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Description

This invention relates to scroll-type machines and more particularly to a scroll wrap configuration which reduces scroll-wrap noise and wear during operation of the machine.

Scroll machines generally comprise mated first and second scroll members each having an end plate on which is provided an upstanding spiral wrap interleaved with the wrap on the other scroll member; the wraps engaging each other at substantially line contacts so as to define traveling pockets of varying volume as one scroll member is caused to orbit relative to the other. The machine may be a pump, compressor or expander.

Some scroll machines have been found to have undesirable noise in operation. In trying to identify the noise it has been found that during manufacture, machining forces can cause the outer free end of one or both of the spiral wraps to be deflected slightly radially outwardly. After machining, the free end spring back to its original position thus presenting a slightly misaligned projection which can cause undesirable engagement between the respective scroll wraps during relative orbital movement. Alternatively, when scroll wraps are machined into a solid surface with no free end on the wrap, tool deflection, rather than wrap deflection, can occur which has the same end result. This engaging contact not only can result in a banging noise but can contribute to wear of the scroll assembly, and possible places additional loads on the crankshaft. Even if there is no distortion of the wrap end it is believed that this may be a relatively noisy area of the machine. Noise also can result from the sudden dynamic change in conditions at the point where the inner ends of the scroll wraps first communicate with the discharge port and/or separate from one another during operation.

The primary object of this invention therefore resides in the provision of a scroll-type machine which overcomes the aforementioned noise and wear problems in a simple and inexpensive manner which does not result in any significant loss of efficiency.

EP-A-0 049 495 discloses a scroll type machine including the features of the prior art portion of claim 1. This prior machine uses interfitting wraps, the active surfaces of which are raised to provide a thicker portion of the wrap near the centre thereof to provide improved sealing at the high pressure section of the machine. This does not meet the primary object of the present invention as defined in claim 1 where, instead of thickening the wraps, the active surfaces, preferably involute surfaces, are relieved at the outer end so as to reduce the noise and wear factor at this point with a steadily increasing ramp surface providing

the connection from the relieved surface to the fully interfitting surface, wear and noise being kept to a minimum during use. In the preferred construction, as defined in claim 9 and/or 12, a further relieved surface is provided near the inner end of the wrap with the tapering ramp surfaces connecting to these relieved surfaces smoothing the transition from loading to unloading of the wrap ends during use of the machine and thus reducing noise.

Other advances and features of this invention will become apparent from the following specification taken in connection with the accompanying drawings, in which:

Figure 1 is a fragmentary vertical section view of the scroll assembly of a hermetic scroll-type compressor embodying the present invention;

Figure 2 is a rotated section view taken generally along line 2-2 of Figure 1; and

Figures 3 and 4 are enlarged fragmentary portions of Figure 2 showing in an exaggerated form the outer ends of the functional portions of the wraps.

Although the principles of the present invention may be applied to many different types of scroll-type machines, the discussion herein relates to a hermetic scroll-type machine including a pair of interfitting spiral vanes of equal shape (involute of a circle) with one being non-orbiting and the other being orbitally driven by a crankshaft, which machine has specific utility in the compression of refrigerant for air conditioning and refrigeration. A machine of the present type is disclosed in assignee's pending application, Serial No. 899,003, filed August 22, 1986 entitled Scroll-Type Machine, the disclosure of which is expressly incorporated herein by reference.

An exemplary embodiment of a scroll compressor 10 according to the present invention comprises a scroll assembly 12 for compressing gases, a motor (not shown), a vertically disposed crankshaft including at one end thereof a crank pin 14 for drivingly interconnecting the scroll assembly to the motor via a drive bushing 15, a compressor body 16, and a shell 18 enclosing all of the above elements. The scroll assembly 12 includes an orbiting scroll member 20 including a scroll end plate 22 and a scroll wrap 24 of desired flank profile (e.g. an involute of a circle) upstanding therefrom, and a non-orbiting scroll member 26 including a scroll end plate 28 and a scroll wrap 30 of similar flank profile upstanding therefrom, compressor body 16 supporting orbiting end plate 22 via the usual thrust surface 31. The scroll assembly also includes a central discharge port 32 in non-orbiting end plate 28, a similarly shaped fluid transfer recess 33 in orbiting scroll end plate 22 and a suction inlet port area 34.

