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A checking fixture design of corrugated pieces in Clutch assembly of automobile gearbox

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Abstract: Car's checking fixture is used to judge the quality of auto parts and vehicle specialized testing equipment. It plays an important rolein the rapid and accurate detection of parts' size accuracy, so as to ensure the quality of the vehicle. Whether the structure and function of fixture can achieve accurate, intuitive, rapid detection of auto parts' requirements become a judge a decisive factor of good or bad. The corrugated piece, steel piece, the friction piece and supporting piece in clutch assembly were stacked in accordance with the terms of the number and the order for assembly. The same series of different models of corrugated piece soften only have subtle differences inthickness and ripple points. According to these characteristics, based on the corrugated points, we designed a fast and efficient online corrugated piece fixture in automobile transmission.
The keyword: Clutch assembly; Corrugated piece; Car's checking fixture; The finite element analysis

I. Introduction

Car's checking fixture is a special measuring tools for automobile product inspection,with its advantages of simple structure and convenience,ect,has always been the first choice of the eligibility of manufacturing products.With the rapid development of newmodels in car companies,time for model updating is increasingly shorten,Car's checking fixture is also in aincreasing need.Strengthening the development of fixture design and application tools,Improving the efficiency of fixture design and testing quality have become the urgent needs of the development of the auto industry.

The corrugated piece, steel piece, the friction piece and supporting piece in clutch assembly are stacked in accordance with the terms of the number and the order for assembly.Corrugated pieces in different models ofsame series often only has slight difference in corrugated points and thickness,Once the assembly error occurs and flow into the next process, the entire disc group of assembly willgo wrong and discardedbecause of the ripple effect.This paper introduces the structural characteristics of thecorrugated pieces in clutch assembly of automobile gearbox.Distinguished by the corrugated points,a kind of corrugated piece online mistake proofing fixture was designed.Comparing with the traditional way of artificial visual inspection on an assembly line,it can reduce the rejection rate, greatly improve the working efficiency of the production line and mistake proofing ability.

II. Disc group of parts in Clutch assembly

2.1 The disc group assembly

For a four shift transmission clutch disc assembly (fig.1), Disc group in clutch assembly is in accordance with the sequence of corrugated piece, steel piece, friction piece, steel piece and supporting piece. If an assembly error flow into the next process until the final process, it will lead to waste, and eventually bring huge economic losses to the enterprise because of product repairmen.

Note:1.corrugated piece(1piece) 2.steel piece(2pieces)
3.friction piece(2pieces) 4.supporting piece(1piece)
Fig.1 Clutch disc assembly

2.2 The corrugated piece

Taking X23, X24 two series of four different types of corrugated piece as an example(Fig.2),The same overall dimensions of corrugated piece,only slightly differentiated by the points and thickness.It's hard to identify because of the close total height and tolerance.

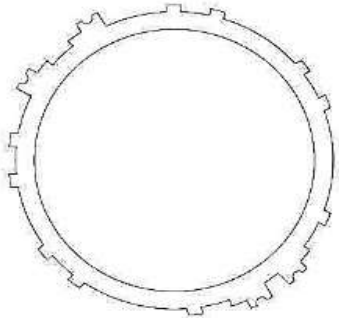


Fig.2 Clutch disc assembly

To prevent mixing situation appeared in the process of assembly, this paper adopted the method of measuring the number of corrugated points to identify the several kinds of corrugated pieces.and the corresponding data were recorded by a displacement sensor.Considering there are four parts to assemble,the sensor of the assembly line should store four sets of data.The sizes of eachtypes of corrugated pieces are shown in table 1.

Tab.1sizes of each types of corrugated pieces

serie	type	corrugated points	Inner diameter	outer diameter	trough	crest
X23	24230818	9	193.5	219.4	0.9±0.05 （setted1.15）	2.59±0.22 （setted2.18）
X23	24256869	10	193.5	219.4	1.33±0.05 （setted1.58）	2.23+0.28-0.08 （stetted1.95）
X24	24231776	7	174	196	1.18±0.05 （setted1.43）	2.82±0.08 （setted2.54）
X24	24263550	10	174	196	1.2±0.05 （setted1.45）	2.1+0.2-0.08 （setted1.82）

III. The design of checking fixture

3.1 The principle and testing method

According to the specific setted sizes of the different types of corrugated pieces and the data of the wave crest and trough, the testing mechanism is acted as follows: After putting in pieces tray, the tray is lifted by the lifting mechanism. Then the spinning mechanism with a displacement probe make a rotation, and testing is completed. Taking the testing data as a feed back to the displacement sensor, then comparing with setted data, determine specific series of corrugated pieces by reading the number of corrugated points. According to this method, the schematic diagram of the checking fixture is shown in figure 3.

