspect of the present invention, in addition to any one of the twenty-second through the twenty-fifth aspects, the scroll is a movable scroll, the self-rotation of which is prevented by the self-rotation preventing mechanism and which is revolved by the revolving mechanism, and the engagement portion, which is engaged with at least either the self-rotation preventing mechanism or the revolving mechanism, is machine-worked on the movable scroll.

(27)

In the twenty-seventh aspect of the present invention, in addition to any one of the twenty-second through the twenty-sixth aspects, the scroll is a fixed scroll that does not revolve, and the positioning portion that positions the fixed scroll with respect to the main body of a scroll-type compressor is machine-worked.

(28)

In the twenty-eighth aspect of the present invention, in addition to any one of the twenty-second through the twenty-sixth aspects, the scroll is a fixed scroll that does not revolve, the fixed scroll is integrated into a part of the main body of a scroll-type compressor, and the positioning portion that positions the part of the main body with respect to the other parts thereof is machine-worked.

(29)

In the twenty-ninth aspect of the present invention, in addition to the twenty-eighth aspect, the bolt holes that connect the part of the main body and the other members thereof are formed at the same time as the scroll portion in the die-casting process of a scroll having the base and the scroll portion, and are not machine-worked.

(30)

The scroll-type compressor in the thirtieth aspect of the present invention comprises a fixed scroll and a movable scroll having a base and a scroll portion erected thereupon, wherein, the scroll portion has such a shape that the thickness thereof gradually decreases in the direction from the proximal end of the base side thereof to the front end thereof, the fixed scroll and the movable scroll, at least the outer side surface and the inner side surface of the scroll portion of which is left as cast, are contained in the main body, being engaged with each other, the relative movement of the fixed scroll with respect to the main body is disabled, and the mechanism, which revolves the movable scroll while preventing the self-rotation of the movable scroll, is arranged between the movable scroll and the main body.

[0007] The characteristics described in each of the twenty-second through twenty-ninth aspects can be applied to the scroll-type compressor described in the thirtieth aspect.

[0008] The present invention may be more fully understood from the description of the preferred embodiments of the invention set forth below, together with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] In the drawings:

FIG.1 is a front cross-sectional view of a scroll-type compressor in an embodiment of the present invention.

FIG.2 is an exploded perspective view of a part of the components of the scroll-type compressor in FIG.1.

FIG.3 is a profile cross-sectional view of the state in which a fixed scroll and a movable scroll of the scroll-type compressor in FIG.1 are combined.

FIG.4 is an enlarged front cross-sectional view of a part of the fixed scroll and the movable scroll in the combined state in FIG.3.

FIG.5 is an enlarged view of part A in FIG.4.

FIG.6 is a profile view of a scroll material used in manufacturing the movable scroll in FIG.3.

FIG.7 is a front cross-sectional view of a die casting process in the method of manufacturing the movable scroll in FIG.3.

FIG.8 is a front cross-sectional view of a trial die casting process in the method of manufacturing the movable scroll in FIG.3.

FIG.9 is a profile view of a chuck used in a machine working process in the method of manufacturing the movable scroll in FIG.3.

FIG.10 is a front cross-sectional view of the state in which the outer side surface of a base of the scroll material is machine-worked in the machine working process in FIG.9.

FIG.11 is a front cross-sectional view of the state in which the outer circumferential surface of the base of the scroll material is machine-worked in the machine working process in FIG.9.

FIG.12 is a front cross-sectional view of a holding jig used in the machine working process in the method of manufacturing the scroll in another embodiment of the present invention.

FIG.13 is an enlarged view of a part of the components of the holding jig in FIG.12.

FIG.14 is a profile view of the state in which the

scroll material is positioned by a positioning jig of the holding jig.

FIG.15 is a profile view of the state in which the scroll material is positioned by the positioning jig used in the machine working process in the method of manufacturing the scroll in another embodiment of the present invention.

FIG.16 is a profile view of the state in which the scroll material is positioned by the positioning jig used in the machine working process in the method of manufacturing the scroll in another embodiment of the present invention.

FIG.17 is a profile view of the state in which the scroll material is positioned by the positioning jig used in the machine working process in the method of manufacturing the scroll in another embodiment of the present invention.

FIG.18 is a profile view of the state in which the scroll material is positioned by the positioning jig used in the machine working process in the method of manufacturing the scroll in another embodiment of the present invention.

FIG.19 is a profile view of the state in which the scroll material is positioned by the positioning jig used in the machine working process in the method of manufacturing the scroll in another embodiment of the present invention.

FIG.20 is a profile view of the state in which the scroll material is positioned by the positioning jig used in the machine working process in the method of manufacturing the scroll in another embodiment of the present invention.

FIG.21 is a profile view of the state in which the scroll material is positioned by the positioning jig used in the machine working process in the method of manufacturing the scroll in another embodiment of the present invention.

FIG.22 is a profile view of a chuck used in the machine working process in the method of manufacturing the scroll in another embodiment of the present invention.

FIG.23 is a front cross-sectional view of the chuck in FIG.22.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0010] The embodiments, in which the present invention is applied to a scroll-type compressor that compresses the refrigerant gas used in an air-conditioner of a vehicle, are described in detail below with reference to drawings. In FIG.1, a main body 10 of a scroll-type compressor comprises plural members of the main body such as a front housing 12, a center housing 14, and a rear housing 16. The center housing 14 in the present embodiment is comprised integrally with a fixed scroll 18, which will be described in detail later. The front housing 12 and the rear housing 16, being positioned in place respectively, are fixed to end surfaces 20 and 22, of the center housing 14, which are separated in the axial direction by plural bolts 24 and 25 (refer to FIG.2), which are the fixing means. Reference number 26 indicates positioning pins used to position the center housing 14 and the front housing 12 when fixing them. As shown in FIG.2, positioning pins 28 are also provided, which are engaged with both the center housing 14 and the rear housing 16 and position them.

[0011] In the main body 10, the fixed scroll 18 and a movable scroll 32 are housed. The fixed scroll 18 comprises a nearly disk-shaped base 34 and a scroll-shaped scroll portion 38 erected in the direction perpendicular to an inner side surface 36, which is a surface of the front housing 12 side of the base 34, from the inner side surface 36. On the outer circumferential edge portion of the base 34, a cylindrical housing portion 39, which extends in the direction perpendicular to the inner side surface 36 and is higher (longer) than the scroll portion 38 (axial length), is formed integrally. On the top end of the housing portion 39, a nearly rectangular plate-shaped flange portion 40 is formed as a mounting portion, and the center housing 14 and the front housing 12 are fixed by tightening the bolts 24 into the bolt holes 41 (refer to FIG.2) formed in the four corners of the flange portion 40 and female screw holes (not shown in drawings) formed in the corresponding locations of the front housing 12. On an outer side surface 42, which is a surface of the rear housing 16 side of the base 34, a cylindrical boss 44 is formed integrally, and the center housing 14 and the rear housing 16 are fixed by tightening the bolts 25 into female screw holes 46 (refer to FIG.2) formed in the end surface 22, which is the front end surface of the boss 44, and bolt holes 47 formed in the rear housing 16.

[0012] The movable scroll 32 also has a shape similar to the fixed scroll 18 and comprises a disk-shaped base 50 and a scroll portion 54 erected in the direction perpendicular to an inner side surface 52, which is a surface of the rear housing 16 side of the base 50, from the inner side surface 52, as shown in FIG.1, and a central axis O_1 of the fixed scroll 18 and a central axis O_2 of the movable scroll 32 are combined with each other eccentrically with the state in which the scroll portion 54 comes into contact with the scroll portion 38 of the fixed scroll 18 at plural points or comes close therewith, as shown in FIG. 3.

[0013] The movable scroll 32 is driven by a drive shaft 60 shown in FIG.1. The drive shaft 60 is provided concentrically with the fixed scroll 18 and supported rotatably by the front housing 12 via a ball bearing 62. One end of the drive shaft 60 protrudes to the outside while the hermeticity between the drive shaft 60 and the front housing 12 is maintained by a sealing device, and the front end of the protruded portion of the drive shaft 60 is connected to an engine, the source of a driving force, via a clutch device such as an electromagnetic clutch and a belt, and on the inner end on the opposite side thereof, an eccentric pin 64 and a balance weight 66 are

provided integrally. The eccentric pin 64 is positioned eccentrically with respect to the main body of the drive shaft 60 and arranged in a large-diameter hole 68, which is a stepped hole formed in the front housing 12. By the eccentric pin 64, a bushing 69 is supported rotatably. The bushing 69 is inserted rotatably, via a needle bearing 74 into, a boss 72 formed in the center of an outer side surface 70, which is a surface opposite to the inner side surface 52 on which the scroll portion 54 of the base 50 of the movable scroll 32 is provided. Therefore, when the drive shaft 60 is rotated, the movable scroll 32 is revolved (orbitted) around the revolving central line of the drive shaft 60 by the eccentric pin 64. These drive shaft 60, the eccentric pin 64, the above-mentioned source of drive force, the clutch device, and so on, constitute the revolving mechanism. In addition, the boss 72 of the movable scroll 32 constitutes an engagement portion at which the scroll is engaged with the above-mentioned revolving mechanism.

[0014] Between the front housing 12 and movable scroll 32, a self-rotation preventing mechanism 80, which prevents the self-rotation while allowing the revolution of the movable scroll 32, is provided. The self-rotation preventing mechanism 80 is described below. In the outer side surface 70 of the base 50 of the movable scroll 32 and in the front housing 12, plural pairs of insertion holes 82 and 84 are formed, and self-rotation preventing pins 86 and 88 are pressed into each of the pairs of insertion holes 82 and 84, respectively. In FIG. 1, only one pair of self-rotation preventing pins 86 and 88 among the plural pairs is shown. The protruded end portions of each pair of self-rotation preventing pins 86 and 88, from the movable scroll 32 and the front housing 12, respectively, extend in parallel to each other at a distance equal to the revolution radius (orbit radius) of the movable scroll 32. A self-rotation preventing ring 90 is inserted with the protruded end portions of each pair of self-rotation preventing pins 86 and 88. This means that the self-rotation ring 90 loosely connects a pair of self-rotation preventing pins 86 and 88 and the distance between the two self-rotation pins 86 and 88, which is restricted by the inner diameter of the self-rotation preventing rings 90, is set nearly equal to the revolution radius of the movable scroll 32. These self-rotation preventing pins 86 and 88, and the self-rotation preventing rings 90 constitute the self-rotation preventing mechanism 80, and the self-rotation preventing mechanism 80 allows the revolution (orbit) about the central axis O_1 of the fixed scroll 18, as the center axis of the revolution, while preventing the self-rotation (rotation on its own central axis O_2) of the movable scroll 32. The insertion holes 82 of the movable scroll 32 constitute an engagement portion at which the engagement with the self-rotation preventing mechanism 80 is attained. In the present embodiment, the revolution mechanism and the self-rotation preventing mechanism collaborate in constituting the mechanism that revolves the movable scroll 32 while preventing the self-rotation of the movable scroll 32.

[0015] The fixed scroll 18 and the movable scroll 32 collaborate in forming a compression chamber 100. As mentioned above, the scroll portion 54 of the movable scroll 32 is made to come into contact with the scroll portion 38 of the fixed scroll 18 at plural points or come close in therewith, and forms the plural crescent-shaped compression chambers 100, with these substantial contact points being the border. When the center O_2 of the movable scroll 32 revolves while rotating in a circular trajectory, with the center O_1 of the fixed scroll 18 being the center, without self-rotation, each of these compression chambers 100 increases its volume once as the contact points between the scroll portion 38 and the scroll portion 54 move toward the center portion, and then it decreases its volume while moving toward the central portion. Therefore, the compression chamber 100, increasing its volume at first, compresses the refrigerant gas, which flows into a suction chamber 110 in the housing portion 39 via a suction hole (not shown in the drawings), as the volume of the compression chamber 100 decreases, and discharges the compressed gas from a discharge port 112 to a discharge chamber 116. The discharge port 112 is formed in the center of the base 34 of the fixed scroll 18 and a discharge valve 114 is provided at the opening of the discharge side thereof to prevent the counter-flow of the gas. The discharge chamber 116 is formed by the cooperation of the boss 44 of the fixed scroll 18 and the rear housing 16 and the refrigerant gas discharged thereto via the discharge port 112 is further sent to an outer circulating passage via a discharge hole 118 (refer to FIG.2).

[0016] Since the fixed scroll 18 and the movable scroll 32 collaborate in forming the above-mentioned compression chamber 100, the inner side surfaces 36 and 52 of both the bases 34 and 50, and front end surfaces 120 and 122 of the scroll portions 38 and 54, which are located farthest from the bases 34 and 50, are made to come close to the opposing bases 50 and 34, respectively, and sealing performance is maintained to a certain level. Moreover, chip seals 126 and 128 are arranged on the front end surfaces 120 and 122, respectively, to improve sealing performance. In other words, a seal groove 130 is formed on the scroll-shaped front end surface 120 of the scroll portion 38 of the fixed scroll 18, which opposes the base 50 of the movable scroll 32, in the longitudinal direction of the front end surface 120, and the string type chip seal 126 is arranged in a scroll layout in the seal groove 130. The chip seal 126 is made of synthetic resin such as a fluoro-resin, has a length that corresponds to that of the seal groove 130, is made to protrude slightly from the front end surface 120 of the scroll portion 38 and at the same time, is made to come into contact with the base 50 of the movable scroll 32 slidably. On the other hand, a similar seal groove 134 is also formed on the scroll-shaped front end surface 122 of the scroll portion 54 of the movable scroll 32, and the above-mentioned chip seal 128 is arranged therein.

