Design of Self-Priming Electric Drill Dust Protector

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Abstract. Combined with the working principle of dry vacuum cleaner, an electric drill dust collector capable of actively absorbing dust is designed. The device can block the dust generated during the work of the electric drill to prevent it from entering the construction site environment, and can collect and store the dust, effectively reduce the amount of dust in the air of the electric drill construction environment, improve the quality of the working environment of the construction workers, and reduce the silicosis of workers Prevalence. In addition, the device is small in size, simple to use, and has a good dustproof effect, and can be widely used in various electric drill construction environments.

1. Introduction
In recent years, China's various types of housing have been increasing, the decoration industry has developed rapidly, and the use of electric drills has gradually increased. As an indispensable tool for the decoration industry, its large use has brought many problems. Among them, dust pollution during electric drill work is an urgent problem to be solved.

Studies have shown that inhaling cement dust from construction sites can increase the prevalence of lung diseases and make the body vulnerable to silicosis. In addition, dust emitted into the air can cause damage to human eyes. When using an electric drill to carry out small-scale renovations of already-occupied houses, the generated dust will pollute the furniture in the houses and cause inconvenience to the homeowners.

In view of the above problems, many people have conducted research on the dust prevention of electric drills, and have also designed some electric drill dust-proof appliances, such as horn-shaped electric drill dust covers and cylindrical dust covers. The use of these two types of dust covers has a certain dust-proof effect. Due to the simple structure, there are certain defects in dust-proof and it is easy to cause dust leakage. When these two types of dust cover leave the working surface after work, dust will be emitted into the environment from the mouth of the dust cover; when the electric drill is working, the dust will diffuse into the air from the drill inlet of the dust cover. Based on the above background, this project combines the working principle of a vacuum cleaner to design a self-priming electric drill dust collector that can effectively prevent dust.

2. Implementation plan
Self-priming electric drill dust preventer adopts modular design and consists of drill bit inlet, low-pressure dust storage room, electric control system and pressure-sensitive film. The overall structure model is shown in Figure 1.
When in use, first attach the device to the working surface, and then insert the electric drill bit into the drill bit inlet. The dust blocking plate installed at the drill bit inlet moves outward in the radial direction under the force of the drill bit. At this time, the fan speed sensor has completed the measurement of the drill bit diameter. The speed of the suction fan is adjusted to the corresponding value, so that the air pressure in the low-pressure dust storage chamber is also adjusted to the corresponding value, and the drill bit moves forward and extends from the dust inlet into the wall. The dust generated during work enters from the dust inlet and is sucked into the low-pressure dust storage room. The working state of the device is shown in Figure 2.

3. Module design

3.1. The inlet design of the drill
The drill inlet module is composed of bearings, inlet outer ring, and dust blocking plate, spring and so on. The entrance of the drill bit is at the top of the device. The outer diameter of the bearing is initially set to 40mm and the inner diameter is 30mm. The diameter of the outer ring of the inlet is initially set to 30mm, which is an interference fit with the inner ring of the bearing. In order to achieve a better dust blocking effect, the dust blocking plate is designed with a total of 4 pieces, each of which has a spring connection, which can move in the radial direction of the bearing.
Figure 3. Appearance and internal structure of the drill inlet.

When the drill does not enter the device, the inlet diameter is at the minimum state. When the drill moves forward into the device, the drill has a forward force on the inclined surface of the dust blocking plate. Under the action of the inclined surface, the force is divided into two component forces, the force 1 is in the axial direction, and the force 2 is along the Radial. The dust blocking plate is pushed away under the action of force 2 and the drill bit enters. Due to the elastic force of the spring, after the drill bit enters the device, the dust blocking plate is always close to the outer wall of the drill bit to ensure that dust will not enter the air environment of the construction site. Because the device is not designed with other air inlets, the inlet of the drill bit needs to be designed to allow air to flow, to ensure that air enters and brings dust into the low-pressure dust storage room.

Figure 4. Schematic diagram of the drill inlet.