The effective ends of wraps 24 and 30 are disposed on diametrically opposed axes "x" and "y", respectively, with the end of wrap 24 indicated at 36 and the end of wrap 30 at 38 (this wrap is continued outwardly and circumferentially to define a suction passage but this continued portion does not act as a wrap because it never engages the orbiting wrap). The inner end of non-orbiting wrap 30 is indicated at 40 and the inner end of orbiting wrap 24 is indicated at 42.

In accordance with this invention it has been discovered that the benefits sought can be obtained if the outer surface of each wrap is relieved in the area thereof where it would otherwise be engaged by the outer end of the other wrap. As shown, orbiting wrap 24 has a portion of its radially outwardly facing surface adjacent its radially outer free end 36 cut away or relieved to define a modified offset surface 50 starting at point "A" at the free end of the wrap and extending approximately 180° to 190° to a point "B" (just past axis "y") and then a ramp surface 52 tapering at a constant rate radially outwardly (approximately 20°) from point "B" to a point "C" whereupon the wrap surface assumes its normal involute shape. Phantom line "D" (Figure 4) represents the outer flank surface of orbiting wrap 24 without being relieved in accordance with the present invention.

Similarly, non-orbiting wrap 30 has a modified offset surface 60 extending approximately 8° to 9° between points "E" and "F" and a ramp surface 62 tapering at a constant rate radially outwardly approximately 20° to 21° from point "F" to a point "G", the latter representing the point where wrap 30 is back to its original profile and thickness. Phantom line "H" (Figure 3) represents the outer involute flank surface of nonorbiting wrap 30 without being relieved in accordance with this invention.

Modified surface 50 and 60 are easily formed by merely offsetting the wrap-machining cutter very slightly radially inwardly (e.g. 0.04 mm in a scroll having an orbiting wrap roughly 85 mm in overall outside diameter) to generate an offset surface parallel to the normal involute surface. Leakage is minimal because the offset is so small and because this is a relatively low pressure zone in the machine.

It has been learned that additional benefits can be obtained by also relieving the wraps near the inner ends thereof. Thus, orbiting wrap 24 has a portion of its radially inwardly facing flank surface adjacent its radially inner free end 42 cut away or relieved to reduce wrap thickness. The removed portion defines a modified surface 64 which tapers at constant rate radially outwardly from a point "J" to a point "K". Similarly, non-orbiting wrap 30 has a portion of its radially inwardly facing flank surface

adjacent its radially inner free end 40 cut away to reduce wrap thickness, the removed portion defining a modified surface 66 which tapers at constant rate radially outwardly from a point "L" to a point "M". Points "J" and "L" are located at a point disposed on the wrap flank surfaces slightly radially outwardly of the point of normal separation of the wraps, preferably at the point that discharge port 32 and recess 33 are opened. The configuration of the discharge port 32 (and corresponding recess 33) is disclosed in detail in assignee's application entitled Scroll Machine Center Port filed of even date in the name of Gary J. Anderson, the disclosure of which is expressly incorporated herein by reference. Points "K" and "M" are located slightly radially inwardly of the normal separation point of wraps if they had true involute flank surfaces. The resulting ramps, which are shown in greatly exaggerated form, smooth the transition from loading to unloading of the wrap ends. Leakage is not a problem in the ramped area because the discharge port is already opened.

Modifying the flank surfaces in the manner described has been found to reduce noise and wear, and it is believed that it will also allow the manufacturing process to be less precise and/or faster, and thus less expensive.

Claims

1. A scroll type machine comprising first and second scroll members (20,26), each of said scroll members including an end plate (22,28) having an outwardly projecting spiral wrap (24,30) thereon, each of said wraps having active flank surfaces and radially inner tip end portions (42,40), and outer (34) and centre (32) ports for receiving and discharging fluid, said wraps (24,30) being interleaved with each other such that said active flank surfaces of said wraps inter-engage each other at a plurality of spaced locations so as to define a plurality of chambers therebetween such that when one of said scroll members (20) is caused to orbit with respect to the other said scroll member (26), said chambers will be caused to travel between said ports, whereby fluid received in one of said chambers through one of said ports is discharged through the other of said ports, the machine further comprising a first relieved surface (50,60) in the outer flank surface of one of said wraps (24,30) said relieved surface extending circumferentially inwardly along said flank surface from a point (A,E) which is circumferentially outwardly of the outer end (Y,X) of said flank surface on the other of said wraps which except for said relieved surface would be an active flank surface to a

point (B,F) circumferentially inwardly past said outer end (Y,X) and a ramp surface (52,62) extending radially outwardly between the point (B,F) at the circumferential inner end of said relieved surface and the adjacent active flank surface (at C,G) on said wrap (24,30), characterised in that the inner end point (B,F) to which the relieved surface (50,60) extends is adjacent to said outer end (Y,X), and the ramp surface (52,62) is a tapering ramp surface extending radially outwardly at a constant rate of change.