[0017] The scroll portion 38 of the fixed scroll 18 and the scroll portion 54 of the movable scroll 32 have such a shape that the thickness thereof decreases gradually in the direction from the proximal ends of the bases 34 and 50 side thereof to the front ends thereof, as shown exaggeratedly in FIG.4, and the fixed scroll 18 and the movable scroll 32 can be reduced in weight because it is possible not only to increase the strength by increasing the thickness of the proximal end where the bending moment is large, but also to make the front end thinner. In addition, at the corner, which is the border between the scroll portion 38 and the base 34, a rounded portion 140 is formed, as shown enlargedly in FIG.5, therefore, the concentration of stress thereof is mitigated. On the other hand, a rounded portion 144 corresponding to the rounded portion 140 is formed on the front end of the scroll portion 54, and an increase in refrigerant gas leakage can be avoided. Similar rounded portions are also formed at the border between the scroll portion 54 and the base 50, and on the front end of the scroll portion 38. The portions, near the center of the scrolls 18 and 32, of the scroll portions 38 and 54 gradually increase their thickness along the spiral curve in the direction of approaching the center as shown in FIG.3.

[0018] The fixed scroll 18 and the movable scroll 32 are manufactured in die-cast of the material (aluminum or aluminum alloy), with aluminum being a predominant element, and the inner side surfaces, the outer side surfaces, and the front end surfaces 120 and 122 of the scroll portions 38 and 54, and the inner side surfaces 36 and 52 of the bases 34 and 50 are left as cast without machine work, and the chill layer is left. The chill layer, in which the change of crystallization rate of the primary crystal α (α phase) and eutectic silicon is not continuous because the portion contiguous to the metal mold is quickly cooled and solidified when the molten metal poured into the metal mold is solidified, is hard and strong therefore the strength of the scroll portion 38 and 54 is improved because of the chill layer existing on the surfaces thereof.

[0019] In the present embodiment, the scroll portions 38 and 54 are incorporated in the main body 10 with the inner side surfaces and the outer side surfaces of the scroll portions 38 and 54 being left as cast. It is possible, however, to form a coating layer on the inner side surfaces and the outer side surfaces of the scroll portions 38 and 54 without machine work. In forming a coating layer, it is preferable to form a hard plating layer such as Ni-B and Ni-P-B-W on, for example Ni-P, and furthermore to form thereon a synthetic resin layer such as polyamide/imide, epoxy resin, polyetheretherketone, phenol resin, and so on, which contain a solid lubricant. It is also possible to form only hard plating layers, to form a hard plating layer that contains a solid lubricant directly on or via another hard coating layer, or to form a coating layer using other various materials.

[0020] Next the method of manufacturing the movable scroll 32 and the fixed scroll 18 of the present scroll-type compressor is described below. The method of manufacturing the movable scroll 32 is typically described with reference to FIG.6 through FIG.11. A scroll material 160 for manufacturing the movable scroll 32 (referred to as a scroll material 160 hereinafter) is die-cast. As shown in FIG.6 and FIG.7, the scroll material 160 comprises a disk-shaped base 162 and the scroll portion 54 perpendicularly erected on an inner side surface 164 of the base 162, which is similar to the case of the movable scroll 32 as a product. The seal groove 134 is molded simultaneously by die-casting on the front end surface of the scroll portion 54. On the outer circumferential surface of the base 162, positioning portions 168, 169, and 170, which protrude from plural points (three points in an example in the figure) equally spaced in the circumferential direction toward the outer circumferential side, are integrally formed. In the positioning portion 168, an engagement hole 172 having the shape of an oval with a long axis in the radial direction is formed. In this embodiment both side surfaces of the positioning portions 168, 169, and 170, which are separated in the axial direction of the scroll material 160, are located on the same planes of the inner side surface 164 and the outer side surface of the base 162, respectively.

[0021] A production metal mold 176, which is the main part of the metal mold machine used in the above-mentioned die-casting process, comprises a production first mold 178 (briefly referred to as the first mold 178 hereinafter unless necessary in particular) and a production second mold 180 (briefly referred to as the second mold 180 unless necessary in particular), which are opened and closed by making them come close to each other and separating them from each other as shown in FIG. 7. The first mold 178 has a cavity 184 that corresponds to the whole of the scroll portion 54, the part of the base 162 of the scroll portion 54 side, and the parts of the positioning portions 168, 169, and 170 of the scroll portion 54 side of the scroll material 160, and the second mold 180 has a cavity 186 that corresponds to the rest (part apart from the scroll portion 54) of the base 162 of the scroll portion 160. In the present embodiment, either one (for example, the second mold 180) is made fixed and the other (for example, the first mold 178), movable. By a drive machine, which is not shown, the first mold 178 is driven and made to come close to and separate from the second mold 180. The direction, in which the first mold 178 is made to come close to and separate from, is that of the thickness of the base 162 of the scroll material 160 formed by the production metal mold 176. With the state in which coupling surfaces 190 and 192, which are opposing surfaces of the first mold 178 and the second mold 180, are coupled, a cavity 194 that corresponds to the shape of the scroll material 160 is formed by the above-mentioned cavities 184 and 186.

[0022] The cavity 194 is communicated with the inner space of a sleeve having a sprue via a channel 196. At the end of the channel 196 of the cavity 194 side, a gate 198, the sectional area of which is smaller than that of

the other portions is provided. The molten metal (in the present embodiment, aluminum alloy as an example of the materials in which aluminum is a predominant element) poured from the sprue is injected to the cavity 194 by an injection machine through the channel 196 and the gate 198. Although figures and description of the injection machine are abbreviated here because it is widely known, it may comprise, for example, a plunger that is moved in the sleeve, a plunger chip which is provided on the front end thereof and is larger in diameter than the plunger, and a plunger drive machine (for example, a hydraulic cylinder).

[0023] In the die-casting process of the present embodiment, the molten aluminum alloy is poured from the sprue of the sleeve and sent to the cavity 194 through the channel 196 and the gate 198 by the injection machine until the cavity 194 is filled, in the state in which the first and the second molds 178 and 180 are closed and the coupling surfaces 190 and 192 are close. After the cavity 194 is filled with the molten metal, the molten metal is allowed to solidify for a specified period and the first mold 178 is separated from the second mold 180. Then the production metal mold 176 is opened and the scroll material 160 is drawn out. After this, machine work is applied to the scroll material 160, but the inner side surfaces, the outer side surfaces, and front end surfaces of the scroll portions 54 and the inner sides surfaces of the base 162 of the scroll material 160 are left as cast without machine work because they are formed with a high accuracy. Because the scroll portion 54 has such a shape that the thickness gradually decreases in the direction from the proximal end of the base 162 side to the front end, therefore, the shape can provide a draft angle of the first mold 178. On the border between the scroll portion 54 and the base 162 and on the front end of the scroll portion 54, the rounded portions 140 and 144 shown in FIG.5 are formed together with the other parts by die-casting. The scroll portion 54 of the scroll material 160 gradually increases in thickness in the direction toward the center thereof from the outer circumferential portion along the spiral curve.

[0024] As mentioned above, the production metal mold 176 (the first mold 178 thereof) with a high accuracy is required in order to leave the inner side surface, the outer side surface, and the front end surface of the scroll portion 54 of the scroll material 160 as cast. Therefore, a trial die-casting process is performed prior to the die-casting process in the present embodiment. In the trial die-casting process, a trial metal mold 200 shown in FIG.8 is used to cast a trial scroll material 206 that has a scroll portion 202 and a base 204, similar to the case with the scroll material 160. The trial metal mold 200 has a trial first mold 208 and the second mold 180, which are opened and closed by making them come close to each other and separate from each other. The trial first mold 208 has a cavity 210 similar to that of the production first mold 178. This means that the cavity 210 has a shape that corresponds to the whole of the scroll portion 202 and the part of the base 204 of the scroll portion 202 side. However, the width, which is the measure perpendicular to the longitudinal direction of the portion that forms the scroll portion 202, of the cavity 210 of the trial first mold 208 is slightly narrower than that of the cavity 184 of the production first mold 178.

[0025] The trial scroll material 206 is cast using the trial metal mold 200 in the similar way as the above-mentioned die-casting process. After the trial die-casting process, the dimensions of the scroll portion 202 of the obtained trial scroll material 206 are measured. Not only the dimensions of the inner side surface and the outer side surface of the scroll portion 202 are measured by a widely well-known dimension measuring machine such as a three coordinate measuring machine, but also the flatness of the inner side surface (the surface on which the scroll portion 202 is provided) of the base 204 is measured by a widely well-known flatness measuring machine, and furthermore, the flatness of the front end surface of the scroll 202 and the height thereto from the inner side surface of the base 204 are measured. The parallelism between the front end surface of the scroll portion 202 and the inner side surface of the base 204 is also measured by a widely well-known parallelism measuring machine. Each measured dimension, described above, is compared with that of the portion that forms the scroll portion 202 of the cavity 210 of the trial first mold 208, and the dimensional difference between the dimension of the scroll portion 202 of the trial scroll material 206 and that of the portion which forms the scroll portion 202 of the cavity 210 is obtained. This dimensional difference represents the amount of the distortion and heat contraction of the trial scroll material 206, which occur when the trial metal mold 200 is used for casting, and is the data indicating how to modify the shape and dimensions of the cavity 184 of the first mold 178 of the production metal mold 176 in order to obtain a scroll material having a scroll portion of desired shape and dimensions. In other words, if a cavity, the surface configuration of which is just reverse to that of a scroll material equipped with a scroll portion of desired shape and dimensions, is modified in advance to eliminate the dimensional difference indicated by the above-mentioned data, it is possible to cast a scroll material equipped with a scroll portion of desired shape and dimensions. The measuring process is described as above.

[0026] Based on the dimensional difference obtained in the measuring process, additional work, which includes the modification required to eliminate the dimensional difference plus the compensation corresponding to the dimensional amount by which the trial first mold 208 is made narrower in width than the cavity 184 of the production first mold 178, as already described, is applied to the cavity 210 of the trial first mold 208. By this additional work, the production first mold 178 equipped with the cavity 184, which has an appropriate shape and dimensions to form the scroll portion 54 with a true

shape and dimensions, can be manufactured. In this manner the production first mold 178 with a high accuracy can be manufactured at a low cost. For example, the production first mold 178 can be manufactured so that degree of contour between the inner side surface and the outer side surface of the scroll portion 54 of the scroll material 160 formed by the production first mold 178 is 40μm or less, and at the same time the flatness of the front end surface of the scroll portion 54 and the inner side surface of the base 162 and the parallelism therebetween are 20μm or less, respectively. This production first mold 178 is used as a component of the production metal mold 176 in the die-casting process mentioned above.

[0027] There can be methods other than that of manufacturing the production first mold equipped with a cavity having the true shape and dimensions as mentioned above. For example, the trial metal mold is made to comprise a trial first mold having a cavity of a shape and dimensions corresponding to the true shape and dimensions of the scroll portion (that is, the surface configuration is just reversed to those of the scroll portion with the true shape and dimensions and the dimensions are appropriate), and then the production first mold equipped with a cavity having the true shape and dimensions may be manufactured based on the dimensional difference obtained by comparing the dimensions of the scroll portion, and so on, of the trial scroll material cast by this trial metal mold and the dimension of the cavity of the trial first mold.

[0028] Machine work is applied to the scroll material 160 cast in the die-casting process. As described above, the inner side surface, the outer side surface, and the front end surface of the scroll portion 54 of the scroll material 160 are not machine-worked but left as cast, and machine work is applied to the base 162 of the scroll material 160, with the scroll portion 54 being the work basis. In the present machine working process, machine work is carried out, with the positioning portions 168, 169, and 170, and the engagement hole 172 cast at the same time as the scroll portion 54 being the work basis. Therefore, the movable scroll 32 can be obtained with the dimensional accuracy almost equal to that when the machine work is carried out with the scroll portion 54 being the work basis.

[0029] The present machine working process is carried out with the scroll material 160 being held firmly with a chuck 230 as shown in FIG.9. The chuck 230 in the present embodiment is of a three-jaw type and has three holding jaws 234, 236, and 238 that can be made to come close in with and separate from each other symmetrically with respect to the central axis of a chuck main body 232. The three holding jaws 234, 236, and 238 are equally spaced at a specified angle. Since the structure of a three-jaw type chuck is widely known, detailed drawings and description are omitted here. To the chuck main body 232, three movable members are held movably along a line perpendicular to the central axis, and the holding jaws 234, 236, and 238 are held with these movable members, respectively. When driven by the drive device, the three movable members are guided by guide grooves 240 to move in synchronization with each other in the radial direction of the chuck main body 232, thereby the three holding jaws 234, 236, and 238 are made to come close in with and separate from each other, with the axis-symmetrical relationship to each other being maintained.

