



Research On “Smart Automatic CO₂ Fire Extinguisher Operating Mechanism”

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ABSTRACT

In introductory discuss the complexities of relationship between human and fire and the status of human efforts to control the disastrous effects of fire. A fire subsequent section examines characteristics and behaviour of fire, with a special note on operating of CO₂ fire extinguisher in building and industry. The text covers these topics regarding fire hazards, hazards of cold burning due to inappropriate practice of handling CO₂ Extinguisher. Industrial and process fire hazards special fire protection and prevention.

Fire hazards of various types of occupied structure including residential buildings, industrial and educational buildings. The role and responsibilities of fire protection devices and systems including fire alarms, detection devices, extinguishment agents, special system, and CO₂ fire extinguisher.

Key Words - CO₂ Fire extinguisher, hazards, detection devices, extinguishment agents, special system.

INTRODUCTION -

TYPE OF FIRE -

Class A: solid materials such as wood or paper, fabric, and some plastics

Class B: liquids or gas such as alcohol, ether, gasoline, or grease

Class C: electrical failure from appliances, electronic equipment, and wiring

Class D: metallic substances such as sodium, titanium, zirconium, or magnesium Class K: grease or oil fires specifically from cooking

INTRODUCTION OF FIRE EXTINGUISHER

A fire extinguisher is an active fire protection device for controlling or extinguishing small accidental fires. During emergency situations, a fire extinguisher can control a small fire. However, these devices should not be used for out-of-control fire events that endanger the user. Usually, a fire extinguisher consists of a cylindrical pressure vessel containing an agent that has the capability to extinguish a fire when discharged. A person can easily operate this device. Non-cylindrical Fire extinguishers are also available but are less common.

FIRE EXTINGUISHER PARTS

Usually, most fire extinguishers consist of similar parts and components even though the extinguishing agent may differ. Common fire extinguisher parts are:

- i. A cylindrical tank containing propellant and an extinguishing agent.
- ii. A release system comprised of a squeeze handle, a valve assembly, and a release lever.
- iii. A safety mechanism comprised of a tamper seal and a pull pin.
- iv. A hose for directing the extinguishing agent.¹

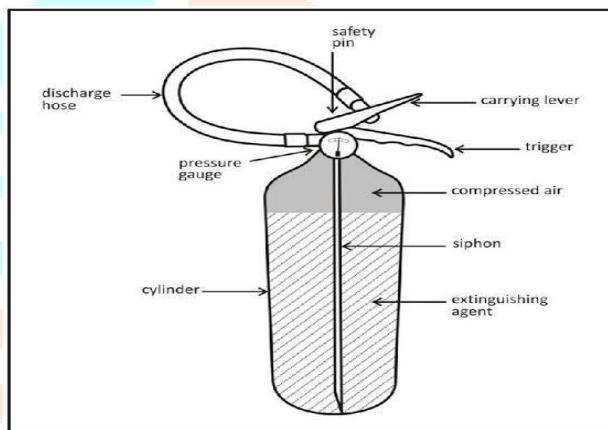


Fig - 1 : fire extinguisher Classes

of Fire Extinguisher

Class A fire extinguisher: These fire extinguishers are used to put out class A fires characterized by fire from ordinary solid or dust combustibles like wood, paper, textile, plastic, fabric, cardboard, etc.

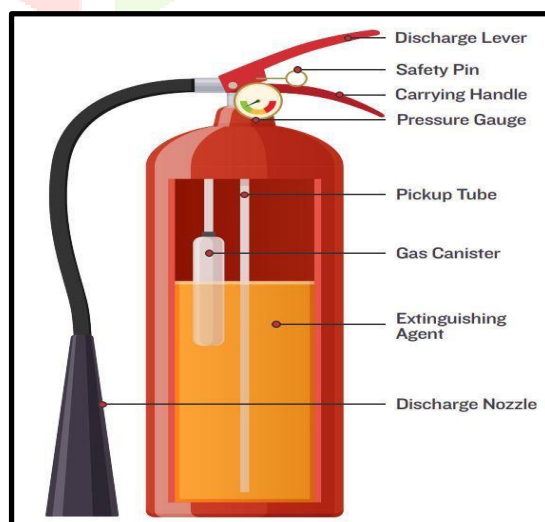


Fig - 2: class A fire extinguisher

Class B fire extinguishers: Class B fire extinguishers are used to prevent Class B fire hazards from flammable liquids like grease, gasoline, oil (except cooking oil), paint, etc