2. A machine as claimed in claim 1, wherein said active flank surfaces have complementary profiles, said relieved surface (50,60) being radially inwardly offset and parallel to said profile (D,H).

3. A machine as claimed in claim 2, wherein said profile is the involute of a geometric shape.

4. A machine as claimed in claim 3, wherein said shape is a circle.

5. A machine as claimed in claim 2, 3 or 4, wherein said active flank surfaces have identical profiles.

6. A machine as claimed in any preceding claim, wherein both of said wraps (24,30) have said relieved surface (50,60).

7. A machine as claimed in claim 6, wherein one (60) of said relieved surfaces has an angular extent of 8° to 9° and the other (50) an angular extent of 180° to 190° .

8. A machine as claimed in any preceding claim, wherein the or each ramp (52,62) has an angular extent of approximately 20° to 21° .

9. A machine as claimed in any preceding claim, wherein a second relieved surface (64,66) is provided on the or each wrap (24,30), said second relieved surface (64,66) being disposed on the inner flank surface of the wrap adjacent the inner tip end (42,40) thereof at the point (K,M) of theoretical tip separation for the wrap active flank profile.

10. A machine as claimed in claim 9, wherein said second relieved surface has a portion extending radially outwardly from said wrap surface.

11. A machine as claimed in claim 10, wherein said surface portion extends radially outwardly at a constant rate of change.

12. A machine as claimed in any one of claims 1 to 8, wherein a second relieved surface (64,66) is provided on the or each wrap (24,30), said second relieved surface being disposed on the inner flank surface of the wrap adjacent the inner tip end (42,40) thereof at the point (J,L) at which the outer surface thereof first becomes exposed to the pressure of fluid in said centre port (32) during operation of said machine.

13. A machine as claimed in any one of claims 9 to 11, wherein said second relieved surface (64,66) extends approximately from the point (K,M) of theoretical tip separation for the wrap active flank profile to the joint (J,L) at which the outer surface thereof first becomes exposed to the pressure of fluid in said centre port (32) during operation of said machine.

Patentansprüche

1. Spiralmaschine, mit ersten und zweiten Spiralelementen (20,26), wobei jedes dieser Spiralelemente eine Endplatte (22,28) mit einer darauf vorgesehenen, nach außen vorstehenden Spiralhülle (24,30), wobei jede dieser Hüllen wirksame Flankenflächen und radial innere Spitzenendabschnitte (42,40) aufweist, und äußere (34) und mittlere (32) Öffnungen zur Aufnahme und Abgabe von Fluid umfaßt, wobei die Hüllen (24,30) einander überlappen, so daß die wirksamen Flankenflächen dieser Hüllen an einer Vielzahl von beabstandeten Stellen miteinander in Eingriff kommen, wodurch sie zwischen sich eine Vielzahl von Kammern derart bilden, daß, wenn eines der Spiralelemente (20) im Hinblick auf das andere Spiralelement (26) zum Kreisen gebracht wird, die Kammern dazu veranlaßt werden, sich zwischen den Öffnungen zu bewegen, wodurch das durch eine dieser Öffnungen in einer der Kammern aufgenommene Fluid durch die andere dieser Öffnungen abgegeben wird, wobei die Maschine desweiteren folgendes umfaßt: eine erste mit Aussparungen versehene Fläche (50,60) in der äußeren Flankenfläche einer der Hüllen (24,30), wobei sich die mit Aussparungen versehene Fläche umfangsseitig nach innen entlang dieser Flankenfläche ausgehend von einem Punkt (A,E) erstreckt, der sich umfangsseitig außerhalb des äußeren Endes (Y,X) der Flankenfläche auf der anderen der Hüllen befindet, die, abgesehen von der mit Aussparungen versehenen Fläche, bis zu einem Punkt (B,F), der umfangsseitig nach innen gerichtet nach dem äußeren Ende (Y,X) angeordnet ist, eine wirksame Flankenfläche sein wird, sowie