[0030] The front ends of the holding jaws 234, 236, and 238 are cut out and form holding surfaces 244 and receiving surfaces 246. The holding surfaces 244 hold the positioning portions 168, 169, and 170, and are comprised of inner circumferential surfaces (planes contiguous to the outer circumferential surfaces of the positioning portions 168, 169, and 170 are included), the radius of curvature of which is larger than those of the positioning portions 168, 169, and 170. The receiving surfaces 246 decide the position of the scroll material 160 in the axial direction by receiving the positioning portions 168, 169, and 170, and all the receiving surfaces 246 are located in a single plane perpendicular to the central axis of the chuck 230. In the receiving surface 246 of the holding jaw 234, an engagement portion 248, which extends in parallel to the central axis of the chuck main body 232, is provided integrally. The engagement portion 248 has a diameter slightly smaller than the dimension of the width, of the engagement hole 172, perpendicular to the longitudinal direction, of the engagement hole 172, formed in the positioning portion 168, and is engaged with the engagement hole 172 so that movement of the engagement portion 248 in the direction of width is substantially disabled and relative movement, of the engagement portion 248 with respect to the engagement hole 172, in the longitudinal direction is allowed.'

[0031] The scroll material 160 is held with the chuck 230 in the state in which the positioning portions 168, 169, and 170 are positioned in the holding surfaces 244 by making the holding jaws 234, 236, and 238 come close in with each other synchronously after the engagement hole 172 of the positioning portion 168 of the scroll material 160 is engaged with the engagement portion 248 of the holding jaw 234 to prevent the movement of the scroll material 160 in the circumferential direction with respect to chuck main body 232. Since the engaging hole 172 is made oval, it is ensured that the holding surface 244 of the holding jaw 234 comes into contact with the outer circumferential surface of the positioning portion 168. Although the engagement portion 248, which is comprised of an engagement pin pressed into the pin hole formed in the receiving surface 246, is the engagement protrusion erected perpendicular on the receiving surface 246, in the present embodiment, it is possible to reverse the positions of the engagement hole 172 and the engagement portion 248. Moreover, it is possible to provide another circumferential position determining portion instead of the engagement hole 172

and the engagement portion 248. For example, it may be possible to form a plane located on a plane that includes the central axis of the chuck 230 on the holding jaw 234 and to make the side of the positioning portion 168 come into contact with the plane. It may be also possible to make the side of the positioning portion 168 come into contact with the engagement portion 248.

[0032] In the state in which the scroll material 160 is positioned and held in place as described above, not only the insertion hole 82 is formed by working tools but also the outer side surface 70 of the base 162 and the outer circumferential surface and the inner circumferential surface of the cylindrical boss 72 are cutting-worked, as shown by the alternate long and two short dashes lines in FIG.10. As described above, the scroll material 160 is positioned in the axial direction of the chuck 230 when the sides of the positioning portions 168, 169, and 170 of the scroll portion 54 side come into contact with the receiving surfaces 246 of the holding jaws 234, 236, and 238. The sides of the positioning portions 168, 169, and 170 of the scroll portion 54 side are formed in the same plane as the inner side surface of the base 162, therefore, the outer side surface of the base 162 is eventually machine-worked with the axis directional basis of the inner side surface of the base 162. As a result, the outer side surface of the base 162 is worked so that it is precisely formed in a state parallel to the inner side surface of the base 162 and the front end surface of the scroll portion 54.

[0033] Subsequently, the outer circumferential surface of the base 162 is machine-worked as shown in FIG.11. At this time, the outer circumferential surface of the boss 72 is held, being positioned in place, with a chucking machine 250 shown by the alternate long and two short dashes line in FIG.11, and the positioning portions 168, 169, and 170 formed integrally on the outer circumferential surface of the base 162 are removed and the outer circumferential surface are cutting-worked by work tools. The boss 72 is cutting-worked with basis of the positioning portions 168, 169, and 170 formed at the same time as the scroll portion 54 in the die-casting process, therefore, if the boss 72 is taken as the work basis, it is almost equal to the case in which machine work is performed with the work basis of the scroll portion 54.

[0034] In the case of the fixed scroll 18, similar to that of the movable scroll 32, the scroll material is cast by die-casting, the surfaces of the scroll portion 38 formed by the die-casting are left as cast, and the end surfaces 20 and 22, the pin holes (engagement holes) into which the positioning pins 26 and 28 are pressed, and so on, are machine-worked. Also in manufacturing the fixed scroll 18, the inner side surface, the outer side surface, and the front end surface of the scroll portion 38 and the inner side surface of the base 34 can be left as cast with a high dimensional accuracy by performing the trial die-casting process, the measuring process, the process to manufacture the production first mold, and so on, as described above. The fixed scroll 18 comprises the housing portion 39, the flange portion 40 and the bolt holes 41, as described above, which are formed at the same time by the production first metal mold together with the scroll portion 54. Therefore, for example, if the housing portion 39 and the bolt holes 41 are used instead of the positioning portions 168, 169, and 170 and the engagement hole 172, to cutting-work the end surface 20 and the pin hole of the positioning pin 26, it is equivalent to the case in which those are worked with basis of the scroll portion 38. If, subsequently, the fixed scroll 18 is positioned in place with basis of these end surface 20 and the pin hole of the positioning pin 26 and if the end surface 22 and the pin hole of the positioning pin 28 are worked, then it is also equivalent to the case in which these are worked with basis of the scroll portion 38.

[0035] In the present embodiment, the fixed scroll 18 and the movable scroll 32 are cast by die-casting and the scroll portions 38 and 54 and the inner side surfaces 36 and 52 of the bases 34 and 50, which used to be machine-worked conventionally, are left as cast, therefore, machine work to these portions is no longer necessary and the amount of wasted materials produced by machine work is reduced, resulting in improvement of the yield of materials and reduction in the cost of production. The time required for the machine working process can also be reduced, resulting in reduction of the cost of production. Moreover, reduction in weight is attained because of the material, the predominant element of which is aluminum, and the durability of the scroll portions 38 and 54, and the scrolls 18 and 32 as a result, is improved because of the chill layers formed in the scroll portions 38 and 54 and on the inner side surfaces 36 and 52 of the bases 34 and 50. However the front end surfaces 120 and 122, and the seal grooves 130 and 134 of the scroll portions 38 and 54 may be formed by machine work.

[0036] Since the portions (the end surface 42 of the base 34, the insertion hole 82, boss 72, and so on) other than the scroll portion are machine-worked with the scroll portion 54 of the scroll material 160 that is cast by die-casting with a high dimensional accuracy being the work basis, the accuracy in position required for the product of the scroll portions 38 and 54 with respect to the portions other than the scroll portions 38 and 54 of the fixed scroll 18 and the movable scroll 32 is ensured. For example, it is possible to control the degree of contour of the scroll portions 38 and 54 of the fixed scroll 18 and the movable scroll 32 to 40μm or less and the flatness of the front end surfaces of the scroll portions 38 and 54 and the inner side surfaces of the bases 34 and 50 and the parallelism therebetween to 20μm or less, respectively, and the clearances between the front end surfaces of the scroll portions 38 and 54 and the opposing inner side surfaces of the bases 34 and 50 of the scroll portions 38 and 54 fall in the setting range, with the state in which the fixed scroll 18 and the movable scroll 32 are combined in the main body 10. By the

successful combination of the fixed scroll 18 and the movable scroll 32, a scroll-type compressor with stable performance can be obtained.

[0037] It is also possible to abbreviate the positioning portions 168, 169, and 170 of the scroll material 160 in the present embodiment, and let the holding jaws 234, 236, and 238 directly hold the outer circumferential surfaces of the scroll material 160. In this case, it is preferable to provide the chuck main body 232 with holding jaws (or engagement portions) that are not able to move and determine the circumferential position of the scroll material 160 with respect to the chuck main body 232 by making these holding jaws come into contact with the inner end or outer end of the scroll portion 54.

[0038] A holding jig 300, which is used in the machine working process of the method of manufacturing a scroll in another embodiment of the present invention, is shown in FIG.12. A jig main body 302 of the holding jig 300 is fixed coaxially to a main shaft 304 (shown by the alternate long and two short dashes line in FIG.12) of a work machine as mechanical working equipment, and functions as a part of the main shaft 304. The holding jig 300 comprises a positioning jig 310 and a fixture 312, and in the present machine working process, machine work is applied to the base 162, and so on, with the state in which a scroll material 316 is positioned with the positioning jig 310 that is engaged physically with the scroll portion 54 of the scroll material 316 and the scroll material 316 is fixed by the fixture 312. Although the scroll material 316 in the present embodiment does not comprise positioning portions or an engagement hole, unlike the scroll material 160 that comprises the positioning portions 168, 169, and 170 and the engaging hole 172, other portions are the same therefore the same symbols are assigned to the same components. The positioning jig 310 used in the present embodiment comprises three or more engagement portions 320 (refer to FIG.14 through FIG.21) that are engaged with three or more points of the scroll portion 54. The engagement portion 320 is a tapered pin member, which has an opening on an end surface 322 of the jig main body 302 opposite to the main shaft 304 and is erected vertically on a bottom surface 326 of a recess 324 that can house the scroll portion 54 and the diameter of which decreases toward the front end. The tapered outer circumferential surface of the engagement portion 320 is inclined in accordance with the inclination of the outer side surface and the inner side surface of the scroll portion 54. When the scroll material 316 is made to come into contact with a shoulder surface 330 formed between the end surface 322 and the bottom surface 326 of the jig main body 302 and with the bottom surface 326, being positioned in the axial direction of the main shaft 304, the tapered outer circumferential surface of the engagement portion 320 and the outer side surface or the inner side surface of the scroll portion 54 are made to come close in with each other.

[0039] The position at which the engagement portion 320 is engaged with the scroll portion 54 is selected so that the location of the center of the scroll material 316 and the rotational phase about the center thereof are determined uniquely. As shown in FIG.14, for example, one of the three engagement portions 320 comes into contact with the inner end, which is an end near the center of the scroll portion 54, in the direction almost parallel to the longitudinal direction of the scroll portion 54, and the other two engagement portions 320 are engaged with the outer side surface and the inner side surface of the scroll portion 54 at the position apart from the inner end of the scroll portion 54 toward the outer end, in a longitudinal direction. The two engagement portions 320 to be engaged with the outer side surface and the inner side surface of the scroll portion 54 disable the relative rotation of the scroll portion 54 with respect to the positioning jig 310 in the direction of decreasing the radius of the engagement point with the engagement portion 320. When one of the engagement portions 320 comes into contact with the inner end of the scroll portion 54, the relative rotation of the scroll portion 54 with respect to the positioning jig 310 in the direction of increasing the radius of the engagement point with the engaging portion 320 is also disabled, therefore, the location of center of the scroll material 316 can be determined uniquely and at the same time the relative rotation of the positioning jig 310 and the scroll material 316 in the normal and reverse direction is also disabled.

[0040] The scroll material 316 is fixed with the fixture 312, being thus positioned accurately by the positioning jig 310. The fixture 312 is provided outside the end surface 322 and comprises plural (three in the present embodiment) engagement jaws 334, which are engaged with the outer side surface of the base 162. Although only two engagement jaws 334 are shown in FIG.12, the three engagement jaws 334 are equally spaced at the same angle intervals. The base 162 is clamped from both sides by the engagement jaw 334 and the shoulder surface 330, or the scroll portion 54 and the base 162 are clamped from both sides by the engagement jaw 334 and the bottom surface 326, then the scroll material 316 is fixed to the jig main body 302. The engagement jaw 334 is made to come close to or separate from the jig main body 302 by a drive unit 340. The drive unit 340 comprises a hydraulic cylinder 342, which is a fluid pressure cylinder, as a drive power source. The hydraulic cylinder 342 comprises a cylinder bore 344, the cross-section of which is circular, formed in the jig main body 302 in the direction parallel to the.axis of the main shaft 304, a piston 350 inserted into the cylinder bore 344 slidably and liquid-tightly, a piston rod 352 that extends in the axial direction from the piston 350, and a spring member 360 comprised of plural Belleville springs connected to each other in tandem, and the engagement jaw 334 is provided integrally on the front end of the piston rod 352. The jig main body 302 functions also as a housing of the hydraulic cylinder 342. The space in a large-diameter hole portion 346 of the cylinder bore 344

is divided into two spaces by the piston 350, the spring member 360 is housed in a chamber formed in the space of the piston rod 352 side, and a chamber formed in the space of the head side is connected to the hydraulic source via a liquid channel. If the hydraulic fluid is supplied to the chamber of the head side, the engagement jaw 334 is moved in such a direction so as to separate from the jig main body 302, resisting the biasing force of the spring member 360.

[0041] While a cam groove 366 is formed on the outer circumferential surface of the piston rod 352, a cam follower 368 protrudes radially inward from the inner circumferential surface of the rod hole of the jig main body 302 as shown in FIG.13, and the cam groove 366 and the cam follower 368 are engaged with each other. The cam groove 366 comprises an axial groove portion 370 that extends in the direction parallel to the axis and an inclined groove portion 372 that extends obliquely downward with respect to the axial direction from the axial groove portion 370. The cam follower 368 is comprised of the front end portion of the pin members, which have a circular cross section and are fixed to the jig main body 302. If the piston 350 is moved upward in FIG.12 from the state in which the top portion of the axial groove portion 370 and the cam follower 368 are engaged with each other (refer to FIG.13), the piston rod 352 is extended while being guided by the engagement of the axial groove portion 370 with the cam follower 368. If the piston 350 is lifted up further, the inclined groove portion 372 and the cam follower 368 are engaged with each other and as a result, the piston rod 352 is extended while being rotated on its axis. Thereby, the engagement jaw 334 is rotated and moved to a point away from the base portion 162 while being separated from the base portion 162 and it will be easier to install or remove the scroll material 316 to or from the holding jig 300. It is also possible to provide the jig main body 302 with the cam groove 366 and to provide the piston rod 352 with the cam follower 368, respectively.

