

Password Based Circuit Breaker for Electric Control Panel using Power Contactor

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Abstract – As we know that most industries use a lot of electrical appliances nowadays, because of lots of usage they need to be maintained frequently after a specific period by the maintenance staff. Due to increasing number of line man accidents during fault repairing or while carry maintenance some precautions need to be taken. This proposed system provides a solution which ensures and enhances the lines man safety by using a power contactor in electric control panel whose main function is to turning (ON/OFF) the supply line depending on the feedback from relay module. This proposed system is fully operated and controlled by Arduino UNO R3.

Keywords — Arduino, Circuit breaker, Keypad, Lineman, Safety, Power contactor.

I. INTRODUCTION

Password Based Circuit Breaker is a project that helps in controlling the electrical lines with the help of a password [7]. Nowadays, electrical accidents to the line man are increasing, while repairing or during carrying maintenance of the electrical lines and applications due to the lack of communication between the machine/appliance operator and maintenance staff. This project coped this problem by ensuring the safety of maintenance staff during maintenance work. This system is operated by the maintenance staff by turning (ON/OFF) the electrical supply from the electric panel going to the electrical applications with the help of the Circuit breaker. Basically this system is given input password by 4x4 matrix keypad and depending on the acceptance of password this system can be operated. An Arduino microcontroller is used which is a heart of the complete circuit and is fed with the programme which helps in executing all the process. The complete circuit is divided into two parts viz, IoT and Electrical part for the simplicity of understanding and also reducing the complexity. These both systems are integrated together and mounted on board in electric control panel. If there is any fault in electrical line, electrical appliance or wanted to carry out maintenance then the line man

will switch off the power supply of the line by entering password and comfortably carrying out the maintenance work or some repair and when done the maintenance staff has to go back to panel to again enter the password to put the lines under normal operations. Separate passwords are used both the times for (ON/OFF) the supply from electric panel. The components used in this system of electrical part are of single phase for implementing are testing of the concept but when wanted to implement is actual practice in all industries the components used are of three phase and of high rating.

II. LITERATURE REVIEW

[1] Mallikarjun G. Hudedmani in his paper described The electric lineman safety system is designed to control the control panel door and circuit breaker by using a password for the safety. A secured password is requested & received from control room by the lineman, then the lineman put password on matrix and as Arduino is associated with GSM which also receives password from control room. If input password from lineman is correct the door of Control panel (open/close) & Circuit breaker is (on/off).

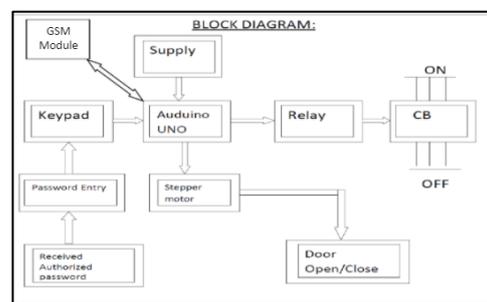


Fig. 1: Block Diagram of Principle of operation.

[2] C. Pearlina Kamalini has designed this project in such a way that maintenance staff has to enter the password to on/off the electrical line. Power is distributed over two sections. Village area and city area run by separate supply voltage. If the demand needed for either village or city area based on the

available power is sharing between two area .The load demand is occurred, the maintainer entering the password to operate the switch the load will share, otherwise switch is opened. The ATmega32 is a low-power CMOS 8-bit microcontroller based on the AVR RISC architecture used.

[3] J.Veena has designed the system is fully controlled by the 8 bit microcontroller of 8051 family. The password is stored in an EEPROM, interfaced to the microcontroller and the password can be changed any time unlike a fixed one burnt permanently on to the microcontroller. A keypad is used to enter the password and a relay to open or close circuit breaker, which is indicated by a lamp. Any wrong attempt to open the breaker (by entering the wrong password) an alert will be actuated, indicated by another lamp

[4] Neha Makode done research to design a system that ensures reliable operation of the Circuit breaker which can monitor different physical conditions like over voltage, unbalance voltage, phase failure voltages, voltage and time delay setting, switch on time for relay and the result displayed on the LCD

[5] Rakesh Narvey, In this paper, the system is fully controlled by Arduino. A matrix keypad is interfaced to the arduino to enter the password. The entered password is compared with the password stored in the ROM of the arduino. If the password entered is correct, then only the line can be turned on/off. Activation / deactivation of the circuit breaker are indicated by a lamp. This system is a simple designed and low budget system.

