Design of progressive die for motor stator and rotor plate with automatic stacking

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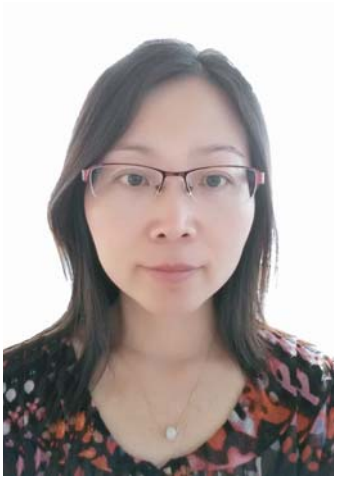

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Key words: motor; stator plate; rotor plate; automatic stacking; multi-position progressive die

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1. Introduction

Since a motor comprises dozens to hundreds of stator and rotor plates, the quantity of stator and rotor plates required to be produced is big.

Traditional production and assembling of stator and rotor plates means conducting forming processes first, like single piece stamping, and then stacking the stator and rotor plates into assemblies. For stamping, stacking and assembling are not carried out in the same die, the efficiency is low. The quality of final assembly cannot be guaranteed.

Below describes the design of progressive dies for automatic stacking and assembling of the stator and rotor plates used for some models of household blender, which solves problems such as low efficiency of traditional processing technologies, big positioning errors and difficulty in controlling the direction of burrs.

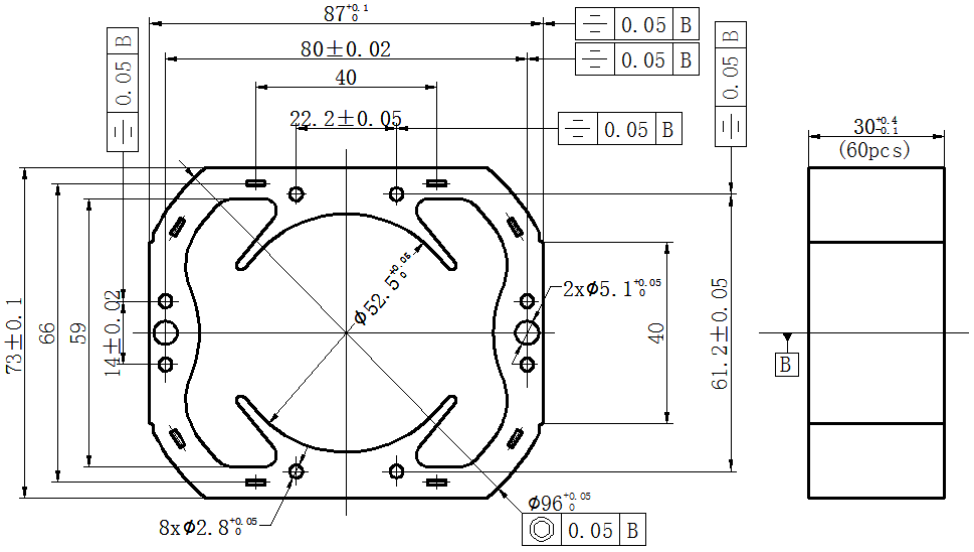


Fig. 1 Stator plate

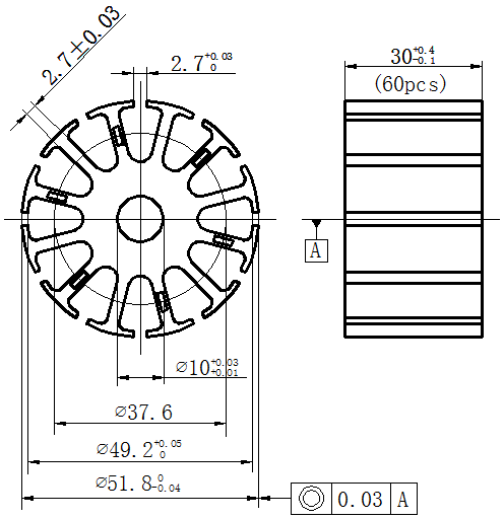


图 2　转子片

Fig. 2 Rotor plate

2. Process Analysis and Determination of Process Schemes

In relation to some model of household blender whose motor rotates 22,000 r/s, Fig.1 and 2 illustrate the stator and rotor plates which are made of 50W470 silicon steel sheet with a thickness of 0.5mm and a block height of 30mm after rivet joint. Besides requiring high symmetry, concentricity and flatness, the stator and rotor plates of the motor also require surface smoothness, least burr, and small geometric tolerance after laminated rivet joint.