[0042] As described above, after the scroll material 316 is positioned in and fixed to the holding jig 300, machine work is applied to the outer side surface of the base portion 162 opposite to the scroll portion 54 using work tools, and while the insertion hole 82 is formed on the outer side surface of the base portion 162, the outer circumferential surface and the inner circumferential surface of the boss portion 72 are cutting-worked as shown in FIG.12. FIG.12 shows that the insertion hole 82 is formed in the base portion 162 and machine work is applied to the inner circumferential surface and the outer circumferential surface of the boss portion 72. As described in the embodiments shown in FIG.1 through FIG.11, the outer circumferential surface of the base portion 162 is machine-worked in the state in which the boss portion 72 is held with the chuck unit, then the outer side surface of the base portion 162 is machine-worked in the state in which the outer circumferential surface of the base portion 162 is positioned and held with a holding unit such as a three-jaw chuck. It is preferable for the holding unit to comprise a receiving surface to receive the inner side surface of the base portion 162 (or front end surface of the scroll portion 54) as the chuck 160 does and, thereby, the outer side surface of the base portion 162 can be worked so that the parallelism thereof to the inner side surface of the base portion 162 and the front end surface of the scroll portion 54 is accurate.

[0043] The positioning jig may comprise four or more engagement portions. Thereby, the scroll material 316 can be positioned more stably and accurately. As shown in FIG.15, for example, one of the four engagement portions 320 is made to come into contact with the inner end of the scroll portion 54 in the direction almost parallel to the longitudinal direction of the scroll portion 54, the other three engagement portions 320 are engaged with the inner side surface of the scroll portion 54, and each central angle between two adjacent engagement portions 320 of the three is made smaller than 180 degrees, each central angle being almost equal to each other. Thereby, the three engagement portions 320 to be engaged with the inner side surface of the scroll portion 54 can disable the scroll material 316 from moving, in any radial direction, with respect to the positioning jig 310, unless the scroll material 316 is rotated. The scroll material 316 is disabled also from relatively rotating, with respect to the positioning jig 310, in the direction, in which the radius of the scroll portion 54 at each engagement point with each engagement portion 320 decreases. If one of the engagement portions 320 and the inner end of the scroll portion 54 are made to come into contact with each other with this state, the relative rotation of the scroll portion 54 in the direction, in which the radius at each engagement point with each engagement portion 320 increases, is also disabled, therefore, the location of the center of the scroll material 316 can be determined uniquely and at the same time both the normal and the reverse rotation of the scroll material 316 with respect to the positioning jig 310 can be also disabled.

[0044] As an example of the case in which one of the four engagement portions 320 is made to come into contact with the inner end of the scroll portion 54 in the direction almost parallel to the longitudinal direction of the scroll portion 54, and the positions of the other three, at which they are engaged with the inner side surface of the scroll portion 54, are selected, the embodiments, for example, shown in FIG.16 and FIG.17 are also applicable in addition to that shown in FIG.15.

[0045] The engagement points of the four or more engagement portions may be other than those described above. Several embodiments are described below. As shown in FIG.18, it is an applicable embodiment in which one of the four engagement portions 320 is made to come into contact with the outer end, of the scroll portion 54 of the scroll material 316, away from the center thereof in the direction almost parallel to the longitudinal

direction of the scroll portion 54, the other three engagement portions 320 are engaged with the outer side surface of the scroll portion 54, and each central angle between two adjacent engagement portions of the three engagement portions 320 is made smaller than 180 degrees. Each central angle between two adjacent engagement portions of the three engagement portions 320 is made almost equal to each other in the present embodiment. In the present embodiment also, the scroll material 316 can be positioned, in the state in which the relative movement, with respect to the positioning jig, in any direction in a plane perpendicular to the central line of the scroll material 316, is disabled, for the same reason as described in the embodiment shown in FIG.15.

[0046] Another embodiment is shown in FIG.19. The positioning jig 310 in the present embodiment comprises the four engagement portions 320. The positions of two of the four engagement portions 320 are selected so that the two pinch the portion, at which the thickness of the portion gradually increases toward the center, from both inner side surface and the outer side surface of the scroll portion 54 almost in the direction of thickness, in the vicinity of the inner end of the scroll portion 54. One of the other two engagement portions 320 is arranged in the vicinity of the inner end of the scroll portion 54 so as to be made to come into contact with the scroll portion 54 in the direction perpendicular to that in which the above-mentioned two engagement portions pinch the scroll portion 54, and the other one of the engagement portions 320 is engaged with the outer side surface, of the scroll portion 54, the radius of which is larger than those where the above-mentioned three engagement portions 320 are engaged. In the present embodiment, the three engagement portions 320 located near the center of the scroll portion 54 improve the positioning accuracy of the portions near the center of the scroll portion 54, and the other engagement portion 320 improves the positioning accuracy of the outer circumferential surface of the scroll portion 54 as well. As a similar example of the positions at which the engagement portions 320 are engaged with the scroll portion 54, those of the embodiment shown in FIG.20 are also applicable.

[0047] Another embodiment is shown in FIG.21. The positioning jig 310 in the present embodiment comprises the four engagement portions 320. Two of the four engagement portions 320 are arranged so as to be engaged with the outer side surface of the scroll portion 54 of the scroll material 316 at two points separated from each other almost in the direction of the first diameter of the scroll material 316, and the other two engagement portions 320 are arranged so as to be engaged with the inner side surface of the scroll portion 54 at two points separated from each other almost in the direction of the second diameter, which is perpendicular to the first diameter. In the present embodiment also, the scroll material 316 can be positioned in the state in which the relative movement thereof, with respect to the positioning jig, in any direction in a plane perpendicular to the central line thereof, is disabled.

[0048] The machine working process in the present invention may be that in which the base portion, etc. are machine-worked in the state in which the scroll portion of the scroll material is held by the chuck. One of the embodiments is described with reference to FIG.22 and FIG.23. A chuck 500 used in the present machine working process has a structure similar to that of a three-jaw chuck, and comprises plural holding jaws. Concretely, the chuck 500 comprises three holding jaws 510, 512, and 514 held movably along the three radii that extend radially from the central axis of a chuck main body 502 with the intervals of the same angle, and a holding jaw 516 installed to the chuck main body 502, the movement being disabled, as shown briefly in FIG.22. The chuck 500 has the chuck main body 502 coaxially fixed to a main shaft 518 (shown with the alternate long and two short dashes in FIG.23) of the work machine, as a machine working unit, and functions as a part of the main shaft 518. Guide grooves 520, extending in the direction of the three radii described above, are formed in the chuck main body 502, three movable members 522 are held movably, being guided by the guide grooved 520, and the holding jaws 510, 512, and 514 are provided integrally in the movable members 522. When driven by a drive 530, the three movable members 522 are moved synchronously in the radial direction of the chuck main body 502, being guided by the guide grooves 520, and thereby the three holding jaws 510, 512, and 514 are made to come close in with and separate from each other by the same amount of distance. The distance of each holding jaw 510, 512, and 514 from the central axis of the chuck main body 502 is made different from each other, however, and the distance of the holding jaw 514 from the central axis line is the largest, that of the holding jaw 512 is the second largest, and that of the holding jaw 510 is the smallest. The holding jaws 510, 512, and 514 have such a shape that they can be inserted into the recess formed by the side surfaces of the scroll portion 54.

[0049] The drive 530 comprises a hydraulic cylinder 532, a kind of the fluid pressure actuator, as a drive source as shown in FIG.23. The hydraulic cylinder 532 comprises a cylindrical housing 534 provided parallel to the axial direction of the main shaft 518, a piston 540, which is slidably and liquid-tightly inserted into a large diameter hole portion 536, with a stepped hole, that extends in the axial direction in the housing 534, and a piston rod 542 that extends in the axial direction from the piston 540. The chuck main body 502 is designed to function as the housing 534 of the hydraulic cylinder 532 as well. The piston rod 542 is held in the housing 534 so that the sliding motion is possible in a small diameter hole portion 544 of the stepped hole described above. The space in the large diameter hole portion 536 is divided into two spaces by the piston 540, and a spring member 550, which is comprised of plural Belleville

springs being connected to each other in tandem, is housed in the chamber formed near the piston rod 542, and is biased in the direction in which the piston rod 542 contracts. The diameter of the large diameter hole portion 536 near the small diameter hole portion 544 is designed to be slightly smaller, and the spring member 550 is arranged thereto. The other space of the large diameter hole portion 536 of the head side is connected to the hydraulic source via a liquid channel 552. If the hydraulic fluid is supplied to the space of the head side, the piston rod 542 is extended, resisting the biasing force of the spring member 550.

[0050] The piston rod 542 and the holding jaws 510, 512, and 514 are connected by a motion conversion device 560 and the extending and contracting motion of the piston rod 542 is converted to the closing and opening motion of the holding jaws 510, 512, and 514. The motion conversion device 560 comprises drive members 562 and driven members 564. The drive members 562 are comprised of pin members that are fixed integrally to a large diameter portion 568, which is provided integrally with the piston rod 542, with a state in which drive members 562 are inclined with respect to the central axis of the piston rod 542. The drive members 562 are protruded forward from the front surface of the large diameter portion 568 and inclined so as to come closer to the central axis of the chuck main body 502 when advanced. The driven members in the present embodiment 564 are formed integrally with the movable members 522 that hold the holding jaws 510, 512, and 514. The driven members 564 are provided with an insertion holes, which are inclined in accordance with the drive members 562, and into which the drive members 562 can be inserted. Therefore, when the piston rod 542 of the hydraulic cylinder 532 is extended, the depth of insertion of the drive members 562 into the insertion holes of the driven members 564 increases, and the holding jaws 510, 512, and 514 are separated simultaneously from the central axis of the chuck main body 502 due to the effect of the slope. When the piston rod 542 is contracted, the holding jaws 510, 512, and 514 are made to come close in with each other.

[0051] The scroll material 316 is positioned in the axial direction when the inner side surface of the base portion 162 of the scroll material 316 comes into contact with the receiving surface, that is, the front end surface of the holding jaws 510, 512, and 514. The holding jaws 510, 512, and 514 come into contact with the three points of the scroll portion 54 of the scroll material 316 almost in a perpendicular direction thereof, respectively, and the holding jaw 516 comes into contact with the outer end of the scroll portion 54 in a direction almost parallel to the longitudinal direction of the scroll portion 54. These points at which the holding jaws 510 through 516 come into contact with the scroll portion 54 determine the location of center of the scroll material 316 uniquely and at the same time are selected so that the relative rotation of the scroll material 316 with respect to the chuck 500 in both the normal and reverse direction are prevented. The three holding jaws 510, 512, and 514 are engaged with the outer side surface of the scroll portion 54 and at the same time each central angle between two adjacent ones of the three holding jaws 510, 512, and 514 is made smaller than 180 degrees, each central angle being almost equal to each other. The inner circumferential surface of the holding jaws 510, 512, and 514 is made to be a holding surface 574. The holding surface 574 holds the outer side surface of the scroll portion 54 and is designed to have a curved surface in accordance with the shape of each contact point of the scroll portion 54, or a surface the radius of curvature of which is slightly larger than that of each contact point. The holding surface 576 is formed also on the end of the holding jaw 516 that holds the outer end of the scroll portion 54.

[0052] Machine work with work tools is applied to the outer side surface and outer circumferential surface of the base portion 162 of the scroll material 316, with the state in which the scroll portion 54 of the scroll material 316 is held with the chuck 500 of the present embodiment so that the relative movement, of the scroll material 316 with respect to the chuck 500, in any direction in a plane perpendicular to the central line thereof is disabled. Since the portions other than the scroll portion are machine-worked with the scroll portion 54 being the work basis, the position accuracy of the scroll portion 54 of the movable scroll 32, as a product, with respect to the portions other than scroll portion 54 is ensured, similarly as described in each embodiment. For example, the outer side surface of the base portion 162 is worked with the state in which the inner side surface of the base portion 162 is received by the front end surfaces of the holding jaws 510, 512, and 514, therefore, the movable scroll 32, the parallelism of which to the inner side surface and the outer side surface of the base portion 162 and the front end surface of the scroll portion 54 is excellent, can be obtained. Therefore, the fixed scroll 18 and the movable scroll 32 can be installed to the main body 10 successfully. Moreover, the outer side surface and the outer circumferential surface of the base portion 162 can be machine-worked simultaneously, while being held by the chuck 500, therefore, the machining efficiency is improved.

[0053] The contact points of the four holding jaws with the scroll portion of the scroll material are not restricted to those described in the present embodiments, but various contact points are possible as those engagement points of the engagement portions illustrated in each embodiment shown in FIG.14 through FIG.21. It is also possible to use a chuck that has five or more holding jaws.