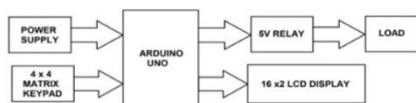


Fig. 2: Block Diagram of Principle of operation

III. CIRCUIT DESCRIPTION

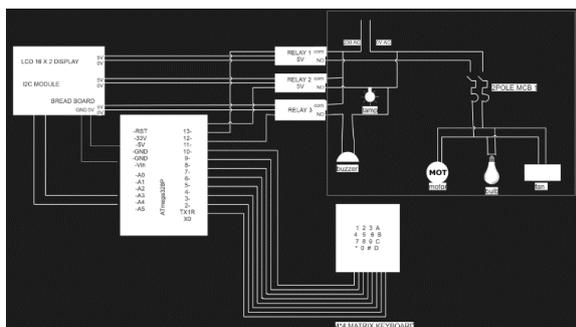


Fig. 3: Circuit Diagram of System

The above circuit diagram is drawn on Softdraw software.

lot circuit consists of Arduino Uno, 4x4 keypad matrix, 16x2 LCD, I2c module, Breadboard and a 4 channel relay, Jumping wires.

The electrical circuit consists of a miniature circuit breaker (MCB), Power Contactor, Terminals, Indication lamp, Channel, Din rail, Single phase motor, Fan, Led bulb and wires.

IV. HOW TO DESIGN PASSWORD BASED CIRCUIT BREAKER CIRCUIT FOR ELECTRIC CONTROL PANEL USING POWER CONTACTOR

- A 4x4 matrix keypad has 8 pins that are connected to Arduino digital pins from 2 to 9 and is used to give the password to the system.

- Arduino's GND and 5V pin is connected to the +ve and -ve terminal of a breadboard. 16 X 2 LCD is having 16 pins that are interfaced to the I2c module which is used to display the text.

- The I2c module has 4 pins as GND, VCC, SDA AND SCL respectively, the GND and VCC are connected to the breadboard while SDA and SCL are given to Analog A4 and A5 of the microcontroller.

- The 4 channel relay module has 5 pins GND, VCC other left are for the input from Arduino out of which 1st next to

GND is connected to digital port 10 of Arduino and similarly 2nd to port 11, this helps in operating RELAY 1 and 2.

- Each RELAY in 4 Channel Relay Board has 3 ports i.e NC (normally closed), Common, NO (normally open), give an external supply of 230V (Phase wire) to Common Port of RELAY 1 and 2.

- Connect NO (normally open) port of RELAY1 to MCB1 port 1 and of RELAY2 to the indication lamp with Phase wire.

- Connect external supply neutral wire(0V) to MCB1 port 2 also to indication lamp's neutral wire.

- Connect MCB1 Phase(230V) and Neutral(0V) to Contactor port A1 and A2 respectively.

- Give External AC supply to MCB2 and it's Output supply to Contactor Port L1 and L2.

- Connect output of Contactor port L1 and L2 to terminal by grouping 230V and 0V separately. Connect 230V and 0V from terminals to all the required applications.

V. ALGORITHM

1. Initially declare the PORT12 and PORT 13 to RELAY 1 and RELAY 2 respectively.
2. Initially display “enter password” on LCD[2].
3. Now read the five-digit password given by the use[2].
4. Compare the entered password with the stored password in the system[2].
5. If the input password matches, correct then ON or OFF RELAY 1, a contactor is NO (normally open) or NC (normally closed) and displays the current status of line on LCD.
6. RELAY 2 responds according to RELAY 1 (if RELAY 1 ON RELAY 2 IS OFF and vice-versa).
7. If the password is wrong, then display “wrong password” on the LCD.
8. After work done, ask the user to enter the password.
9. Option for reset password is provided in system by pressing “D” key on matrix keypad.

