Combining the Characteristics of the Field to Determine the Retrieval Ideas and Improve The Retrieval Efficiency of Machine Tool Fixtures

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Abstract: Within the field of machine tool fixture, there are many design principles recognized by the industry, and there are many institutions based on industry consensus as the corresponding workpiece clamping. In the process of developing, the search work, the examiner needs to have his own understanding. It is not only based on the specifications of the inherent application fixture. It should be based on the relevant technical perspectives in the field, and understand the design ideas and related principles of the fixture. The specific functions of the components of the fixture are formed as a fixture design principle within the field and retrieved. Through the actual case, combined with the characteristics of the field, the analysis of the fixture design ideas is carried out, and the retrieval ideas of the machine tool fixtures are determined, which can effectively improve the retrieval efficiency.

1. Introduction:
In the field of machine tool fixture, the structure of fixture for clamping workpiece will inevitably be different, because of the difference of workpiece shape. It is difficult to retrieve the corresponding workpiece fixture in the relevant patent database for patent application of the special workpiece. Therefore, in the process of selecting relevant documents or measuring the creativity of application, the examiner has a great difficulty. Even if there is a difference in the structure of the clamp due to the difference in the clamping workpiece, the fixture must have a positioning device, a clamping device, and a fixture. Although the positioning device is composed of different positioning elements, it must meet the six-point positioning principles. The clamping device is nothing more than a separate or comprehensive use of a wedge clamping mechanism, a screw clamping mechanism, an eccentric clamping mechanism, a hinge clamping mechanism, and a linkage clamping mechanisms, centering clamping mechanisms, etc.

2. Fixtures design idea
Based on the design idea and principle of fixture, the positioning device and clamping device are the key parts to ensure the workpiece processing quality.

2.1 Positioning device design
The positioning device should make the workpiece positioning convenient and stable, and meet the processing requirements of the workpiece. In the actual production process, the full positioning and incomplete positioning are generally used to meet the positioning requirements, and the under positioning cannot be used. Repeated positioning can be used when the machining accuracy is high or
the machining process needs to be stable, but the possible adverse effects should be eliminated. The three common positioning methods of workpieces are: 1) workpieces with planar structure, generally 1-3 support nails or support plates are positioned to limit 1-3 degrees of freedom; 2) workpieces with round hole structure, usually using diamond pins, cylindrical pin, taper pin or mandrel positioning respectively, limit 1, 2, 3 and 4 degrees of freedom; 3) external cylindrical structure of the workpiece, usually using active short V-shaped block, short V-shaped block, long V Block positioning; limits are limited to 1, 2 and 4 degrees of freedom respectively, and can also be positioned by positioning sleeves and semi-circular sleeves. As for the tapered hole, the cone mandrel is generally used for positioning, limiting 5 degrees of freedom. When the workpiece clamping rigidity is poor, the auxiliary support or the floating support can be used to increase the clamping rigidity.

2.2 Design of clamping device

2.2.1 Clamping system design
The performance of the clamping mechanism is closely related to the fixture design. Its reliability and operability are the key factors in the performance evaluation of the fixture. The design of the clamping mechanism must meet the following requirements: 1) The clamping mechanism must protect the positioning without damaging the positioning; 2) The clamping rigidity of the workpiece must be ensured, and the clamping deformation error is controlled within the required range; 3) The clamping mechanism must be safe, labor-saving, convenient and so on, it should have sufficient strength and rigidity.

The clamping force of the clamping mechanism should first determine its point of force and direction according to the principle of determining the point and direction of the clamping force. The direction of the clamping force should be favorable for positioning and pointing to the main positioning surface, which is beneficial to reduce clamping force, pointing to the direction of the rigidity of the workpiece, the point of the clamping force should be within the area of the support or support, the part of the workpiece with good strength and rigidity should be as close as possible to the processing part; secondly, it is reasonable to ensure clamping force that the workpiece is clamped without causing undesired deformation of the workpiece. Generally, the static balance principle is used for estimation, and the safety factor is determined in combination with the actual working conditions to determine the required clamping force.

The type of clamping mechanism is generally determined according to production conditions and clamping force. The wedge or eccentric clamping mechanism can be used when the clamping stroke is small and the clamping force is small; the screw clamping mechanism should be used when the clamping stroke and the clamping force are large; the centering clamping mechanism can be used when the rotary center or the symmetrical center plane is needed; when the clamping efficiency is multi-component, multi-directional or high, the clamping mechanism can be used, then the linkage clamping mechanism is adopted.