[0054] Several embodiments of the present invention are described in detail as above, but these are only examples and in the present invention numerous variants and modifications, other than the aspects of "summary of the invention" described herein, could be made there-

to by those skilled in the art.

Claims

1. A method of manufacturing a scroll for a scroll-type compressor, comprising:

a die-casting process wherein a production scroll material, having a base and a scroll portion erected thereon, having such a shape that the thickness of the scroll portion gradually decreases in the direction from the proximal end of the base side thereof to the front end thereof, is cast using a production metal mold that opens in the direction of thickness of the base, and

wherein the production metal mold comprises a production first mold having a cavity of a shape that corresponds to at least the entire scroll portion, and

a production second mold having a cavity of a shape that corresponds to at least a part of the base; and

a machine working process wherein a scroll, as a product, can be obtained by machine-working the base of the production scroll material, which is cast in the die-casting process, and by at least the outer side surface and the inner side surface of the scroll portion of the production scroll material being left as cast.

2. A method of manufacturing a scroll for a scroll-type compressor, as set forth in claim 1, wherein the machine working process includes a process in which the base is machine-worked with the work basis of at least either the outer side surface or the inner side surface of the scroll portion left as cast.

3. A method of manufacturing a scroll for a scroll-type compressor, as set forth in claim 1, further comprising:

a trial die casting process that casts a trial scroll material using a trial metal mold equipped with a trial first mold having the same cavity as or a similar one to that of the production first mold;

a measuring process including, measuring first dimensions of at least the outer side surface and the inner side surface of the scroll portion of the trial scroll material, comparing the first dimensions with the second dimensions of the corresponding portions of the cavity that has formed the scroll portion of the trial first mold, and obtaining the dimensional difference between the first dimensions and the second dimensions; and

a manufacturing process to manufacture the production first mold, to the cavity of which, having a shape corresponding to a scroll portion with the true shape and dimensions, modifications based on the dimensional difference obtained in the measuring process are made;

wherein the production first mold is used as a component of the production metal mold of the production scroll material.

4. A method of manufacturing a scroll for a scroll-type compressor, as set forth in any one of claim 1 or claim 3,

wherein a positioning portion, which has a relative position specified in advance with respect to the scroll portion, is formed on the base in the die-casting process, and

wherein the scroll material is positioned by utilizing the positioning portion and the base is machine-worked in the machine working process.

5. A method of manufacturing a scroll for a scroll-type compressor, as set forth in any one of claim 1 through claim 3, wherein the machine working process includes a process in which the scroll material is fixed by a fixture and the base is machine-worked after the scroll material is positioned with a positioning jig that is physically engaged with at least either the outer side surface or the inner side surface of the scroll portion of the scroll material.

6. A method of manufacturing a scroll for a scroll-type compressor, as set forth in any one of claim 1 through claim 3, wherein the machine working process includes a process in which the base is machine-worked in the state in which at least either the outer side surface or the inner side surface of the scroll portion of the scroll material is held with a chuck.

7. A scroll for a scroll-type compressor, comprising a base and a scroll portion erected thereon,

wherein the scroll portion has such a shape that the thickness of the scroll portion gradually decreases in the direction from the proximal end of the base side thereof to the front end thereof, and at least the outer side surface and the inner side surface of the scroll portion are left as cast.

8. A scroll for a scroll-type compressor, as set forth in claim 7, wherein a rounded portion is formed at the border between the scroll portion and the base and at the same time a rounded portion corresponding to the rounded portion is formed on the front end of the scroll portion.

9. A scroll for a scroll-type compressor, as set forth in either claim 7 or claim 8, wherein the scroll is a mov-

able scroll, the self rotation of which is prevented by a self-rotation preventing mechanism and which is revolved by a revolving mechanism, and wherein an engagement portion engaged with at least either the self-rotation preventing mechanism or the revolving mechanism is machine-worked on the movable scroll.

10. A scroll-type compressor, comprising a fixed scroll and a movable scroll having a base and a scroll portion erected thereon,

wherein the scroll portion has such a shape that the thickness thereof gradually decreases in the direction from the proximal end of the base side thereof to the front end thereof, the fixed scroll and the movable scroll, at least the outer side surface and the inner side surface of the scroll portion of which are left as cast, are contained in a main body, being engaged with each other, the relative movement of the fixed scroll with respect to the main body is disabled, and a mechanism, which revolves the movable scroll while preventing the self-rotation of the movable scroll, is arranged between the movable scroll and the main body.

Fig.1

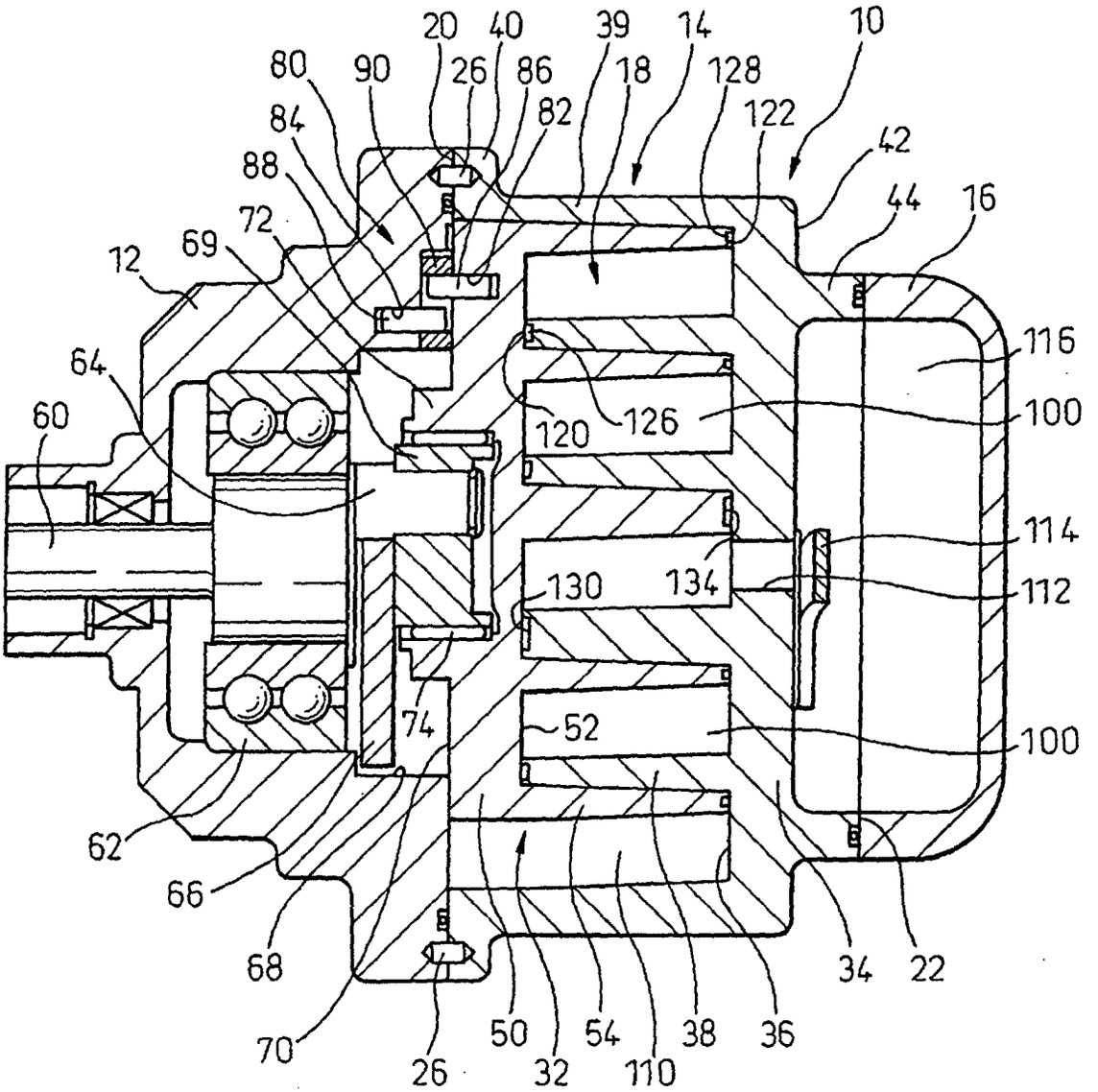
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Fig.2

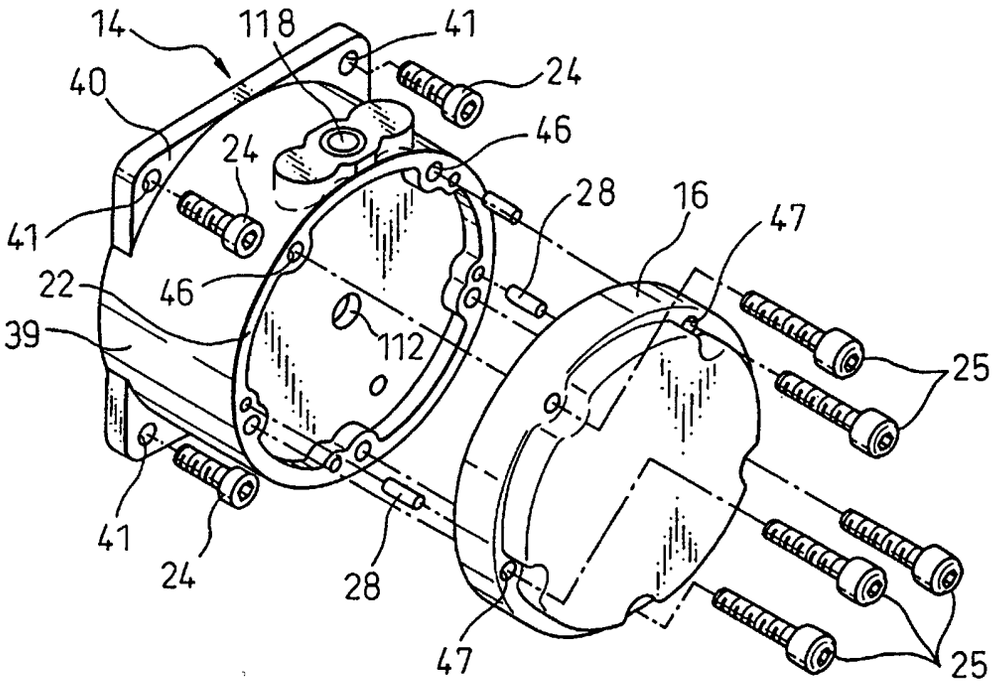
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Fig.3

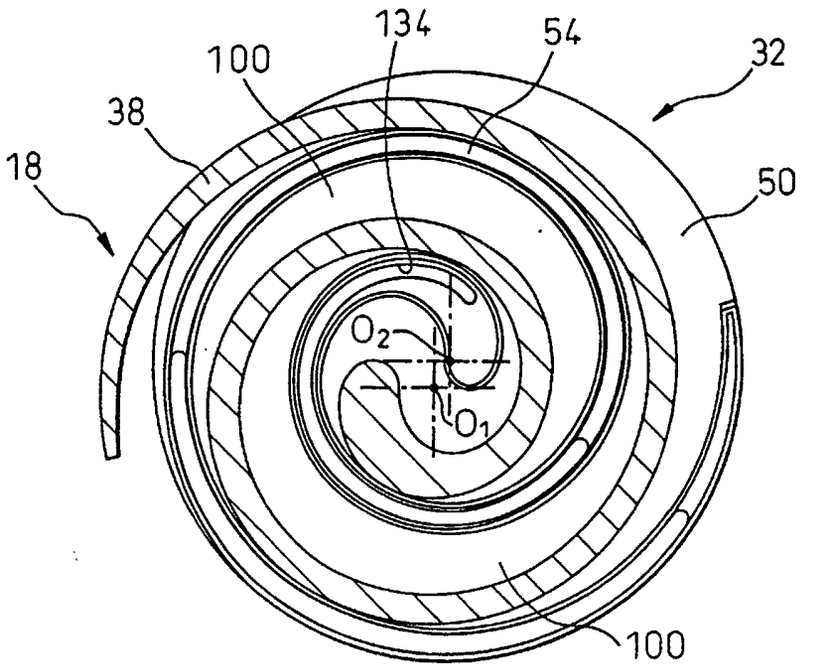
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Fig. 4