VI. HOW TO OPERATE THE PASSWORD BASED CIRCUIT BREAKER FOR ELECTRIC CONTROL PANEL USING POWER CONTACTOR PROJECT

1. Write the program to the Password based Circuit Breaker for electric control panel in IDE (Integrated Development Environment) software for Arduino and create. AR file.
2. Burn program to the controller with help of Arduino Programming Board and IDE Software.
3. Now give the connections as per the circuit diagram[7].
4. While giving the connections, make sure that there is no common connection between AC and DC supplies[7].
5. Use a 5V power supply circuit to provide a regulated 5V DC supply to the Arduino UNO R3 Pmicrocontroller[7].
6. Switch on both AC and DC supplies.
7. Now relay output pins get 230V. So, do not touch the load connected pins[7].
8. LCD displays “Enter Password”.
9. Enter the password with the help of a 4 X 4 matrix keypad.
10. Now, if the password is correct, then RELAY 1 (i.e. if it is already ON, now it becomes OFF and, if it is already OFF, now it becomes ON) that operates Contactor (ON/OFF) through MCB1 and displays line (or load) status on LCD (“Under Maintenance” or “Supply ON”).
11. If the password is wrong, then the "wrong password" is displayed on the LCD.

12. After work done, the microcontroller asks to enter a password by displaying “enter password”.
13. If a staff member forgets the password of the system, it can be easily set up again.

VII. COMPONENTS

A. IOT COMPONENT

1. 16X2 LCD display

It is an electronic display module used in various applications. this LCD has 16 columns and 2 rows that's why the LCD is called 16×2 LCD. So, it contains a total of 32 characters.

In the market different types of LCD available like 8×1, 8×2, 10×2, 16×1 LCD, etc. but 16×2 LCD is most widely used.



Fig. 4: 16 X 2 LCD Display unit.

Function :

- It displaying data to operate the system effectively and displays an error message if there is any.

Specification :

Parameter	Value
PCB Dimensions	80mm x 35mm x 11mm
Screen Dimensions	64.5mm x 16mm
Characters Lines	16 x 2
Dots with Cursor	5 x 7
Power Supply	+5v (Also Available for +3V)

Table no-1: Specifications of LCD

2. LCD I2C Serial interface module

I2C is an “Inter-integrated circuit”. This module has an inbuilt PCF8574 I2C chip. This chip converts the I2C data into the data required by the LCD. It is an easy-to-use display module, It can make the display easier.it having less cost.



Fig. 5:LCD I2C Serial interface module

Function :

- It works as a control interface to signal processing devices that have separate data interfaces and it connects ICs to other electronic systems.

Specification :

Parameter	Value
Screen Type	Dual colour LCD
Screen Resolution	128*64 Pixels
Screen Active Area (L*W)	47.1*26.5mm
Individual Pixel Size	0.33*0.33mm
Operating Frequency	16 MHz
Weight	20g

Table no-2: Specifications of I2C.

3. Bread Board

A breadboard is a solder less device used with electronics components to built the circuit. It having bunch of tiny holes. Most electronic components in electronic circuits can be interconnected by inserting their leads or terminals into the holes and then making connections through wires where appropriate[8]. The holes which are connected through green line represents they are connected internally. The Red line indicates Power, which is normally connected to the power rail. The Blue line indicates Ground, which is normally connected to the ground of the circuit. IC's like Decade Counter can be placed in the middle breadboard to share the 1st eight pins to the yellow line and the 2nd eight pins to the green lines.

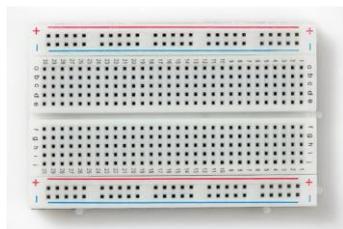


Fig. 6: Bread Board

Function :

- To make quick electrical connections between components- like resistors, LED, capacitors, etc. .

Specification :

Parameter	Value
Dimension	6.5*4.4*0.3 inch
Hole/Pitch Style	Square wire holes (2.54mm)
Rating	300/3 to 5Amps

Withstanding Voltag	1,000V AC / 1 minute
Insertion Wire Size	21 to 26 AWG wire

Table no-3: Specifications of Bread Board.

4. Arduino Uno

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P micro controller[9]. The board is having with sets of digital and analog input/output (I/O) pins that interfaced to various boards and other circuits. The board has 14 digital I/O pins, 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. Arduino consists of both a physical programmable circuit board and a piece of software, or IDE that runs on your computer, used to write and upload computer code to the physical board.

