
Design of a fire detection and alarm device

Hui Liu ^{1, a}, Yuanjia Qi ^{1, b}

¹School of Mechanical and Electronic Engineering, Shandong University of Science and Technology, Qingdao 266590, China.

^am18865558192@163.com, ^b1003414589@qq.com

Abstract

In this paper, design of fire detection and alarm device named safeguard intelligent fire extinguisher, it is an all-weather monitoring, intelligent extensible fire extinguishing equipment, it can be hung on top of a plant, smart scalable to facilitate close to the fire, two-way mobile increase extinguishing fire area, 360 - degree rotating nozzle orientation, etc, and its main working principle were introduced. It has a good development prospect and promotion value in factories, warehouses and other areas where inflammable goods are stored.

Keywords

Intelligence; fire extinguishing equipment; inductor; automatic fire extingui.

1. Introduction

Fire safety is a top priority of each enterprise, there are some in today's factory fire safety problems, in order to prevent the occurrence of fire cause serious damage to the factory, the factory will prepare some portable fire extinguisher, can use them in a timely manner when the fire extinguishing to ensure safety. However, these fire extinguishers only have the function of extinguishing fire, and if no one discovers a fire, they will have no use value and cannot be put out in time. Safeguard the function of the intelligent fire extinguisher by itself, can be found in the first time and for fire detection and alarm, automatic fire extinguishing, also available manual remote control fire, and then through their sensitivity to fire, it also enhances the use value of fire extinguishers and their own value[1-4].

2. Design Solutions

2.1 Transmission Section

The fire extinguishing platform needs to be suspended in the air during the descent, which requires the device to have self-locking function. And I choose the worm helix Angle is less than 3-6 degrees (lead Angle is less than the friction Angle) of the worm, worm gear and worm drive can realize self-locking function, and on the other hand, worm gear and worm drive has big reduction ratio, stable work, work the advantages of low noise[5].

The selected worm gear material is 45 steel, low cost, relatively slow wear, can withstand shock and vibration loads, and work smoothly [6].

2.2 Fire Extinguishing Device Section

The fire extinguishing device part mainly includes two-position and five-way electromagnetic valves and fire-fighting spray pipes. The two-position five-way solenoid valve is a miniature DC solenoid valve, which has the advantages of exquisite workmanship, small size, light weight, stable performance, easy installation, stable operation, and long service life. Extinguishing spray tube is

composed of two parts, connection soft hose of resistance to high pressure spray nozzle is red, about 17 mm outside diameter, inside diameter of about 12 mm, spray tube are connected by a tee tubes, through large area of scattered spray pipe tee joint can connect nozzle, the nozzle is made by stainless steel material, can effectively increase the range.

2.3 Fire Control Section

The fire extinguishing control section mainly includes smoke detectors, audible and visual alarms, and the like.

2.3.1 Smoke Detectors and Sound and Light Alarms

When a blazing fire occurs, there are more tiny particles of smoke in the air. When smoldering, there will be more smoke particles in the air. If a large amount of small particles of smoke is produced after a fire, the ion smoke sensor will alarm when the alarm circuit detects that the concentration exceeds the set threshold.

2.3.2 Time Relays and Contactors

The working principle of the intermediate relay: when the contactor coil is energized, the coil current generates a magnetic field, which makes the precision iron core generate an electromagnetic attraction moving iron core and drives the contact action. The normally closed contact is disconnected and the normally open contact is closed. The two are linked. When the coil is out of power, the electromagnetic suction disappears, and the armature is released under the action of releasing the spring to restore the contact. The normally open contact is disconnected and the normally closed contact is closed.

Ultrasonic distance sensor works: the sensor emits ultrasonic waves, detects echoes, and calculates obstacle distances. If it is less than or equal to the set distance of the module, the OUT pin will output 0, otherwise it will drive the triode of the module (C open output) at the same time, which is convenient for directly driving the relay. See Fig.1.

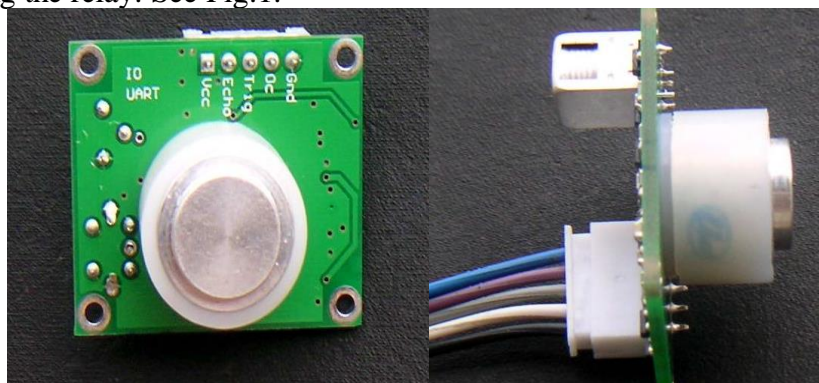


Fig 1. Ultrasonic distance sensor

2.4 Drive Section

The driving device part mainly includes a motor, a caster, a pulley, and the like.