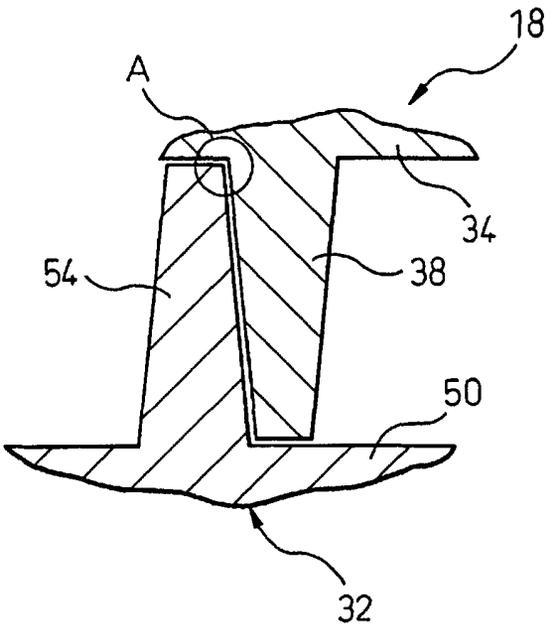

Fig. 5

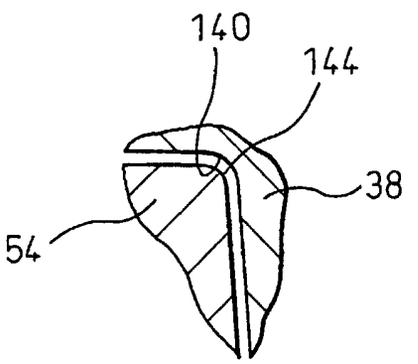

Fig.6

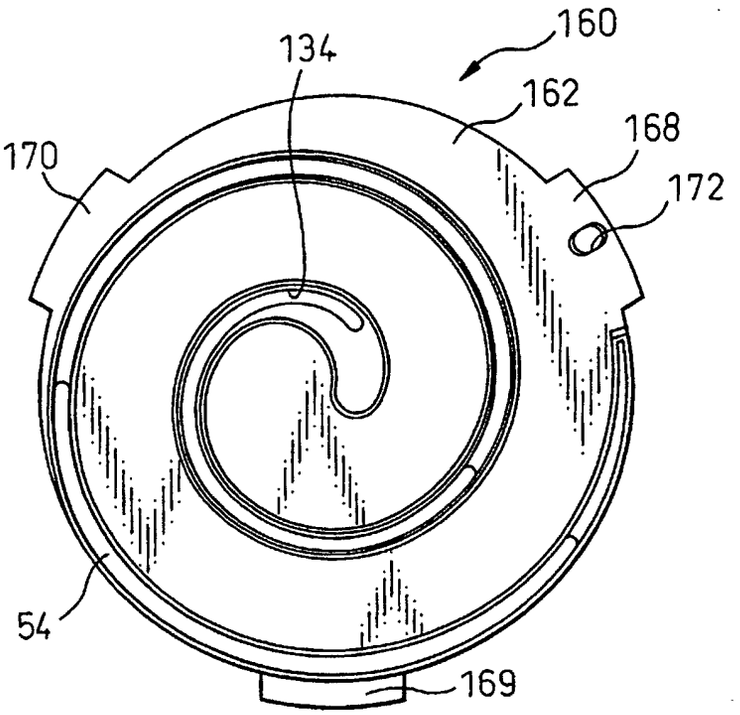
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Fig.7

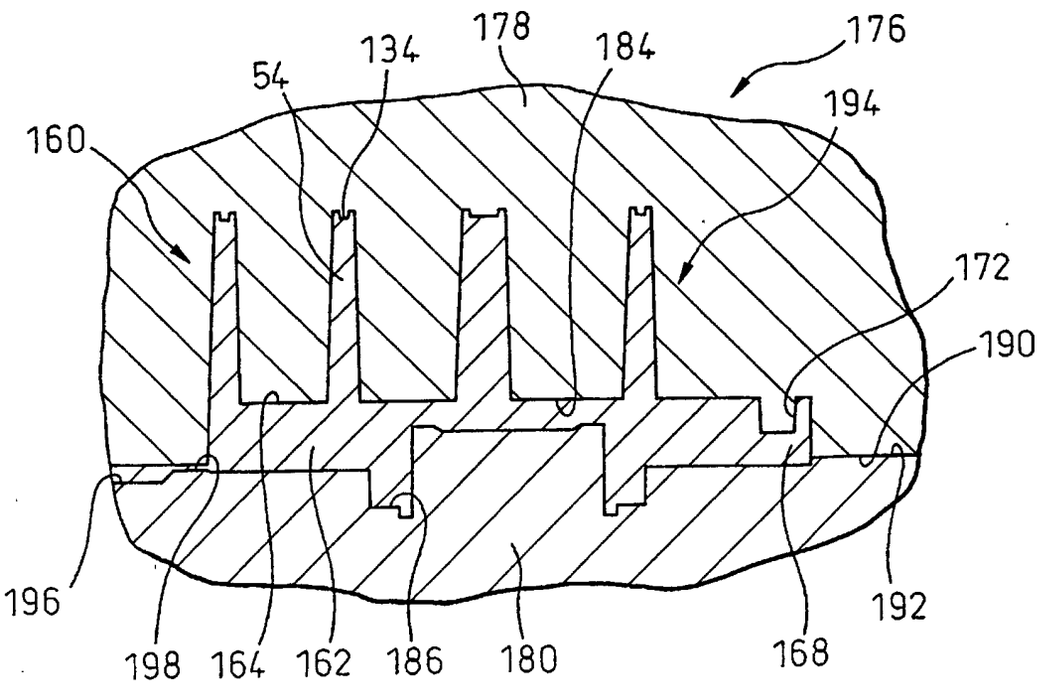
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Fig. 8

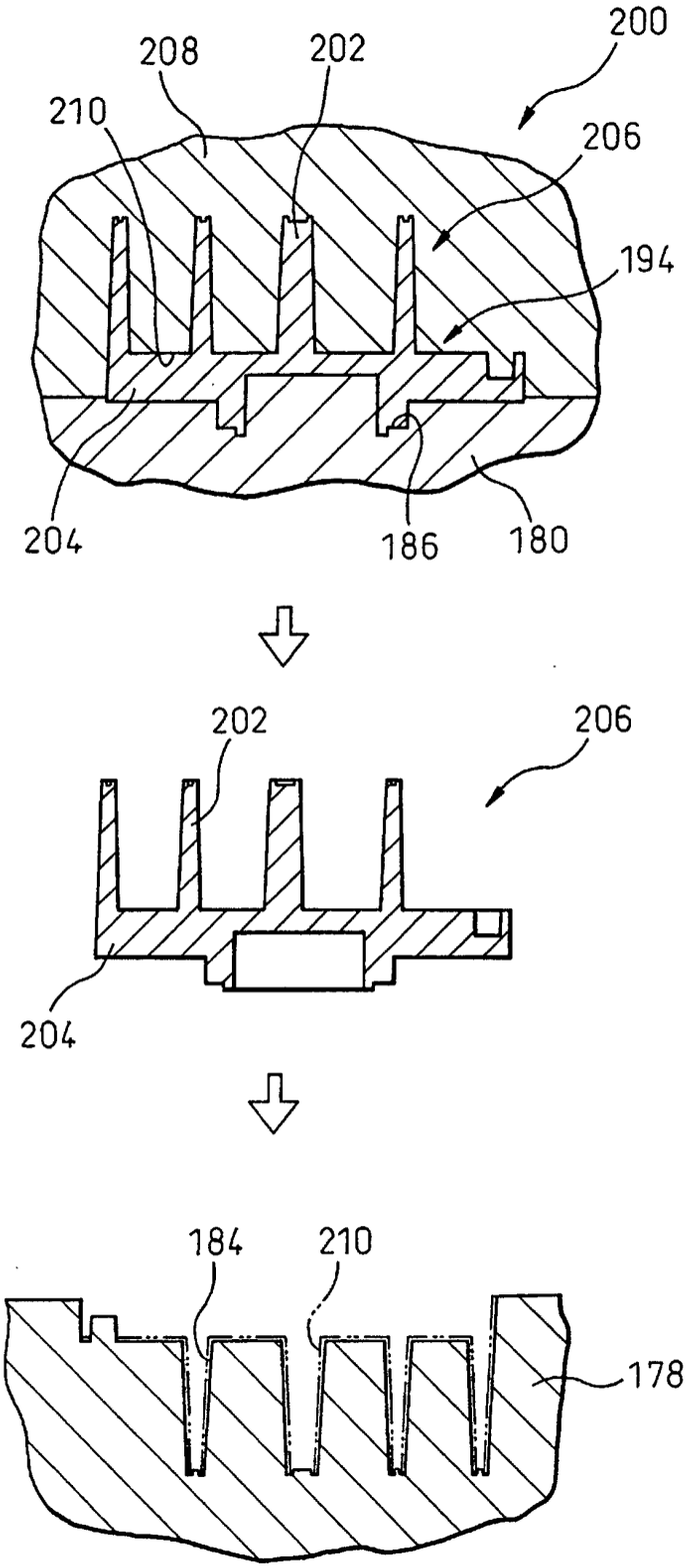

Fig.9

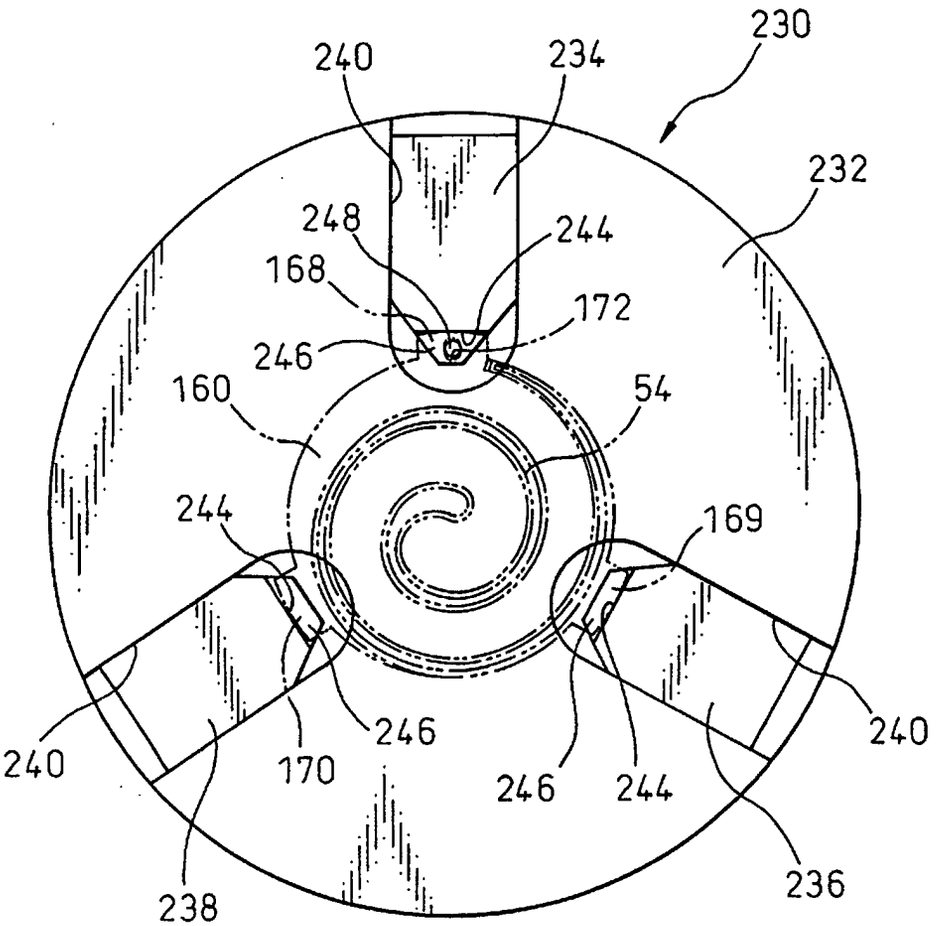
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Fig.10