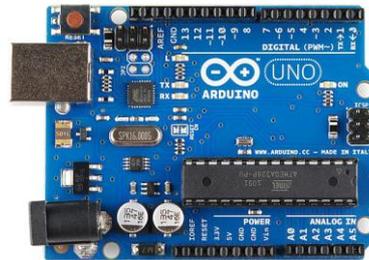


Fig. 7: Arduino UNO

Function :

- It conceives and organizes the program.
- It reduces the chances of errors.
- It makes the program compact and small.

Specification :

Parameter	Value
Microcontroller:	Microchip ATmega328P
Operating Voltage	5 Volts
Input Voltage	7 to 20 Volts
Digital I/O Pins	14 (of which 6 can provide PWM output)
Flash Memory	32 KB of which 0.5 KB used by bootloader
SRAM	2 KB
EEPROM	16 MHz

Table no-4: Specifications of Arduino UNO.

5. 4 Channel Relay Module

The 4 Channel Relay Module is a convenient board. It is designed to interface with a micro-controller such as

Arduino, PIC, etc. It also comes with a LED to indicate the status of the relay[10].



Fig. 8: Relay module

Function :

- It control high voltage, a high current load such as motor, solenoid valves, lamps, and AC load.

Specification :

Parameter	Value
Control signal	TTL level
Max. switching voltage	250VAC/30VDC
Max. switching current	10A
Size	76mm x 56mm x 17mm

Table no-5: Specifications of Relay Module.

6. 4X4 matrix keyboard:

The 4*4 matrix keypad usually is used as input in a project. 4x4 keypad will have eight terminals. It has 16 keys[11]. In them four are rows of matrix and four are columns of matrix. These 8 pins are driven out from 16 buttons present in the module.it has an additional ‘*,’ ‘#’ and 4 other auxiliary buttons that can be used for various functions in the application.

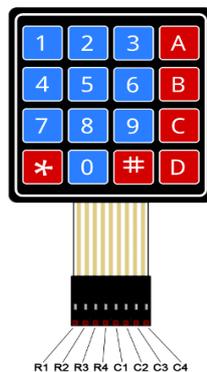


Fig. 9: 4X4 matrix keyboard

Function :

- For controlling systems or embedded systems when there is human interaction is needed.
- It gives input to the embedded systems

Specification :

Parameter	Value
Maximum Voltage	24V
Maximum Current	30 mA
Maximum operating temperature	0°C to + 50°C

Table no-6: Specifications of 4X4 matrix keyboard.

7. Power connector

The Arduino Uno can be powered by using the USB connection or with an external power supply. External power can come either from an AC-to-DC adapter or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack[12]



Fig. 10: Power connector

Function :

- To provide power supply to the Arduino.

Specification :

Parameter	Value
Input	100~240V, 50/60Hz
Output	9V, 1A
Connector size	5.5 x 2.1mm.
Cable Length	100cm

Table no-7: Specifications of Power Connector.

8. Jumping Wire

A jump wire is an electrical wire, or group of wires, with a connector or pins at each end which is normally used to interconnect the components of a breadboard or test circuit, internally or with other equipment or components, without soldering.

Jump wires are fitted by inserting their "end connectors" into the slots provided in a breadboard, and the header connector of a circuit board, or a piece of test equipment[13]



Fig. 11: Jumping Wire

Function :

- connect two components with each other without soldering.

Specification :

Parameter	Value
Length	200mm (7.87")
Wire Colors	brown, red, orange, yellow, green, blue, purple, grey, white, black (each cable includes 4 of each color)
spacing	Standard 0.1" (2.54mm)
Weight	31g (1.1oz)

Table no-8: Specifications of Jumping Wire.

B. ELECTRICAL COMPONENT

1. Miniature Circuit Breaker (MCB)

It is an automatically operated electrical switch used to protect low voltage electrical circuits from damage caused by excess current from an overload or short circuit[14].MCB’s are typically rated up to a current up to 125 A, do not have adjustable trip characteristics, and can be thermal or thermal-magnetic in operation.