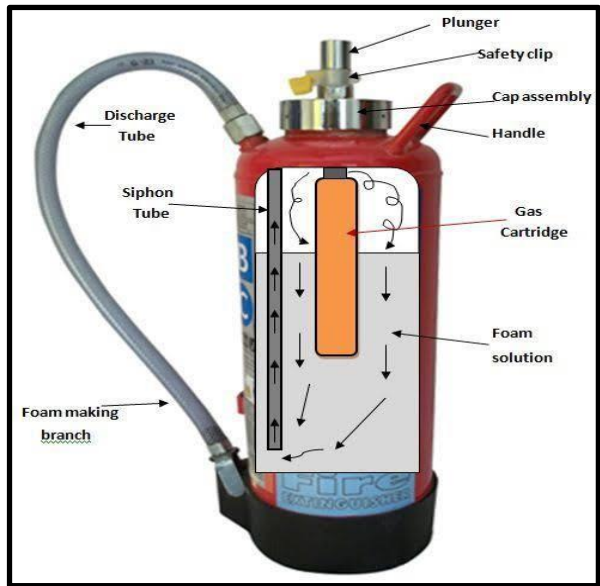


Fig - 3 class B fire extinguishers

Class C fire extinguisher: Class C fires originated from flammable gases like methane, butane, propane, hydrogen, etc. are best handled using class C fire extinguishers.

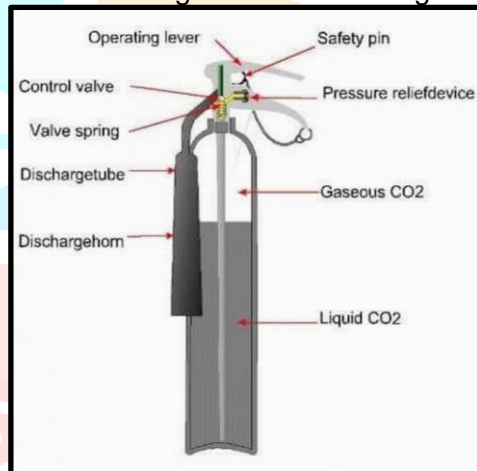


Fig-4 class C fire extinguishers

Class D fire extinguisher: Class D fire extinguishers are widely used to put out fires generated from combustible metals, such as magnesium, sodium, potassium, lithium, titanium, or aluminum

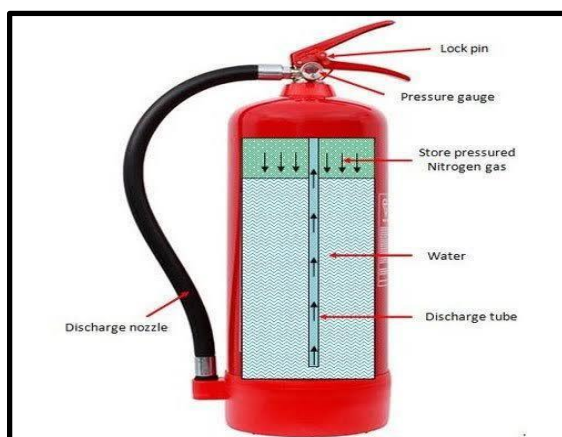


Fig - 5 Class D fire extinguisher

Class E fire extinguisher: These fire extinguishers are used to extinguish fires that originated from live electrical sources. However, in many countries, this is not recognized as a separate fire class because once the electric power supply is switched off it can be considered as any of the other five classes.

Class F fire extinguisher: Class F fire extinguishers find their use to extinguish class F fires characterized by fires from cooking oils, vegetable oils, fats, butter, etc.²



Fig - 6 Class F fire extinguisher

CO2 FIRE EXTINGUISHER -

CO₂ fire extinguishers contain carbon dioxide gas (CO₂) under very high pressure (about 55 bar at room temperature) and can be easily recognized by their flute-shaped discharge horn. CO₂ extinguishers are Colour coded with a black field on the otherwise red extinguisher. CO₂ fire extinguishers suppress fires by replacing oxygen, without which there can be no fire, with the inert CO₂ gas. Although the CO₂ is very cold when it comes out of the extinguisher, this does not make it a suitable choice for tackling Class A fires, such as solid combustibles like paper, wood, and fabrics. Class A fires require water-based extinguishers that penetrate/saturate the burning material to prevent re-ignition. A still smouldering Class A fire could simply re-ignite once the CO₂ gas has dispersed. So, we designed **“Smart Automatic Operating Mechanism of Co₂ Fire Extinguisher”** while working on ground level of this project we faced lot of issues related for finding spare parts of precise measurement and suitable for designing concept. We have searched online and offline for spare parts such as motor, adapter, electrical components. For expert guidance from the field, we have visited so many industries or firms like Jyoti Fire Engineers, Natrang Gases, and Much more for detailed knowledge and doubt solving.^{3, 4}