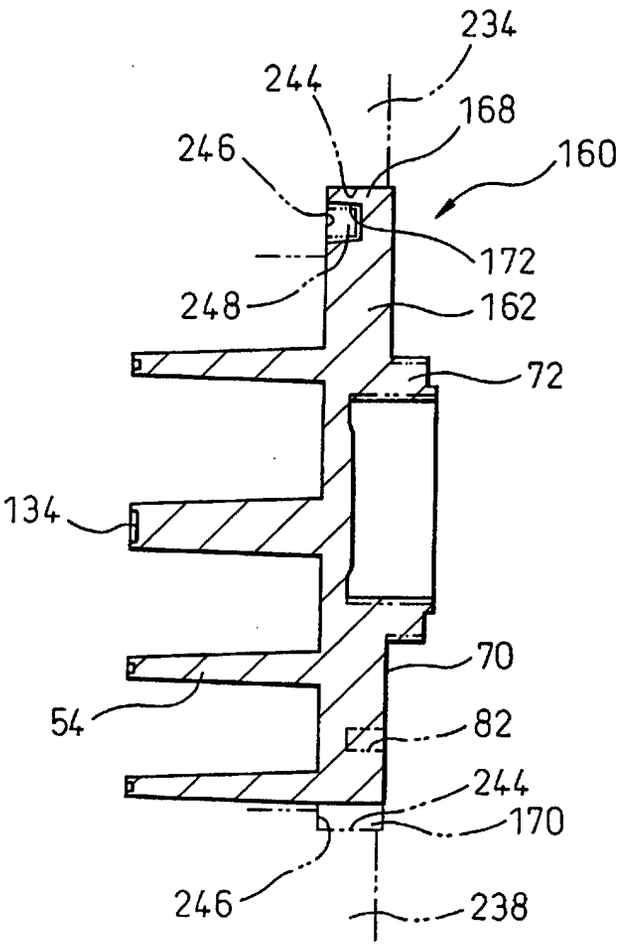

Fig.11

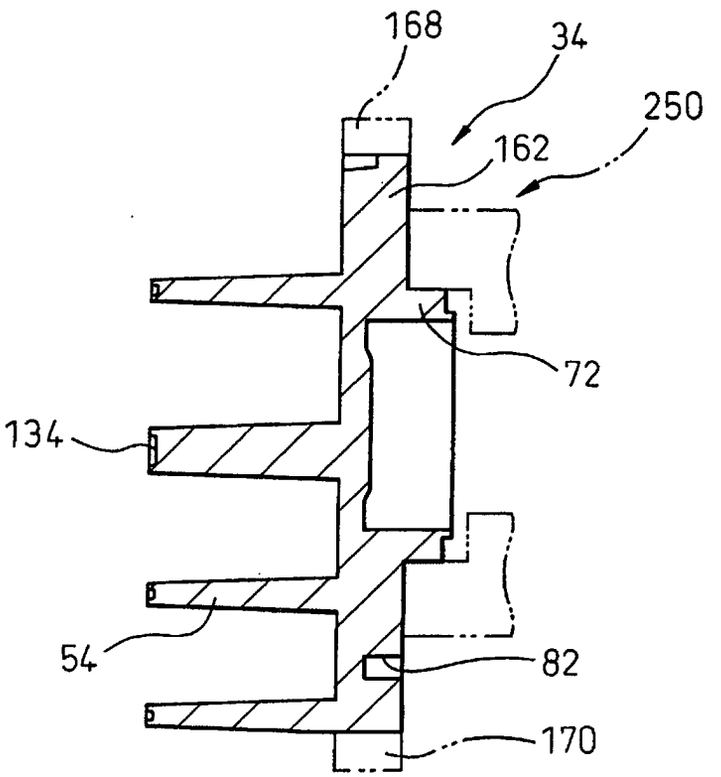

Fig.12

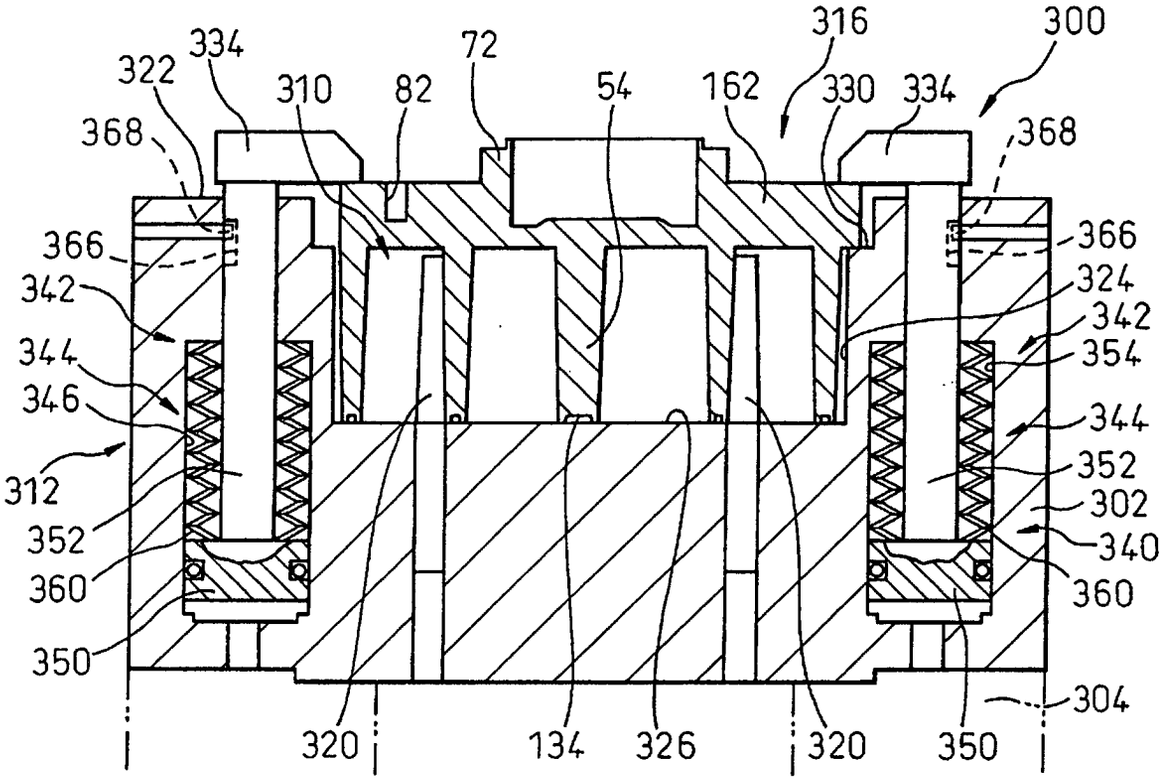
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Fig.13

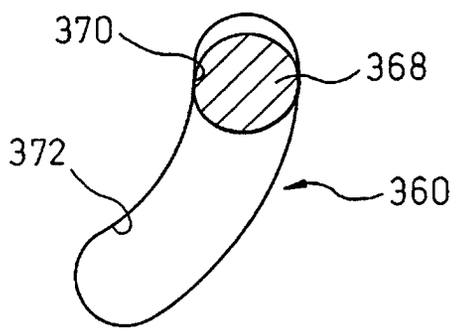
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Fig.14

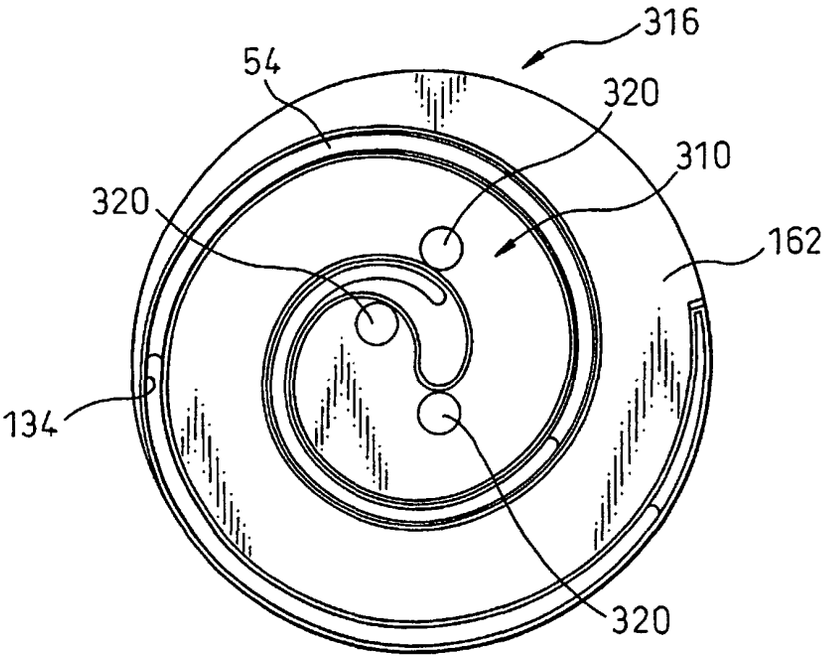

Fig.15

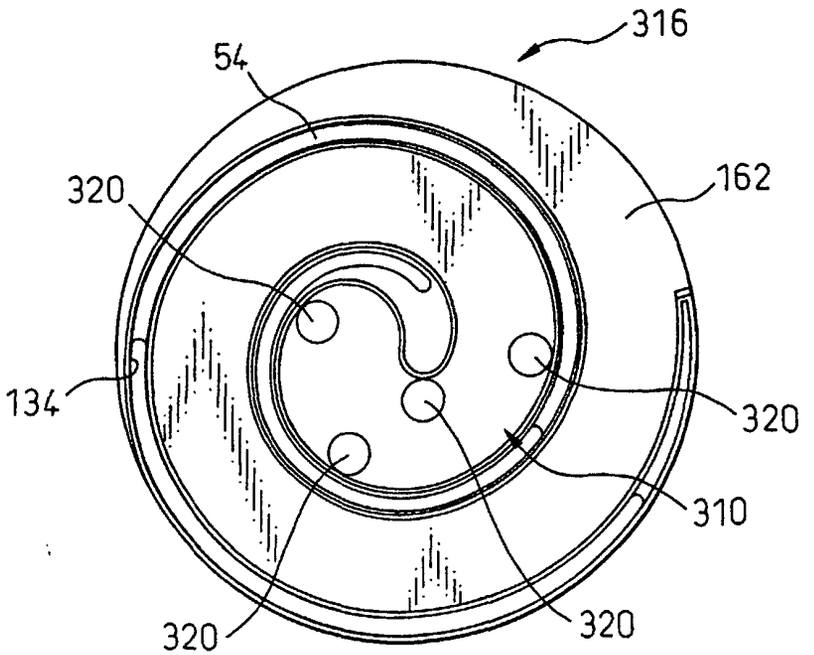

Fig.16

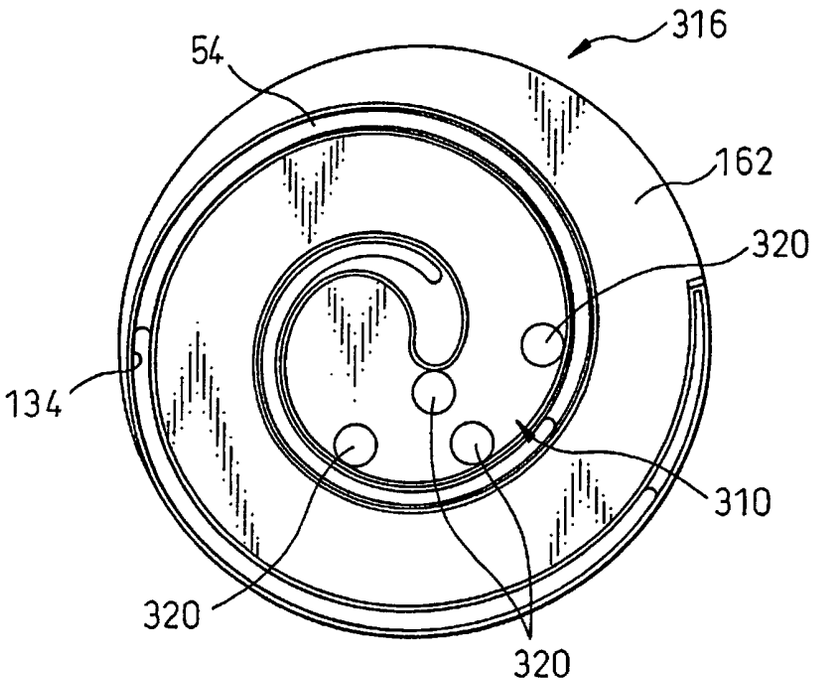

Fig.17

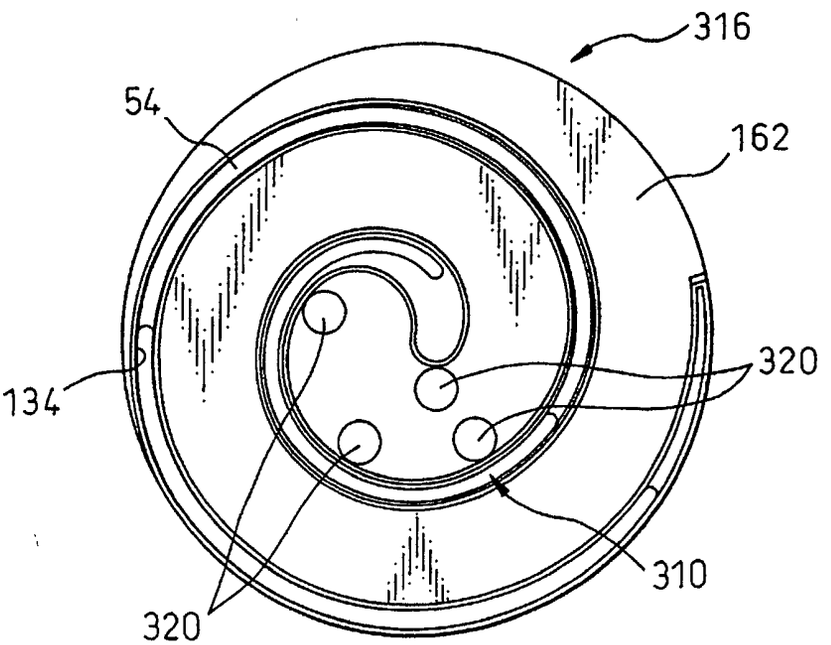

Fig.18

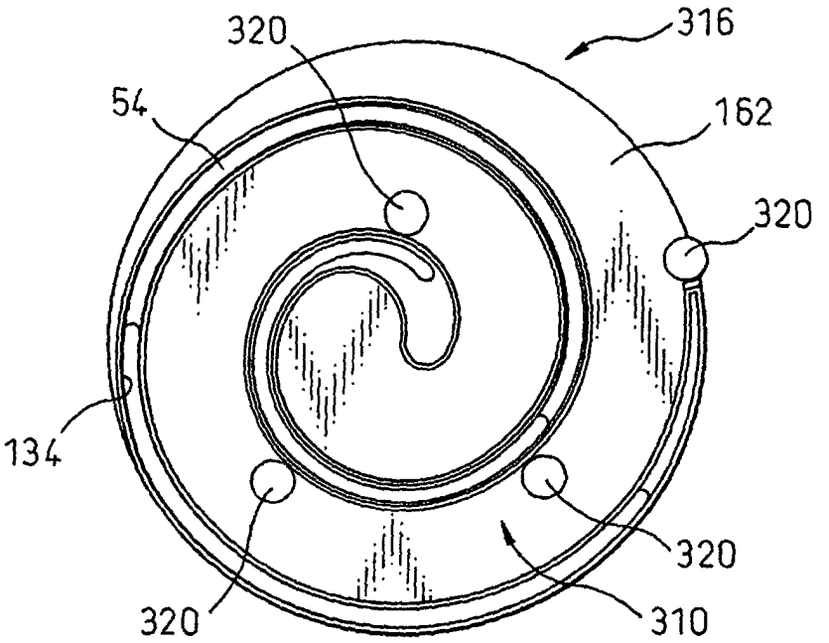
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Fig.19