2.2.2 Power plant design
Commonly used power sources for machine tool fixtures are manual, hydraulic and pneumatic. Manually uses manpower as a source of force. The pneumatic (hydraulic) clamping device generates power through the cylinder (hydraulic cylinder) through compressed air (pressure oil) as a medium, and their structure and working principle are substantially the same. The pneumatic clamping device has low cost, environmental protection and rapid action, but the structure size is large, the clamping force is small and unstable, and relatively large noise pollution exists. The hydraulic clamping device has compact structure, stable operation and large clamping force, but the cost is high, and there is a problem that the hydraulic oil leaks and pollutes the environment. Manual clamping can be used for single-piece, small-batch production or assembly line operation; pneumatic or hydraulic clamping can be used when automatic line or production efficiency is high, and the cutting force is not large and stable should be pneumatic, otherwise hydraulic operation is adopted.
3. Cases analysis
Combining the characteristics of the machine tool fixture field and determining the search ideas, the efficiency of the machine tool fixture is improved. The independent rights of the application documents are as follows:

3.1 Fixture for inclined hole drilling machine
The structure of the fixture of a workpiece inclined hole drilling machine is shown in Fig. 1. It consists of fixture body 1, positioning device, clamping mechanism and guiding device 6. The positioning device is composed of supporting plates 2 and 3 mounted on three different spatial planes (as shown in Fig. 4). The clamping device consists of hook-shaped pressing plates 4 and 5.

3.2 Retrieval difficulties
The shape of the workpiece clamped by this fixture is irregular and has distinct industry characteristics. It is very difficult to retrieve the fixture of the same workpiece in the patent database. Its locating and clamping device must meet the structural characteristics and processing requirements of the workpiece, so it is more difficult to retrieve the relevant elements.[1]

3.3 Retrieval process
Relevant reviewers actually understood the application and then launched the initial search, and did not retrieve the fixture that was targeted and consistent with the application. On this premise, from the technical perspective of examiner’s position in this field, it is clear that the shape of the workpiece in this application is irregular, and it belongs to the hexahedron structure in this field according to the principle and thought of fixture design. Usually, the six-point positioning principle is used to select the positioning mode and determine the structure and position relationship of the positioning element.[2]

The correct position of the workpiece in the fixture is ensured by positioning, which is realized by the contact or cooperation between the positioning datum of the workpiece and the working surface of the positioning element. The point, line and surface used to locate the workpiece in the fixture are the locating datum, and the surface contacted or matched with the locating datum in the fixture is the working surface or the supporting surface. When choosing the location datum, the principle of datum coincidence is adopted as far as possible, so that the non-coincidence error of datum is zero, thus reducing the location error.

The position of workpiece in three-dimensional space can be described by degree of freedom, which refers to the uncertainty of workpiece position in space. As shown in Fig. 2, the workpiece can move in six directions in three mutually perpendicular coordinate planes. It also has six degrees of freedom, three degrees of freedom to move along the coordinate axis Ox, Oy and Oz, and three degrees of freedom to rotate around the coordinate axis Ox, Oy and Oz.
To determine the correct position of the workpiece in a certain direction of the fixture, the degree of freedom in that direction must be limited. In order to ensure that the workpiece is in the fixture for a stable and unchanged position, it is necessary to limit the six degrees of freedom of the workpiece. Therefore, positioning belongs to the restriction of freedom[^4].

Surface with more restriction of freedom on workpiece is the main positioning datum, surface with less restriction of freedom is the secondary positioning datum or guiding positioning datum, and one degree of freedom is the thrust positioning datum. As shown in Fig. 4, the XOY plane is the main datum, with three supporting points in contact with it, restricting the three degrees of freedom that move along the OZ axis and rotate around the OX and OY axis. The larger the triangle area obtained by connecting the three supporting points, the better the stability of the positioning of the workpiece. Therefore, the largest surface of the workpiece should be chosen as the main datum. The plane is extremely oriented datum plane, two supporting points are arranged to contact it, which restricts the two degrees of freedom of workpiece moving along the OX axis and rotating around the OZ axis. The farther the distance between the two supporting points is, the smaller the guiding error caused by the height difference of the supporting pin is, and the higher the positioning accuracy is. Usually, the long and narrow surface of workpiece is chosen. ZOX plane belongs to thrust positioning datum. A supporting point is arranged to contact it, which limits the degree of freedom of movement of the workpiece along the OY axis. The supporting point generally chooses the surface with the best strength, the shortest length or the narrowest area and the opposite direction of the cutting force on the workpiece, so as to reduce the clamping force. The selection and distribution of six supporting points restrict the position of workpiece in fixture, which belongs to the principle of six-point positioning[^5].

In the actual production process, the positioning of the workpiece does not need to restrict all the six degrees of freedom of the workpiece. The actual quantity of the limited degrees of freedom should be determined according to the structural characteristics of the workpiece, the processing requirements of the process and the mode of production organization[^6]. The case is shown in Figure 4.
On the premise of being familiar with the principle of six-point positioning, the examiner, based on the technical perspective of the field, clearly identifies the basic elements of retrieval, can determine the most practical technology, and makes clear that the application is used for drilling inclined hole fixture. The main difference is that there are differences in the actual positioning methods due to the shape difference of the workpiece, and combined with six-point positioning. According to the principle of position, the design method of the technicians in this field is obtained. It is necessary to fully understand the practical function of fixture design in the process of searching special fixture for specific workpiece[7].

4. Conclusion:
All in all, the retrieval effect of machine tool fixtures should be familiar with the design ideas and principles of fixtures, and be studied in combination with actual cases. In the field of machine tool fixtures, the actual retrieval ideas need to be comprehensively understood on the premise of clear fixture design ideas. The role of the fixture design form within the field, the actual retrieval work, can ensure the improvement of retrieval efficiency, so that the probability of deviation during retrieval is reduced.

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