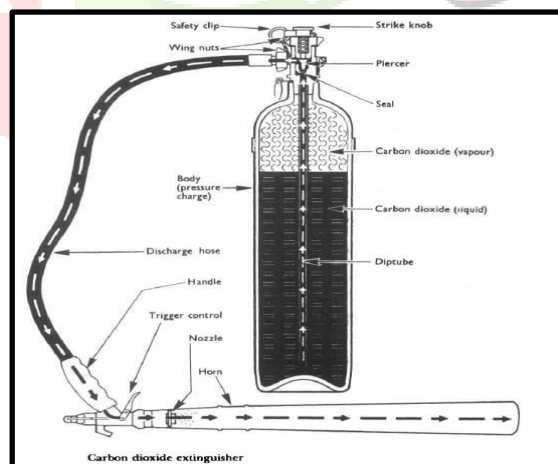


Fig - 7 CO₂ Fire extinguisher

"WE HAVE STARTED THE WORK ON PROJECT ARE AS FOLLOWS"

1. We have searched a lot of information About sensor operated firefighting systems available in the market with the help of internet and field experts.
2. Discussed our concept of project with project guide the topics that we have searched
3. Finalize the topic "Smart Automatic Operating Mechanism of CO₂ Fire Extinguisher"
4. We had a discussion on the final topic with our project guide.
5. Collected Different case studies on electrical fire.
6. Sort listed some informative papers which are related to our project.
7. Worked on design parameters which are related to our project.
8. From the above information we proposed our project.
9. Started working on actual design of CO₂ Fire extinguisher stand and Fire Alarm Control Panel.
10. As per the design it was a totally new Concept, so the Fabrication workers are not interested in doing such non-conventional design work.
11. So, we reached near about 20 Fabrication Shops for the project work
12. On 4th May 2022 we meet with Hindustan Tungsten Carbide Sinnar Nashik, with the help of their workshop we created the CO₂ Fire Extinguisher holding Stand
13. As per the guidance from our project guide we contact to knowledgeable person in ENTC Field who gave us directions for electrical equipments.
14. We bought some Electric Components from DNA Solution and from an online market. 15. We arranged and connected all the electronic Components as per the guidance of ENTC expert and study related to Project ^{5,6}

• DEVICES AND CIRCUITS

1) ARDUINO -

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analogue inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter. Revision 2 of the Uno board has a resistor pulling the 8U2 HWB line to ground, making it easier to put into DFU mode.

Revision 3 of the board has the following new features:

- 1.0 pinout: added SDA and SCL pins that are near to the AREF pin and two other new pins placed near to the RESET pin, the IOREF that allow the shields to adapt to the voltage provided from the board. In future, shields will be compatible both with the board that uses the AVR, which operates with 5V and with the Arduino Due that operates with 3.3V. The second one is a not connected pin that is reserved for future purposes.
- Stronger RESET circuit.
- At mega 16U2 replace the 8U2. "Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for

the Arduino platform; for a comparison with previous versions, see the index of Arduino boards. Summary Microcontroller ATmega328 Operating Voltage 5V Input Voltage (recommended) 7-12V Input Voltage (limits) 6-20V Digital I/O Pins 14 (of which 6 provide PWM output) Analog Input Pins 6

DC Current per I/O Pin 40 mA DC Current for 3.3V Pin 50 mA Flash Memory 32 KB (ATmega328) of which 0.5 KB used by bootloader SRAM 2 KB (ATmega328) EEPROM 1 KB (ATmega328) Clock Speed 16 MHz Schematic & Reference Design

EAGLE files: arduino-uno-Rev3-reference-design.zip. ⁷



Fig - 8 Arduino Uno R3 Front.