3.2. Design of low-pressure dust storage room
The low-pressure dust storage room is composed of a filter screen, a support frame, a handle, a support foot and two suction fans. The structure is shown in Figure 5. The filter screen is replaceable. Initially set the size of the dust storage room to be $20\text{mm} \times 144\text{mm} \times 38\text{mm}$. The low-pressure dust storage chamber is located below the entire unit. To facilitate the cleaning of dust, the storage room can be removed after the buckle is opened. Because the suction fan is installed on the side of the device, the gas in the device is sucked out from the side of the device. In order to ensure that the dust is evenly distributed in the filter screen, to prevent local airflow in the filter screen from being too large, there are gaps on three sides between the filter screen and the shell to ensure that the airflow can diffuse from around the filter screen. The suction fan is located below the device side. In order to ensure that the dust can be evenly distributed in the dust storage chamber with a relatively long length, two suction fans are initially set. Due to the different amount of dust produced by drills of different diameters per unit time during operation, the suction fan is set at different speeds, so that the dust generated during the work of the electric drill can be fully sucked in without waste of energy. Initially set the fan to have 6 different speeds, corresponding to different drill bits. As the diameter of the
electric drill bit increases, the speed of the fan also increases, the air pressure in the low-pressure dust storage chamber decreases, and the suction of dust increases.

**Figure 5.** Low-pressure dust storage room.

### 3.3. Design of electric control system

The electronic control system is all electrical components including power supply, including control circuit board, fan speed sensor, fan motor, etc. Considering that the amount to be controlled is relatively simple, a 51 single-chip microcomputer is selected. The control model is shown in Figure 6.

![Control model](image)

**Figure 6.** Control model.

This device directly controls the speed of the suction fan, and then controls the suction pressure. The 51 single-chip microcomputer uses the C program to achieve the function, and the programming is simple. After the switch is turned on, the speed of the suction fan is the minimum. When the drill bit enters the device, the fan speed sensor installed at the entrance of the drill bit detects the diameter of the drill bit, and then converts the information into an electrical signal and transmits it to the microcontroller. The single-chip microcomputer processes the signals and controls the fan to adjust to the corresponding speed, thereby realizing the control of the pressure. The control process flowchart is shown in Figure 7.

![Control process flowchart](image)

**Figure 7.** Control process flowchart.
3.4. Pressure sensitive adhesive
The pressure-sensitive adhesive module uses a pressure-sensitive adhesive that can be repeatedly pasted. This kind of gel can be peeled off after the object is pasted, and then the object can be pasted. By mounting this kind of material on the surface of the device, the device can be repeatedly attached to the working position of the electric drill, thereby achieving the purpose of not needing to hold the device while working.

4. Benefit Analysis
According to the analysis of the research results, if dustproof measures are not taken during the construction of the electric drill, the air in the construction environment will be polluted. If the two types of electric drill dust covers mentioned above are used to intercept the dust, it has a certain dust-proof effect. About 6% of the dust will enter the construction environment when using the horn-shaped electric drill dust cover; about 5% of the dust will enter the construction environment when using the cylindrical dust cover for dust prevention. The dust leaked from both types of dust cover enters the construction environment from the dust cover mouth and the drill bit inlet. When using a self-suction electric drill dust cover for dust protection, only 1.1% of dust particles enter the construction environment due to its ability to be close to the work surface and active dust extraction. Compared with the two types of dust covers, they enter the construction environment. The amount of dust is reduced by 90.9% and 78.0%, respectively. Compared with the simple structure of the electric drill dust cover, the dust-proof effect has been significantly improved, and the goal of high-efficiency dust-proof has been achieved.

5. Conclusion
The self-priming electric drill dust cover designed for this project can actively collect dust generated during electric drill work. Because the self-priming structure and low-pressure dust storage room are designed, dust will not be emitted into the air after being collected. Compared with the traditional dust cover, it has a better dust-proof effect, can effectively reduce the amount of dust in the environment during the construction of the electric drill, realize environmental protection construction, improve the quality of the working environment of the constructor, ensure the health of the constructor, and reduce silicosis Prevalence of disease. Government departments now advocate environmental protection construction, so it has a lot of room for development in the future.

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