The stamping material is cold-rolled non-orientation silicon steel sheet, which needs good surface finishing and high dimension accuracy. However, such material is comparatively hard, and has greater shear strength than general materials. For this, it is recommended to choose materials with good wear resistance and toughness die component materials. Due to the relationship between stator plate and rotor plate, it is ideal to mix and put them together into the same die for punching and shearing, which can effectively enhance the utilization rate of strip materials. Since stator and rotor plates require high stamping precision and present complex shapes, it is appropriate to apply multi-station progressive dies for their stamping, including punching and blanking.

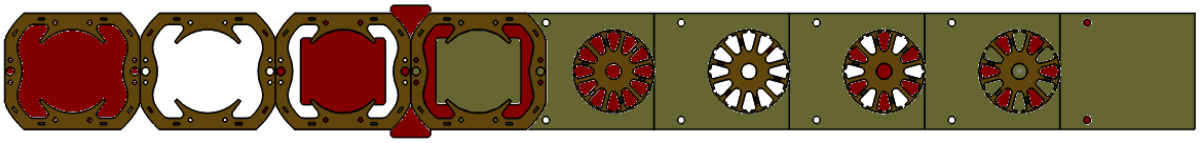


Fig. 3 Layout Design

3. Layout Design

As a key step in progressive die, layout design reflects the positioning of parts in the whole stamping process, as well as mutual positions, material utilization rate and the correctness

of die structure design.

Layout design can be carried out not only by the designing approach based on experience, but also facilitated by using special computer aided design (CAD) software solutions.

In the design, a three-dimensional progressive die design system based on SOLIDWORKS - 3DQuickPress - is used to complete an optimal design of layout and design of stator and rotor plates, which sets 8 positions in total, respectively including: ① pierced pilot holes and 6 shaping holes inside rotor plates; ② the other 6 shaping holes inside the rotor punching plates; ③ lamination counting holes; ④ rotor plate blanking and lamination; ⑤ stator punching plate holes and part of internal profile; ⑥ stator punching plate holes, the remaining internal profiles inside and part of external profile; ⑦ stator punching plate lamination counting holes; ⑧ stator plate blanking and lamination. (See Fig. 3)

4. Die Structure Design

4.1 Overall Die Design

In die structure, stator plates are designed with 8 lamination counting holes and rotor plates with 6, which have the same shape.

Counting holes are located in upper die pad due to its particular structure and function. While for other convex dies, the punch holders should be parallel to the surface of the fixing plate. Due to large external dimensions and numerous stations, to guarantee the stability of discharging devices during the die operations, it is required to apply spring-operated stripping mechanism, meanwhile, the stripper plate and the 6 guide posts of die set work together by means of steel ball guide sleeve, which can solve the heating problem in high speed stamping.

Since there exists high deformation of at the junction station of last rotor station and the first stator station, to prevent strip materials from attaching to the lower die surface which may further affect feeding, lifter guide pins with functions of guiding and lifting will be set in the lower die.

The two groups of lifter guide pins are distributed on both sides of the strip materials and are fixed onto the lower die pad, being assembled with springs and screws.

As the outer edge of strip materials has been cut off after the sixth step, the end of strip materials will be oriented via guide plate.

The guide plate and the strip material take a single side gap of 0.03mm, and the boss on the guide plate can prevent the strip material being pulled up.

The three-dimensional die assembly drawing is as shown in Fig. 4, in which the structure of lower die plate can be seen in Fig. 5.

