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ABSTRACT

It is common practice to employ a circle as a basic figure to form an involute curve which is widely used in the wrap design of the scroll compressor. This type of curve is characterized by its variable curvature, so there must be need to equip a machine tool with some special software when manufacturing the wrap based on the involute of basic circle.

A new type of curve named as "THE INVOLUTE OF BASIC SQUARE" has been recently studied in an attempt of replacing the conventional one. It takes a square with a certain side length as a figure. This geometrical improvement on the curve has led to the easiness and high accuracy in manufacture, thus becoming a guarantee of high quality of scroll compressor.

In the paper, the forming process and the design method of the curve, the relationship between two kinds of curves are introduced.

Some degign problem concerning the compressor's dynamics is also dsicussed.

INTRODUCTION

The basic elements in a scroll compressor are identical scroll wraps whose quality are vital to the compressor's performance. Geometrically speaking, the wraps are usually made on the basis of an involute of basic circle (IOC), so some special software is needed when making them at a high-precision machine tool because of its variable curvature. This may cause additional error besides the error from the machine tool itself.

To solve this problem, a new type of curve has been involved in a series of tests. This is so-called "the involte of basic square" (IOS).

THE FORMATION OF IOS

As is well known, if one unwraps a string from a circle, keeping the string taut, the end of the string will trace out an involute of basic circle. Likewise, an involute of basic square can be obtained when unwraping a string from a square as shown in Fig.1. It is obvious from the formating process that, the curve consists of several quarter circle, that is, its curvature changes every quarter circle.

THE CLASSIFICATION OF THE WRAP BASED ON IOS

The scroll compressor's wrap based on IOS can fall into two categories according to the relationship of the side length of the square (a) and the thickness of the wrap (t) as described below.

1) $a > t$

Fig. 2 shows that the four apices of the square are respectively the centers of the quarter circles. Being derived $\triangle = (a-t)/2$, a series of radii are given as follows:

$$R_{11} = \triangle \qquad R_{12} = t + \triangle$$

$$R_{21} = a + \triangle \qquad R_{22} = a + t + \triangle$$

$$R_{31} = 2a + \triangle \qquad R_{32} = 2a + t + \triangle$$

$$\vdots \qquad\qquad \vdots$$

$$R_{n1} = (n-1)a + \triangle \qquad R_{n2} = (n-1)a + t + \triangle$$

Besides, from the dynamic behavior of the wraps, we get the fundamental equation:

$$\varepsilon = 2a - t$$

where ε—the orbiting radius of the moving wrap. Therefore, the case of $a > t$ means the case of $a < \varepsilon$. This indicates that these two squares are apart by the distance $\triangle$' that is written as

$$\triangle' = \varepsilon - a = 2a - t - a = a - t = 2\triangle$$

2) $a < t$

In this case, $\triangle = (t-a)/2$, and a series of radii shown in Fig.3 can be calculated as follows:

$R_{11} = 0$ $\quad$ $R_{12} = t - \triangle$

$R_{21} = a - \triangle$ $\quad$ $R_{22} = a + t - \triangle$

$R_{31} = 2a - \triangle$ $\quad$ $R_{32} = 2a + t - \triangle$

$\vdots$ $\quad$ $\vdots$

$R_{n1} = (n-1)a - \triangle$ $\quad$ $R_{n2} = (n-1)a + t - \triangle$

It is contrary to the above, two squares overlap by the distance $\triangle'$.

$$\triangle' = a - \varepsilon = a - 2a + t = t - a = 2\triangle$$

THE END DESIGN OF THE WRAP BASED ON IOS

The end design of the wrap based on IOS is a special problem that should be seriously dealt with.

Looking at Fig.4 illustrating the ends of the wraps in detail, there seems to be a compensation work to do. Assuming the discharging point is at T in Fig.4 while the center of the moving square at Om', we can define β to present the angle of the pressure loss:

$$\beta = 270^\circ - \theta$$

where β—the roll angle of the moving wrap.

Consider the case of non-compensation first, we can express the line segment $\overline{OcA}$ below:

$$\overline{OcA} = R_{2\cdot 1} + a/2 = a + \triangle + a/2 = 2a - t/2$$
$$= (p - t)/2$$

where p—the scrill pitch, thus the final stop point of the cutter used will be at Oc with its radius $(p-t)/2$. The profile of the end dotted in Fig.4 seems to be a bit "thin". To make compensation, we move the point from Oc to Oc' just along the arc $\overset{\frown}{Oc\,Oc'}$, that is, the center of the cutter is expected at Oc'. The compensation angle is α shown in the Fig.

A optimum searching program has been put into use so as to seek optimal compensation angle. Usually, α is about within 30°.

THE PRINCIPLE OF THE EQUIVALENCE IN CIRCUMFERENCE

Although the wrap design based on IOS can be completed in its own way, it may also make use of the method used in the case of IOC provided that the principle of the equivalence in circumference is observed, that is, let

$$4a = 2\pi R$$

Where—the radius of IOC.

Let's take an example of $a = 3.1250$, $t = 3.5000$, and $\varepsilon = 2.7500$, the table I shows the comparison between two kinds of curves. One can find that IOS is so similar to IOC under the condition that a designer can use the method dealing with IOC to finish dynamic and thermodynamic calculation first, then shift the radius of the basic circle to the side length of the basic square by the value of $a=\pi R/2$ to carry out the manufacturing work.

It's to be noted that the similarity in two kinds of curves offers much convenience to a designer. It does not mean there is a error in the motion of the wraps based on IOS. In fact, they can work with each other very well just like the case of IOC.