2.5 Support Section

The supporting part mainly includes frame and material, bearing pedestal and shaft, etc. The upper part of the fire extinguisher is 60cm long, 40cm wide and 30cm high. The lower part of the frame is 60cm long, 40cm wide and 20cm high. Frame materials for 304 Angle iron, fully USES the bolt connection, remove the simple convenient, to avoid the welding method is easy to rust shortcomings, small deformation, small cold cracking tendency, greatly improve the stability of the framework. The shaft is 16mm in diameter and 60cm in length. Made of 45 steel, bearing pressure >500N. The bearing seat is made of HT250 material, and its long life is suitable for high-speed operation. See Fig.2.

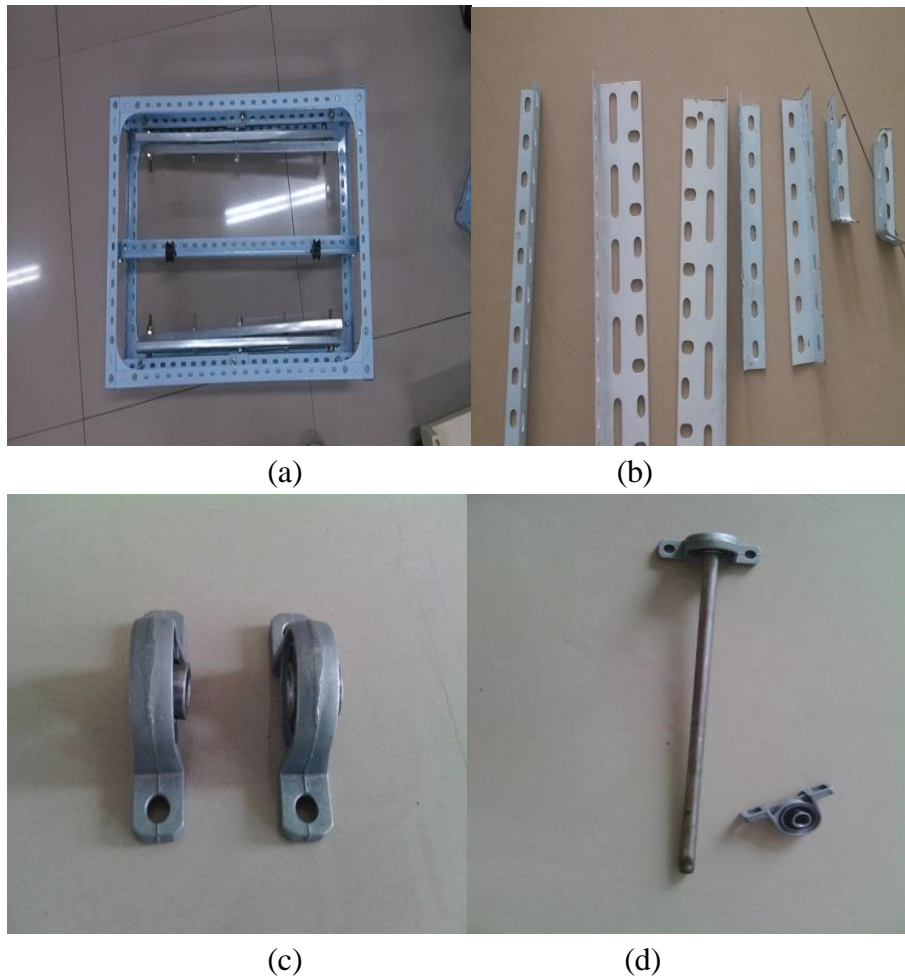


Fig 2. (a)The framework; (b) material; (c) bearing; (d) shaft

2.6 The Monitoring System

The camera itself has 30 infrared lights. Night vision range up to 15 meters. By controlling the photosensitive resistance on the infrared lamp board, the infrared lamp can only start in the dark environment. Even in complete darkness, the camera can achieve perfect surveillance. The fuselage is waterproof aluminum alloy shell, anti - oxidation. The camera has a tiny audio and video transmitter built into it, and an external line has audio and video cables. Can use wireless already, also can use the sound and video line that the machine brings, connect TV or monitor directly, use as cable. The tail of the machine is equipped with a small microphone, which can listen for sound in a range of about five meters. The waterproof performance of the whole machine is good, the joint of the shell is closely matched, and the rubber waterproof ring is built in. Even in places like antenna holes and microphone holes that inevitably require openings, the inside is fixed with waterproof glue.