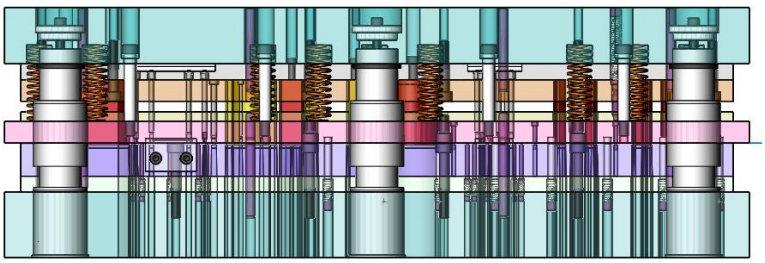


Fig. 4 Three-dimensional die assembly drawing

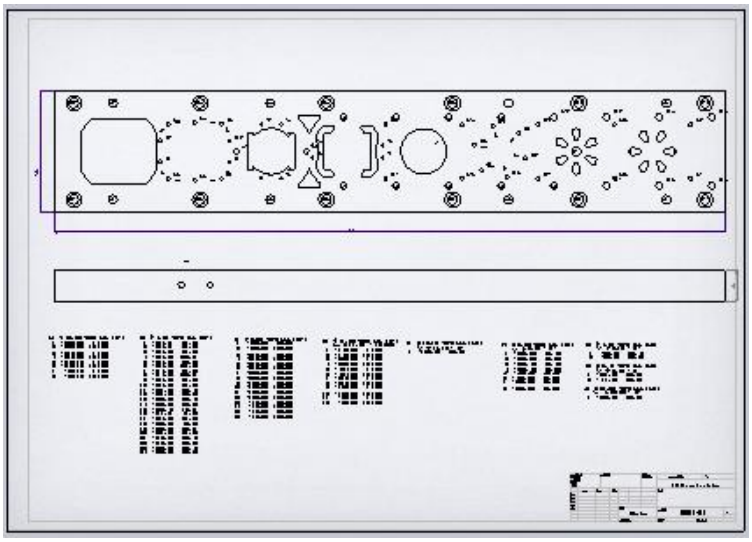


Fig. 5 Structure of lower die plate

4.2 Notes for Die Design

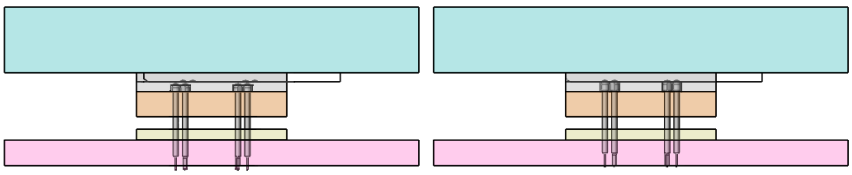
4.2.1 Laminated Plates Automatic Counting and Grouping Device

The stator and rotor plates after rivet joint have a thickness of 30mm block with 60 plates. A V-shaped rivet button is punched for rotor plates in the third station.. Blanking and laminate press for rotor plates are set on fourth station. Then achieve laminated rivet joint through the interference fit among the V-shaped rivet buttons. and the first rotor plate in each group shall be punched through, in this way the plate will not overlap the last rotor plate of the previous group, so as to realize the function of rotor core grouping[2].

Similarly, punch V-shaped rivet buttons for stator plates on the seventh station, blanking and laminate press for stator plates and carry out stator core grouping on the eighth position.

Fig. 6 shows a laminated plate automatic counting and grouping device, wherein the pneumatic cylinder drives the slide plate to move the counting holes, and the working state of the pneumatic cylinder is controlled by a solenoid valve.

The quantity of punching plates required for core lamination shall be set in the control box, and the signal of each punching stroke will all be input to the control box; when the set number of plates are reached under punching, the control box will send a signal[3] to pull out the slide plate by the solenoid and the pneumatic cylinder, in order to eject the die of counting holes out downwards for punch-through operation. (see Fig. 6 (a)); when not requiring punching-through, the pneumatic cylinder piston will push in the slide plate when the die of counting holes punches V-shaped rivet buttons (Fig. 6b).



(a) Counting status (b) Laminated rivet joint

Fig. 6 Laminated plates automatic counting and grouping device

4.2.2 Safety Monitoring and Protection Device

Since the punching press works at high speed, in case of wrong feeding and the machine is not shut down properly, dies and equipment may be damaged. Fig. 7 illustrates a commonly-used safety monitoring and protection device, concerning the situation that the material fed does not reach the designated position. When the materials fed have reached the specified location, the head of the detection punch can pass through the pilot hole and pass through the stripper plate. When the materials are not rightly fed due to error, the head of the detection punch cannot enter into the pilot hole and has to retract, the movement will push the probe and trigger the emergency stop micro switch, and then the machine tool will stop working immediately. At this moment, the punches in the upper die do not enter the die yet, thus avoiding damage to the dies and equipment. Furthermore, this prevents the generation of large quantities of scrap.

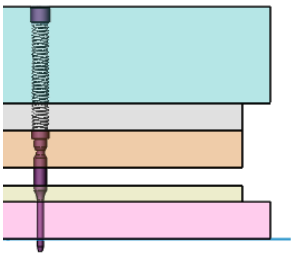


Fig. 7 Safety monitoring and protection device

5. Conclusion

As a key component for household appliances, motor is highly demanded in the market. In the design of progressive dies for motor stator and rotor plates, what makes such die different from others is the full consideration of multi-station mixed operations in high speed stamping of stator and rotor plates, as well as the influence over the die structure due to the requirement for stacking and assembly in stamping process. Such die designed and manufactured exhibits good condition in usage after being put into production and operation, which shortens the die research and development period and improves the quality of finished parts. It brings good benefits to the enterprise.