Data-setting principle is as follows: taking the 24230818 parts from X23 series as an example, The parts' minimal thickness size is 0.9±0.05,set it 0.95.The parts' maximal thickness size is 2.59±0.22,set it 2.38.While the testing data lower than 0.95 is trough, higher 2.38 is crest. Then subtract the error of the tray and the testing mechanism. Eventually set trough of 1.15, crest of 2.18.As long as the measured data between two troughs appear higher than or equal to 2.18,there is a corrugation.

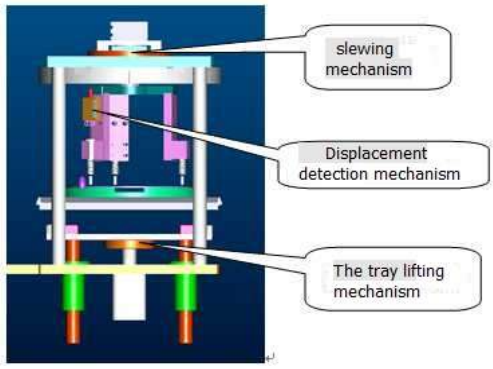


Fig.3 schematic diagram of fixture

3.2 Design of the checking fixture

Since there are four types of corrugated pieces in X23、X24 series, so the displacement sensor can store four groups of data to measure crests and troughs. At the same time, in order to prevent the sensing line from knotting when when rotating, weadded a drag chain to the slewing mechanism. Only one displacement probe of three is connected to the displacement sensor which actually works, the remaining two is used to prevent materials from over pressing which is caused by the probe. The power to lift the tray doesn't need to be very high Because the mass of corrugated pieces is light, so both the tray lifting mechanism and the slewing mechanism all choose the three-phase hybrid stepping motor. According to the design idea, the fixture effect is finally completed as shown in figure 4.

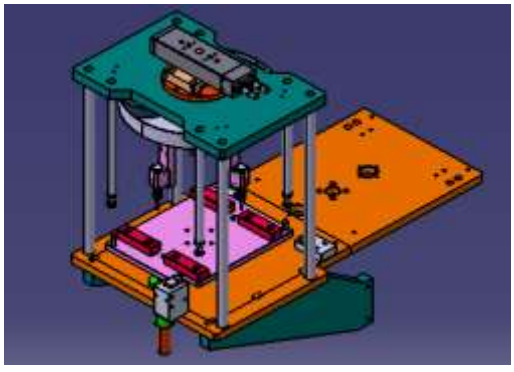


Fig.4theactual effect diagram of fixture

3.3 Corrugated pieces' location on the fixture

The ultimate goal of fixture design is to ensure the parts' processing quality and check the performance. The design is mainly on size measurement, by comparing with the design data, then judge the type of work piece tested on the tray, so as to prevent the wrong process.

The fixture revolves round corrugated pieces and determine the number of the corrugated points by comparing the change of the data, so it requires the lifting parts to keep vertical to the displacement probe after the tray is lifted. The center of the three displacement probe needs to be in line with the center of the corrugated pieces. Initial setted fixture location system was as shown in figure 5.

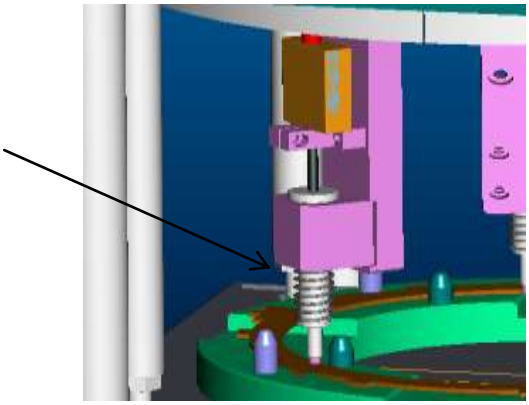


Fig.5 Locating mechanism

IV. Fixture's optimization and improvement

4.1 Issues in the practical assembly line

When the preliminary design was completed, we produced some fixture samples to do the practical production and inspection. But we found that in the practical assembly, the rejection rate of the clutch disc group was still on a high level compared with expectations. Tracing to the line, taking appropriate amount of sample to analyze, it is found that the corrugated pieces assembly quality influence the whole disc group assembly line's rejection rate. After testing we found that the thickness of the corrugated pieces are not in accordance with the requirements of the assembly quality, then after apreliminary analysis, the cause of this problem was when measuring the number of the corrugated pieces, the displacement probe had a vertical load on the corrugated pieces due to the spring. In order to verify this assumption, the three-dimensional model of the corrugated pieces was analyzed, as shown in Figure 6.