3. Working Principles

Security guard working principle of the intelligent fire extinguisher: when fire occurs, the smoke rising, smoke sensors in recognition, by making use of the smoke sensor signal into intelligent fire extinguishing equipment control system, sound and light alarm, warning alarm occurred. The power switch is automatically closed at the same time, the surveillance cameras start monitoring work, through a fire extinguisher on pulley works closely with the track's case, under the control of the electric circuit, through fire extinguisher main box slide to the fire. At the same time, under the fire extinguisher box to start working distance sensor, through ultrasonic positioning make fire extinguisher nozzle operation platform, falling to the distance for the source of a certain position (artificial setting distance) in advance. Followed by a fire extinguisher nozzle switch is closed, jet fire

extinguishing material (water or dry powder), implementation of fixed-point and timing of fire of fire, until the smoke sensors induction can't smoke, smoke alarm switch is automatically disconnected, after the case back to its original position. See Fig. 3.



Fig 3. Security guard intelligent fire extinguisher

4. Theoretical Design Calculation and Circuit Diagram

4.1 Theoretical Design Calculation

Dynamic analysis of fire extinguisher, fire extinguisher of motor output shaft torque M , through the worm gear and worm drive, to the drive shaft torque of M_t , F_0 , the power of the driving wheel to guide rail on the driving wheel force F_t ; F_t is opposite to F_0 in the same direction. F_t is the external force that pulls up and down the fire extinguisher, which is defined as the driving force of the fire extinguisher.

$$F_t = F_0 = f = mg$$

$$V = 0.05 \text{ m/s}$$

Rolling friction factor (without sliding): $u = 0.15$

$$m = 5.6 \text{ kg}$$

$$g = 9.8 \text{ N/kg}$$

$$G = mg = 5.6 \text{ kg} \cdot 9.8 \text{ N/kg} = 54.88 \text{ N}$$

$$F = 54.88 \cdot 0.15 = 8.232 \text{ N}$$

$$F_0 = f \quad P = F_0 \cdot v = 0.4166 \text{ W}$$

Calculation of turbine worm transmission ratio:

$$\text{Motor turbine speed: } n_0 = 140 \text{ r/min} = 2.3 \text{ r/s}$$

$$\text{Radius of motor turbine: } r_0 = 30 \text{ mm} = 0.03 \text{ m}$$

$$\text{The linear speed of a motor's turbine: } v_0 = 0.44 \text{ m/s}$$

$$\text{Radius of vortex rod: } r_1 = 20 \text{ mm} = 0.02 \text{ m}$$

$$\text{Worm speed: } n_1 = 1.8 \text{ r/s}$$

$$\text{Transmission ratio: } i = n_0 / n_1 = 1.27$$

4.2 Working Circuit Diagram

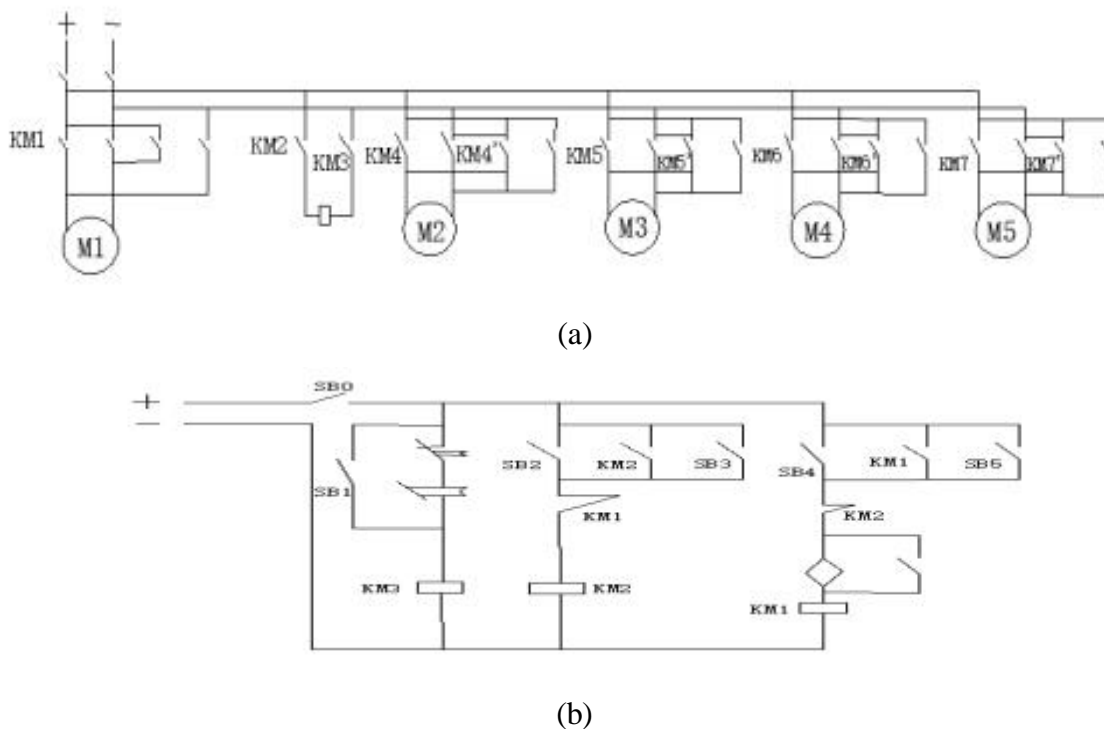


Fig 4. (a) The main circuit; (b) Control circuit

Working principle of circuit diagram: main circuit is the circuit part of execution; the control circuit is the main part of the control circuit. The remote control circuit is the part of the remote control circuit. M1 is the motor that connects worm and worm of worm wheel to control the rise and fall of box body. M2 is also an electric motor that controls the movement of fire extinguishers along the tracks. M3 is also the motor that controls the rotation of the fire sprinkler. M4 is also an electric motor, controlling the fire sprinkler head to swing left and right. The M5 is also a motor that controls camera rotation. KM represents the switch controlled by the relay, that is, the switch in the relay. Where, KM1 is closed and the motor is turning forward. KM1 'closed, motor reversed. Other relay switching principles are the same. The solenoid valve in the main circuit is electrically-on and power off [8].

5. Conclusion

Fire more than twenty thousand each year in our country in recent years, property losses, and bring a lot of chain reaction, caused wide attention in society, therefore, to develop a kind of intelligent fire extinguishing system is imminent. At present, most of our common fire extinguishers are equipped with portable dry powder fire extinguishers, which are usually placed in a certain place. When there is a fire, operators need to find a fire extinguisher to put out the fire. This often leads to the inability to find a fire extinguisher, or the crowded scene of grabbing a fire extinguisher everywhere, delaying the best time to put it out. And the existing small fire trucks are also difficult to drive in the complex cargo plant [10].

For this, we design a multi-function intelligent scalable - safeguard intelligent fire extinguisher extinguishing equipment, mainly used in fire protection engineering, its smoke signal can be transmitted to the control system, make the operation platform, extinguishing, reaches the set time, operation platform, and rising, fire fighting to an end. The equipment can also make use of the scalability of the operating platform, the two-way mobility of the equipment and the 360-degree free sprinkler equipment for manual directional fire extinguishing. It has changed the traditional fire product mobility is poor, small fire fighting car multifarious workshop, workshop is hard to drive the goods, and a smoke sensor device, ultrasonic distance sensor, remote sensing device, using relay

contactor to complete the entire process of automatic fire extinguishing control, its low cost, convenient for mass production.

Acknowledgements

First of all, I would like to extend my sincere gratitude to my friend, Yuanjia Qi, for his instructive advice and useful suggestions on my thesis. I am also deeply indebted to all the other tutors and teachers in Translation Studies for their direct and indirect help to me. Finally, I am indebted to my parents for their continuous support and encouragement.

References

- [1] Wen Bangcun. Mechanical design manual [M]. The third edition. Machinery industry press, 2007. 1.
- [2] Liu Hongwen. Mechanics of materials [M]. The fifth edition. Beijing: Advanced education press, 2004. 1.
- [3] Zhao Qing. Engineering mechanics [M]. The second edition. Machinery industry press, 2009. 6.
- [4] Deng Wenyong, SONG lihong. Metal technology [M]. The fifth edition. Beijing: Advanced education press, 2008. 4.
- [5] Sun Heng, Chen Zuomo, Ge Wenjie. Mechanical principles [M]. The eighth edition. Beijing: Advanced education press, 2013. 5.
- [6] Yu Yongsi, Qi Min. Mechanical engineering materials [M]. The ninth edition. Dalian: Dalian university of technology press, 2012. 12.
- [7] Department of theoretical mechanics, Harbin Institute of Technology. Theoretical mechanics [M]. The seventh edition. Beijing: Advanced education press, 2009. 7.
- [8] Qin Cenghuang. Electrotechnician [M]. The seventh edition. Advanced education press, 2010. 5.
- [9] He Mingxin, Qian Keqiang, Xu Maozun. Mechanical drawing [M]. The sixth edition. Beijing: Advanced education press, 2010. 7.
- [10] Chen Shuaihua, Tang Yong. Design of controllable automatic fire extinguishing robot [J]. Robotics, Vol. 5 (2015), p.54- 56.