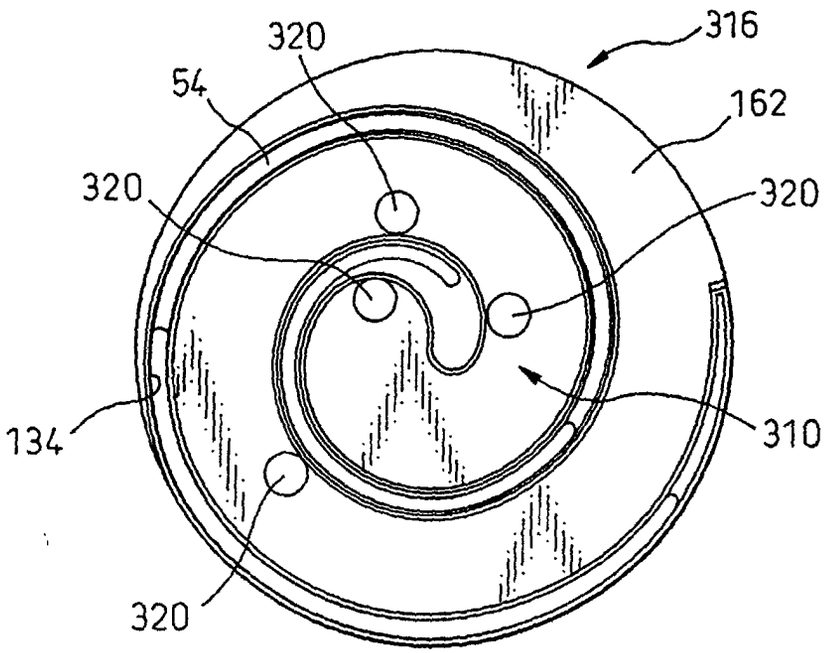
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Fig. 20

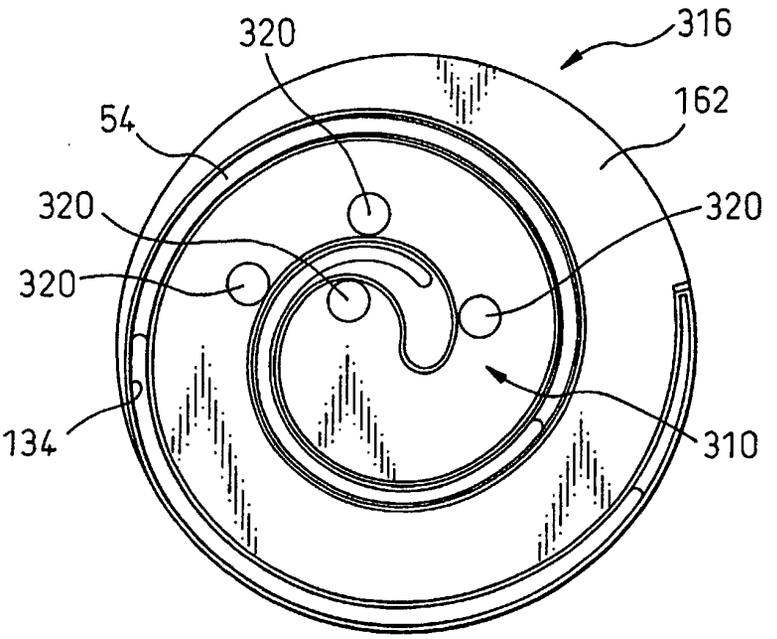
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Fig. 21

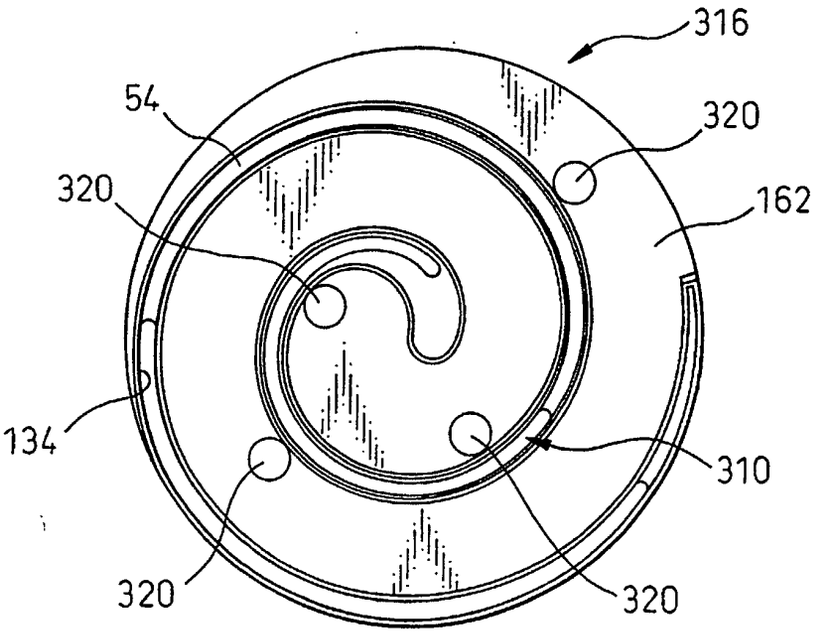
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Fig.22

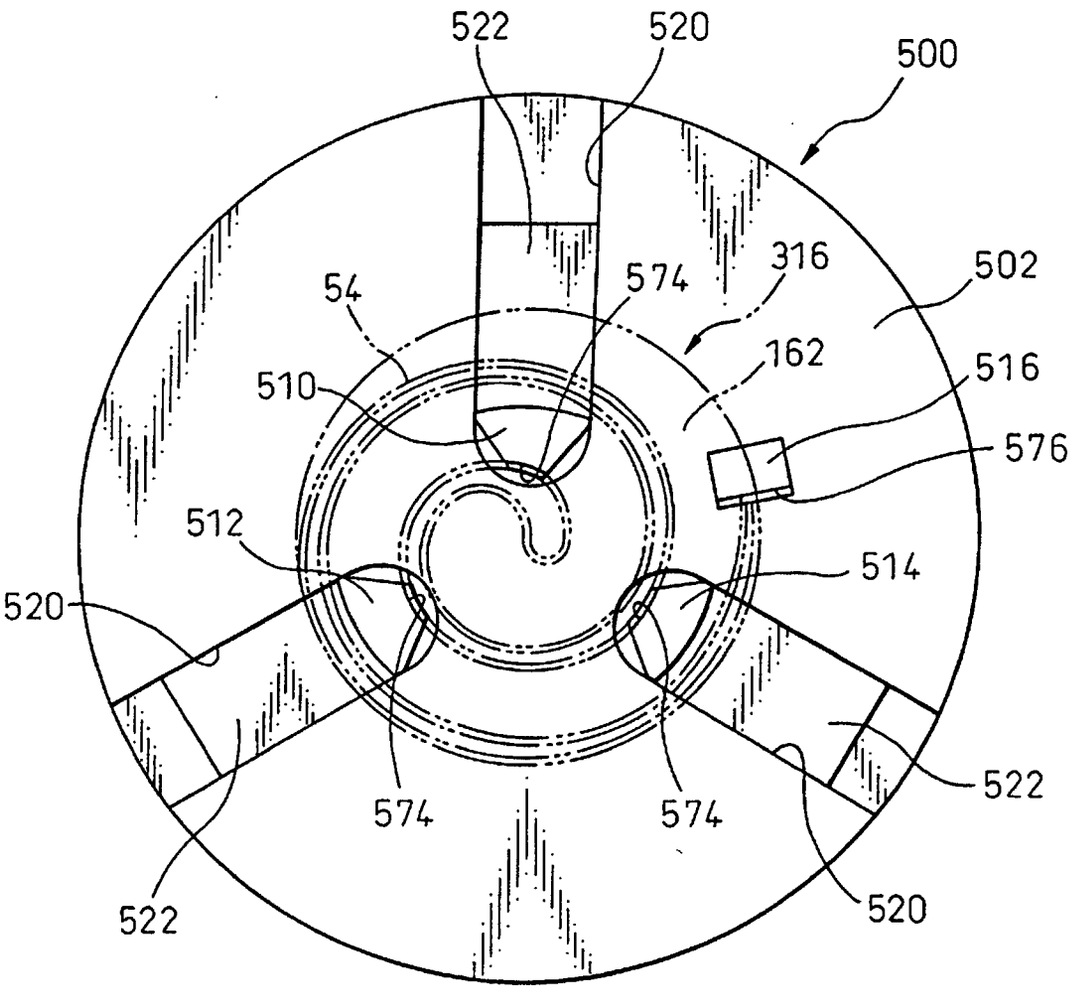
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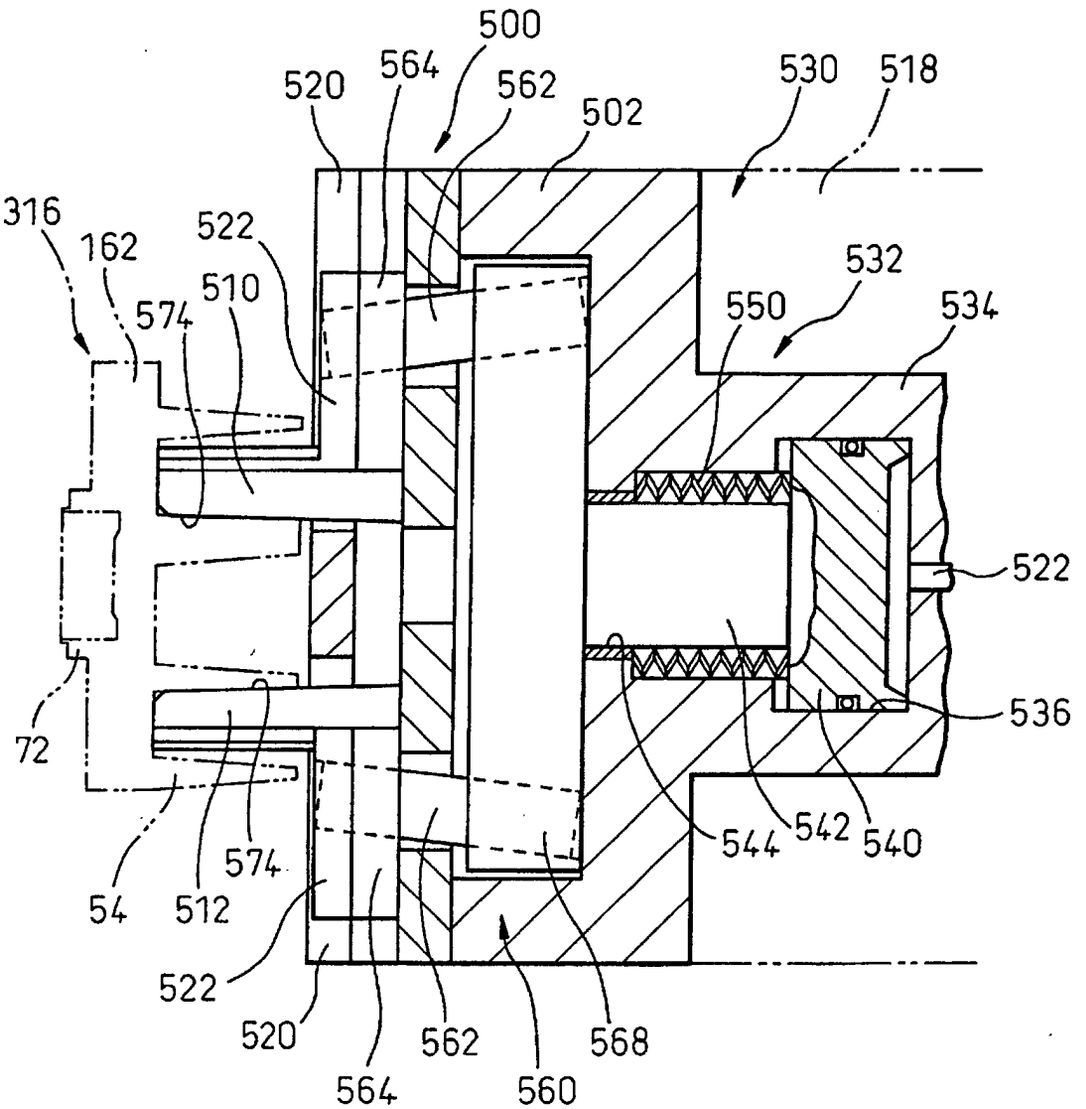
Fig. 23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