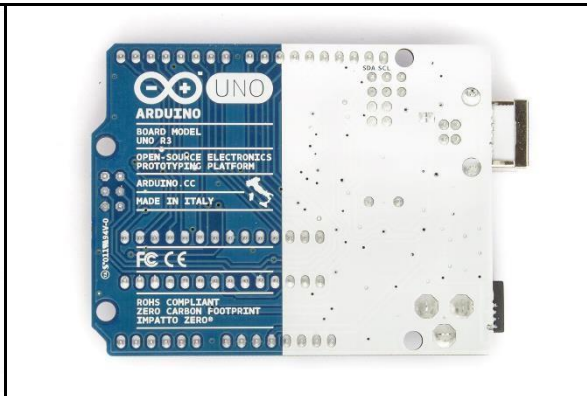


Fig - 9 Arduino Uno R3 Back **The power pins**

are as follows:

- VIN. The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- 5V. This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 12V), the USB connector (5V), or the VIN pin of the board (7-12V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator and can damage your board. We don't advise it.
- 3V3. A 3.3-volt supply generated by the on-board regulator. Maximum current draw is 50 mA.

1) LED DISPLAY

1. 16-character x 2 lines
2. Controller LSI HD44780 is built-in
3. +5V single power supply
4. Display colour: LM016L: Gray, LM016XMBL: New Gray

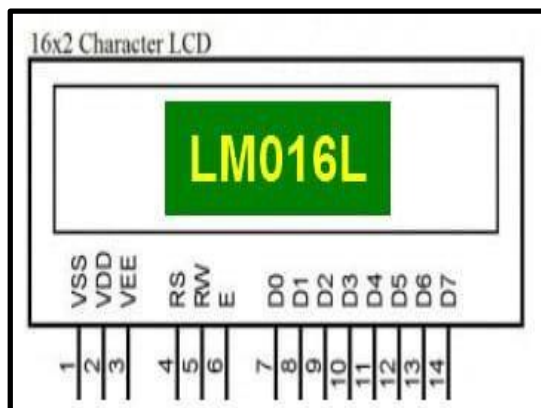


Fig – 9 LM016L datasheet pin diagram

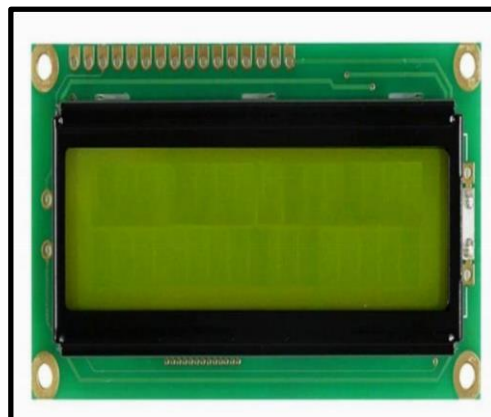


Fig - 10 LED Display

MECHANICAL DATA

1. Module size: 84W x 44H x 10.5T (max.) mm
2. Effective display area: 61W x 15.8H mm
3. Character size (5 x 7 dots): 2.96W X 4.86H mm
4. Character pitch: 3.55 mm
5. Dot size: 0.56W x 0.66H mm
6. Weight: about 35g

2) BUZZER



Fig.-11 (Buzzer)

Buzzer

Transducer - converts electrical energy into mechanical energy

Two categories: Active and Passive (you have one of each type in your kit)

Active Buzzer is the slightly taller one, with a solid, plastic coat on the bottom and a label that says to remove it after washing.

Only requires an external DC voltage to make it sound (batteries or USB from Arduino)

An active buzzer has a built-in oscillating source, so it will make sounds when electrified.

Can turn it on or off to make various sounds

You can use a 100 Ω resistor with it but its optional.^{8,9}

3) FLAME SENSOR

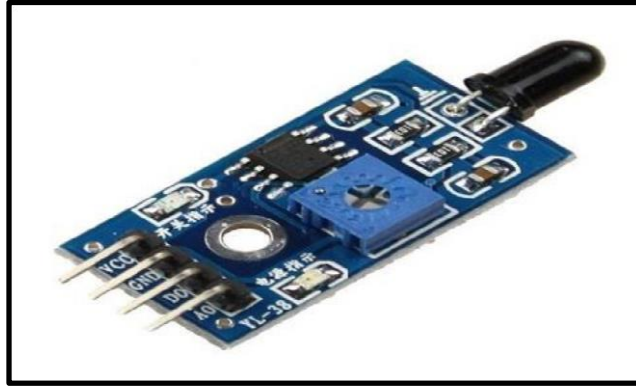


Fig.12 (Flame Sensor)

Working And Applications of Flame Sensor:

A sensor which is most sensitive to a normal light is known as a flame sensor. That's why this sensor module is used in flame alarms. This sensor detects flame otherwise wavelength within the range of 760 nm – 1100 nm from the light source. This sensor can be easily damaged to high temperature. So, this sensor can be placed at a certain distance from the flame. The flame detection can be done from a 100cm distance, and the detection angle will be 60°. The output of this sensor is an analogue signal or digital signal. These sensors are used in firefighting robots like as a flame alarm.

features of this sensor include the following.