- eine Rampenfläche (52,62), die sich radial nach außen zwischen dem Punkt (B,F) an dem umfangsseitig inneren Ende der mit Aussparungen versehenen Fläche und der benachbarten wirksamen Flankenfläche (bei C,G) auf der Hülle (24,30) erstreckt, dadurch gekennzeichnet, daß sich der innere Endpunkt (B,F), zu dem sich die mit Aussparungen versehene Fläche (50,60) erstreckt, nahe dem äußeren Ende (Y,X) befindet, und daß die Rampenfläche (52,62) eine sich verjüngende Rampenfläche ist, die sich mit einer konstanten Steigung radial nach außen erstreckt.
2. Maschine nach Anspruch 1, bei der die wirksamen Flankenflächen komplementäre Profile aufweisen, wobei die mit Aussparungen versehene Fläche (50,60) radial nach innen versetzt und parallel zu dem Profil (D,H) ist.
 3. Maschine nach Anspruch 2, bei der das Profil die Evolvente einer geometrischen Form ist.
 4. Maschine nach Anspruch 3, bei der diese Form ein Kreis ist.
 5. Maschine nach Anspruch 2, 3 oder 4, bei der die wirksamen Flankenflächen identische Profile aufweisen.
 6. Maschine nach einem der vorhergehenden Ansprüche, bei der beide Hüllen (24,30) die mit Aussparungen versehene Fläche (50,60) aufweisen.
 7. Maschine nach Anspruch 6, bei der eine (60) der mit Aussparungen versehenen Flächen eine Winkelausdehnung von 8° bis 9° und die andere (50) eine Winkelausdehnung von 180° bis 190° aufweist.
 8. Maschine nach einem der vorhergehenden Ansprüche, bei der die oder jede Rampe (52,62) eine Winkelausdehnung von etwa 20° bis 21° aufweist.
 9. Maschine nach einem der vorhergehenden Ansprüche, bei der eine zweite mit Aussparungen versehene Fläche (64, 66) auf der oder jeder Hülle (24,30) vorgesehen ist, wobei sich die zweite mit Aussparungen versehene Fläche (64,66) auf der inneren Flankenfläche der Hülle nahe deren innerem Spitzenende (42,40) an dem Punkt (K,M) des theoretischen Spitzenabstands für das wirksame Flankenprofil der Hülle befindet.

10. Maschine nach Anspruch 9, bei der die zweite mit Aussparungen versehene Fläche einen Abschnitt aufweist, der sich radial nach außen ausgehend von der Hüllenfläche erstreckt.
11. Maschine nach Anspruch 10, bei der sich der Oberflächenabschnitt mit einer konstanten Steigung radial nach außen erstreckt.
12. Maschine nach einem der Ansprüche 1 bis 8, bei der eine zweite mit Aussparungen versehene Fläche (64,66) auf der oder jeder Hülle (24,30) vorgesehen ist, wobei sich die zweite mit Aussparungen versehene Fläche auf der inneren Flankenfläche der Hülle nahe deren innerem Spitzenende (42,40) an dem Punkt (J,L) befindet, an dem deren Außenfläche während des Betriebs der Maschine zuerst dem Druck eines Fluids in der mittleren Öffnung (32) ausgesetzt wird.
13. Maschine nach einem der Ansprüche 9 bis 11, bei dem sich die zweite mit Aussparungen versehene Fläche (64,66) etwa ausgehend von dem Punkt (K,M) des theoretischen Spitzenabstands für das wirksame Flankenprofil der Hülle aus bis zu dem Verbindungspunkt (J,L) erstreckt, an dem die Außenfläche davon während des Betriebs der Maschine zuerst dem Druck des Fluids in der mittleren Öffnung (32) ausgesetzt wird.

Revendications

1. Machine de type à volutes, comprenant une première et une seconde pièces (20, 26) formant volutes, chacune desdites pièces formant volute comportant une plaque (22, 28) d'extrémité ayant sur elle une enveloppe (24, 30) en spirale en saillie vers l'extérieur, chacune desdites enveloppes ayant des surfaces de flanc actives et des parties (42, 40) d'extrémité radialement internes, et des orifices extérieur (34) et central (32) pour recevoir et décharger un fluide, lesdites enveloppes (24, 30) étant intercalées l'une avec l'autre de telle sorte que lesdites surfaces de flanc actives desdites enveloppes s'engagent l'une dans l'autre en une pluralité d'endroits espacés, de façon à définir une pluralité de chambres entre elles, de telle sorte que lorsque l'une des pièces formant volute (20) est amenée à décrire une orbite par rapport à ladite autre pièce formant volute (26), lesdites chambres sont amenées à se déplacer entre lesdits orifices, grâce à quoi le fluide reçu dans l'une desdites chambres à travers l'un desdits orifices est déchargé à travers l'autre desdits orifices; la machine com-