CONCLUSION

The presentation of an involute of basic squre has offered a opportunity to improve the state in the wrap-making, which will conduce to promote the development of the scrall compressor known as "new generation compressor" From this, we may conclute as follows:

1) Using IOS to design the wraps will get rid of the need for possessing a special software that most of machine tools have not equipped with at least nowdays.

2) Enhancing the accuracy of the wraps and improving the smoothness of the side of

the wraps are another advantage for using IOS. It is certain that the whole scroll machine can also benefit from this usage.

ACKNOWLEDGMENT

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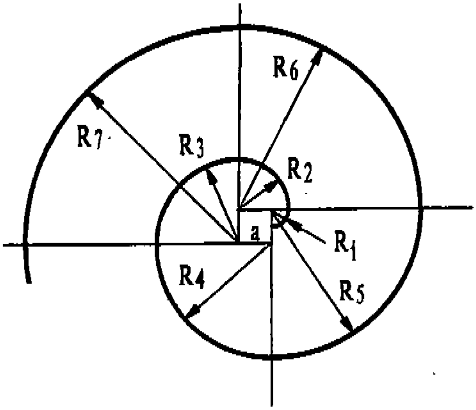

Fig.1 The Formation of IOS

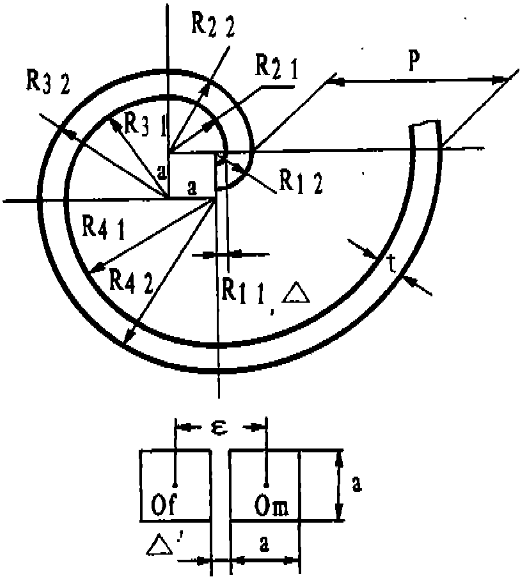

Fig.2 Wrap Design (a > t)

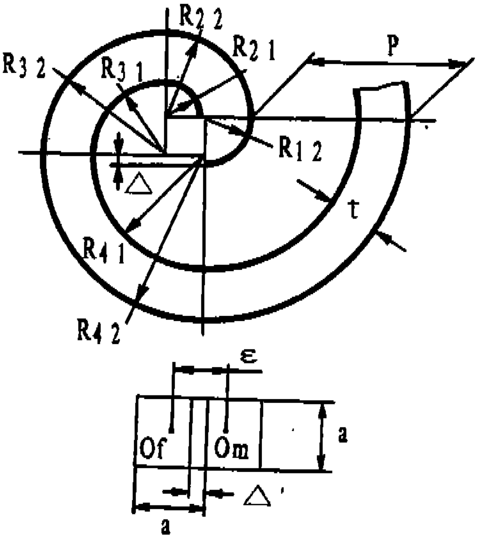

Fig.3 Wrap Design (a< t)

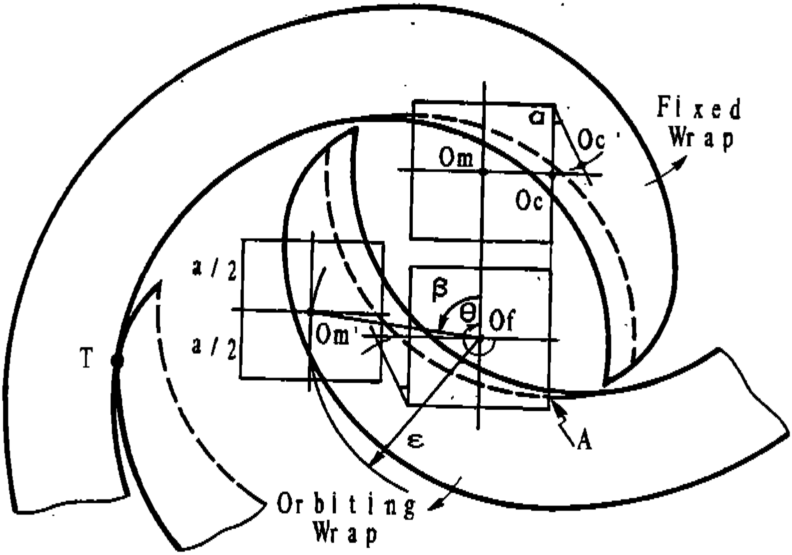

Fig.4 End design of the Wraps

Table 1 The Comparison Between IOC and IOS

Point	Polar Angle	Polar Amplitude		Difference
		IOC	IOS	
1	0.1197	2.5299	2.4988	0.0311
2	0.3404	3.1499	3.2341	-0.0842
3	0.8049	4.2518	4.1774	0.0744
4	1.3516	5.4464	5.4860	-0.0396
5	1.8158	6.4269	6.4424	-0.0155
6	2.4835	7.8110	7.7793	0.0317
7	3.0472	8.9655	9.0329	-0.0674
8	3.6513	10.1945	10.1276	0.0669
9	4.2751	11.4570	11.4923	-0.0353
10	4.5616	12.0353	12.1019	-0.0666
Average				-0.0105