- Photosensitivity is high
- Response time is fast
- Simple to use
- Sensitivity is adjustable

Applications

These sensors are used in several dangerous situations which include the following.

- Hydrogen stations
- Industrial heating
- Fire detection
- Fire alarm

4) GAS SENSOR -

It is a device which detects the concentration level of the gases present in the atmosphere. This project contains interfacing of MQ2 sensor with Arduino and its code. Nowadays, sensors play a major role in safety systems. To detect smoke and fire, smoke sensors are used. They provide appropriate action on time for safety purposes. There are numerous types of sensors available to measure environmental characteristics like light, noise, smoke, etc.¹⁰

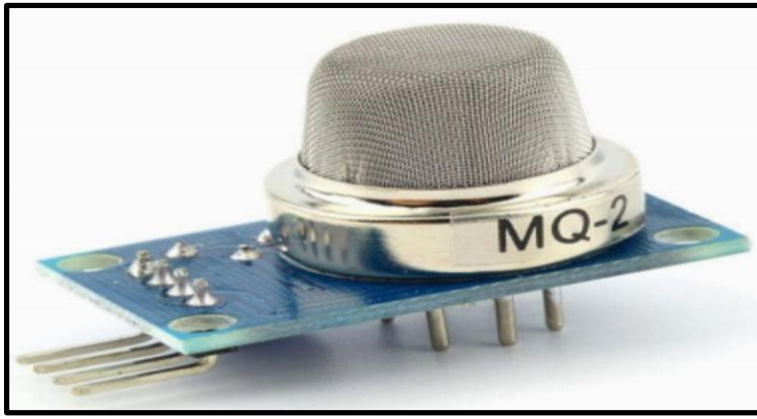


Fig - 13 Gas Sensor

Gas Sensor Work

The sensor has a sensing element to sense the smoke or any gaseous material. In this sensor, the sensing material is a stainless-steel mesh. This mesh contains aluminium-oxidebased ceramic, coated with tin

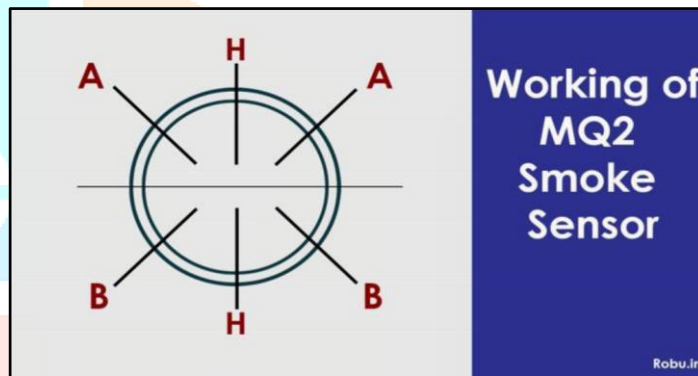


Fig.14 (Working of MQ2 Smoke Sensor)

.Tin oxide has donor electrons present in it, which are attracted towards oxygen. So by identifying the donor electrons, we can detect the amount of oxygen that gets absorbed as well as we can oppose the flow of current to give the signal.

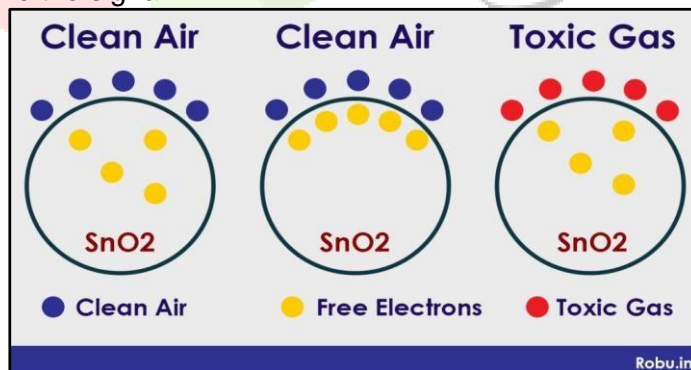


Fig-15

MQ2 Gas Sensor

The MQ2 module of the gas sensor is useful for gas leakage detection in the home as well as in the industries. It observes the level of gases present in the atmosphere. The gas sensor operates on 5V and 800mW.