prenant de plus une première surface (50, 60) en dépouille dans la surface de flanc extérieure de l'une desdites enveloppes (24, 30), ladite surface en dépouille s'étendant circonférentiellement à l'intérieur le long de ladite surface de flanc à partir d'un point (A, E) qui est circonférentiellement à l'extérieur de l'extrémité extérieure (Y, X) de ladite surface de flanc sur l'autre desdites enveloppes, laquelle, excepté pour ladite surface en dépouille, serait une surface de flanc active en un point (B, F) circonférentiellement à l'intérieur au delà de ladite extrémité extérieure (Y, X), et une surface (52, 62) en rampe s'étendant radialement vers l'extérieur entre le point (B, F) à l'extrémité intérieure circonférentielle de ladite surface en dépouille et la surface de flanc active adjacente (en C, G) sur ladite enveloppe (24, 30); caractérisée en ce que le point (B, F) d'extrémité intérieure, à partir duquel la surface (50, 60) en dépouille s'étend, est adjacent à ladite extrémité extérieure (Y, X), et en ce que la surface (52, 62) en rampe est une surface conique, la surface en rampe s'étendant radialement vers l'extérieur selon un taux constant de variation.

2. Machine selon la revendication 1, dans laquelle lesdites surfaces de flanc actives ont des profils complémentaires, ladite surface (50, 60) en dépouille étant décalée radialement à l'intérieur et parallèle audit profil (D, H).

3. Machine selon la revendication 2, dans laquelle ledit profil est la développante d'une forme géométrique.

4. Machine selon la revendication 3, dans laquelle ladite forme est un cercle.

5. Machine selon la revendication 2, 3 ou 4, dans laquelle lesdites surfaces de flanc actives ont des profils identiques.

6. Machine selon l'une quelconque des revendications précédentes, dans laquelle lesdites deux enveloppes (24, 30) présentent ladite surface (50, 60) en dépouille.

7. Machine selon la revendication 6, dans laquelle l'une (60) desdites surfaces en dépouille présente une extension angulaire de 8 à 9 degrés, et l'autre (50) une extension angulaire de 180 à 190 degrés.

8. Machine selon l'une quelconque des revendications précédentes, dans laquelle la rampe ou chaque rampe (52, 62) présente une extension

angulaire approximativement de 20 à 21 degrés.

9. Machine selon l'une quelconque des revendications précédentes, dans laquelle une seconde surface (64, 66) en dépouille est prévue sur l'enveloppe ou chaque enveloppe (24, 30), ladite seconde surface (64, 66) en dépouille étant disposée sur la surface de flanc intérieure de l'enveloppe adjacente à l'extrémité intérieure (42, 40) de cette dernière au point (K, M) de séparation théorique d'extrémité pour le profil de flanc actif de l'enveloppe.

10. Machine selon la revendication 9, dans laquelle ladite seconde surface en dépouille présente une partie s'étendant radialement à l'extérieur de ladite surface d'enveloppe.

11. Machine selon la revendication 10, dans laquelle ladite partie de surface s'étend radialement à l'extérieur selon un taux constant de variation.

12. Machine selon l'une quelconque des revendications 1 à 8, dans laquelle une seconde surface (64, 66) en dépouille est prévue sur l'enveloppe ou chaque enveloppe (24, 30), ladite seconde surface en dépouille étant disposée sur la surface de flanc intérieure de l'enveloppe adjacente à l'extrémité intérieure (42, 40) de cette dernière au point (J, L) où la surface extérieure devient au début exposée à la pression du fluide dans ledit orifice central (32) pendant le fonctionnement de ladite machine.

13. Machine selon l'une quelconque des revendications 9 à 11, dans laquelle ladite seconde surface (64, 66) en dépouille s'étend approximativement depuis le point (K, M) de séparation théorique d'extrémité pour le profil de flanc actif de l'enveloppe jusqu'au point (J, L) où la surface extérieure de cette dernière devient au début exposée à la pression du fluide dans ledit orifice central (32) pendant le fonctionnement de ladite machine.