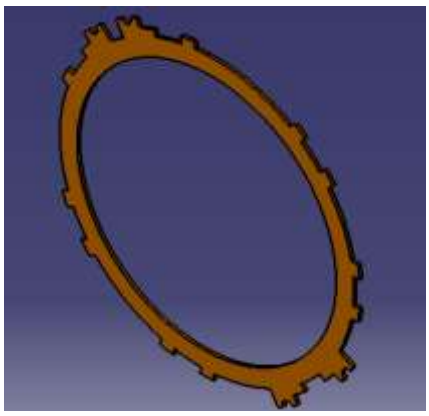
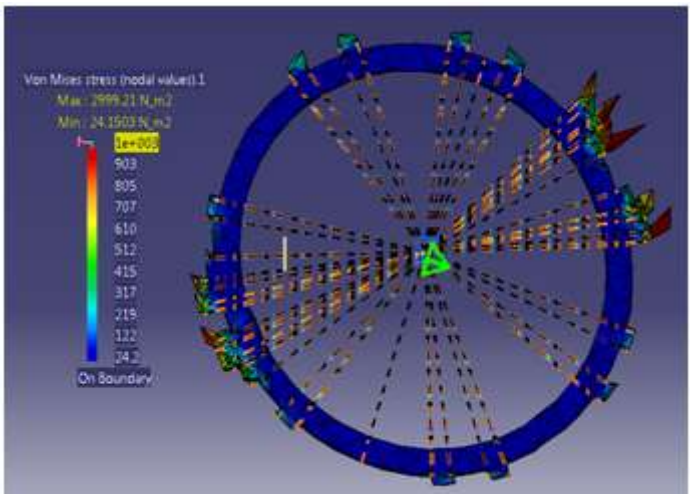


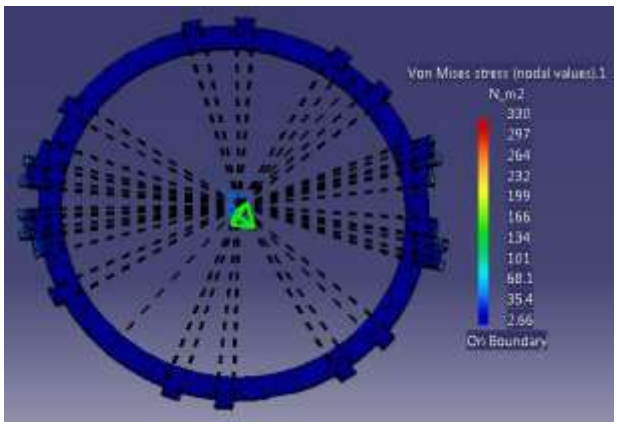
Fig.6Corrugated pieces 3D model

4.2 Finite element analysis and optimization of the corrugated pieces

In order to verify whether the deformation of the corrugated pieces was related to the vertical load of the probe, the finite element analysis of the corrugated sheet was carried out. Because the mass of the probe was small, the load was mainly derived from the tension of the spring. When the load was 1N and 0.11N, the deformation of the corrugated pieces was obtained as shown in Figure 7.



(a)



(b)

Fig.7Deformation of 1N (a) and 0.11N (b) on the corrugated pieces

By the finite element analysis, when the stress of the corrugated sheet was more than 1N, the deformation was obvious. It was proved that the deformation of the corrugated pieces was related to the tension of the spring which will affect the identification of the type of corrugated pieces. Finally, after consideration, the decision was not adding load to the probe, the probe's own gravity was the only pressure on the corrugated pieces.

V. Conclusion

After Optimization design, the checking fixture of corrugated pieces in Clutch assembly of automobile gearbox, met the production line of corrugated pieces detection and error proofing requirements, work more reliably, improved the working efficiency of the production line and reduced the rejection rate of the disc assembly line, and in accordance with the development trend of standardization, automation and flexibility.

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