Construction of the Smoke Sensor

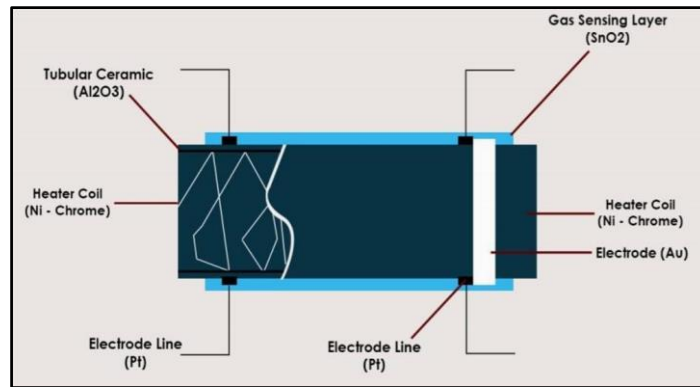


Fig.16 (Construction of Smoke Sensor)

Generally, all types of gas sensors including MQ2 gas sensors are constructed by metal oxide semiconductors. These gas sensors have one sensing element which consists of the following elements.

- Tubular ceramic
- Electrodes
- Heater Coil
- Gas sensing layer
- Electrode

Pinout of the Gas Sensor



Fig. 17

- VCC provides power to the sensor comparator board and needs to be connected to the 5V of the Arduino
- GND is the ground pin and needs to be connected to the GND pin of the Arduino.
- D0 is the digital output pin, which shows the digital representation of the detected gas.
- A0 is the analogue output pin from which we can detect the gas type by analysing analogue values.

Adjustment of the Sensitivity of Gas Sensor

To adjust the sensitivity of this sensor for the gas, you need to keep this sensor in the gas type you want to detect. Now we must rotate the potentiometer on the sensor. Rotate it till the Red LED on the sensor gets ON. If we must increase the sensitivity, rotate it clockwise, and if we must decrease the sensitivity, we have to rotate it anticlockwise.¹¹

Components Required

- Arduino Uno.
- Connecting cable.
- Breadboard.
- MQ2 Gas sensor.
- Dupont cables

Interfacing of MQ2 Sensor with Arduino

- 1) the VCC pin of the sensor to the 5V of the Arduino.
- 2) Connect the GND of the sensor to the GND of the Arduino.
- 3) Connect the digital pin of the sensor D0 to the digital pin number 8 of the Arduino
- 4) Connect the analogue pin of the sensor to the analogue pin A0 of the Arduino.

MANUFACTURING OF CO₂ FIRE EXTINGUISHER STAND

The material uses to make the stand is CI (cast iron). the square rod and strips are purchased form shop and fabricated as per design at HTC workshop. It took 2 whole days to get done per the design . there were some problems but we resolve them by making some changes in our design without compromising with the strength and working efficiency.



Fig. 18

Fig. 19

For holding the valve, we have designed the assembly of two circular plates of mild steel having four nut and bolts of 3 mm.



Fig - 22.



Fig - 23



Fig - 24

We have purchased 30 rpm gear motor having 50 kg torque from online market.



Fig. 25

By the Assembly of all the components and help by the project guide we done our project Successfully.¹²

13

EXPERIMENTAL RESULTS

We have taken a successful test of our project at premises of Natrang gases by using Scrap Sheets of Paper for Testing of our project we burned a fire from scrap sheets of paper by using lighter. After that our project works Successfully on time and successfully Extinguish the fire

CONCLUSION

It is a smart automatic mechanism of CO₂ fire extinguisher system operates by detection of flames or fumes which will be produced at the time of fire.

CO₂ work by displacing oxygen or taking away the oxygen element of the fire triangle. The CO₂ is also very cold as it comes out from the extinguisher, so it cools the fuel as well.

As we know the CO₂ is also very cold as it comes out from the extinguisher so it can be operated by a trained person only. otherwise, it will cause **cold burning**

To overcome this situation, we have developed an automatic CO₂ extinguisher operating system. This system is tried and tested in normal room temperature

At 30^oc to 40 ^oc. this process is working properly according to our knowledge.

We have taken a successful test of our project at premises of Natrang gases by using Scrap Sheets of Paper For Testing of our project we burned a fire from scrap sheets of paper by using lighter. After that our project works Successfully on time and successfully Extinguish the fire

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