Fig. 12: Miniature Circuit Breaker (MCB)

Function :

- To protect an appliance against sustained overloading and short-circuit faults.
- It will also give protection against earth faults provided that the earth fault loop impedance is low enough.

Specification :

Parameter	Value
Standard Rated Current(In)	6A to 63A
Poles	SP, SP+N, DP, TP, TP+N, FP

Rated Short Circuit Breaking Capacity(Icn)	10000A(10kA)
Rated Voltage(Ue)	240/415 V AC
Rated Frequency(f)	50Hz
Rated Insulation Voltage(Ui)	660 V~
Ambient Temperature	-5 to 55°C
Contact indication	Red-ON & Green-OFF
Trip fault Indication	Mid Trip feature

Table no-9: Specifications of Miniature Circuit Breaker.

2. Contactor

A contactor is an electrically-controlled switch. It is switching an electrical power circuit. A contactor is typically controlled by a circuit which has a much lower power level than the switched circuit, such as a 24-volt coil electromagnet controlling a 230-volt motor switch. Contactors are designed to be directly connected to high-current load devices.[15]



Fig. 13: Power Contactor

Function :

- Switching an electrical circuit on or off.

Specification :

Parameter	Value
Rated thermal current	50 A
Rated operational current	415V, 50 Hz
. Main contact	3 NO
Coil voltage range	270V AC, 50Hz or better

Table no-10: Specifications of Power Contactor.

3. Terminals

A terminal is the point at which a conductor from a component, device or network comes to an end. Terminal also called as electrical connector. External

Circuits can be connected it may be fitted with a connector .



Fig. 14: Terminals

Function :

- Transfer electrical current from a power or grounding source to a use.

4. Electrical wiring

Electrical wiring used for electrical installation of cabling and associated devices such as switches, distribution boards, sockets, and light fittings etc.It is made up of plastic channels.



Fig. 15: Electrical wiring

Function :

- They protect cables and wiring in commercial, industrial applications.

Specification :

Parameter	Value
Dielectric strength	16kV/mm
Specific Resistance	6.1x10 Ohm.o
Thermal properties	Flammability-UL94V-0
Izod impact strength	UL94V-0

Table no-11: Specifications of Electrical wiring.

5. Bulb

An electric bulb refers to an electric lamp which consists of a translucent or transparent glass housing.It produces light on the application of electricity.Such a bulb is certainly powerful enough to lighten up a dark place.



Fig. 16: Bulb

Function :

- A bulb converts electrical energy to light. When electric current flows through it, the bulb produces light. A switch stops and allows the electricity to flow through the circuit.

Specification :

Parameter	Value
Wattage	10W
Voltage	220-240V
Operating Frequency	50-60Hz
CRI	>80

Table no-12: Specifications of Bulb.

6. Single-phase motor

A single-phase motor is an electrically-powered rotary machine that can turn electric energy into mechanical energy. It works by using a single-phase power supply. They contain two types of wiring: hot and neutral[16]. single-phase induction motors are the simple motors which operate on single -phase A.C. and in which torque is produced due to induction of electricity caused by the alternating magnetic fields.They only have a single alternating voltage. The circuit works with two wires and the current that runs across them is always the same.



Fig. 17: Single-phase motor

Function :

- It convert electric energy into mechanical energy.

Specification :

Parameter	Value
Input voltage	240
Frequency	50
Rated power	60
Rated torque	0.4
Range of speed	1455-1465

Table no-13: Specifications of Single-Phase Motor.

7. Exhaust fan

An exhaust fan is a ventilation device. It draws out polluted air from a room and replaces it with fresh air. Air is considered polluted when it contains high amounts of moisture, carbon dioxide, and unpleasant

odors. Exhaust fans are used to pull excess moisture and unwanted odors out of a particular room or area.



Fig. 18: Exhaust fan

Function :

- To pull air out of the space. The stale, humid, or contaminated air is propelled through the exhaust vent, exiting the home.

Specification

meter	Value
Operating Voltage (VDC)	12
Operating Current (A)	0.138
Power Consumption (Watt)	1.44
Operating Temperature (°C)	-10 to 70

Table no-14: Specifications of Exhaust Fan.

8. Din Rail

A din rail is a metal rail. It is used for mounting electrical components, circuit breakers, and the same industrial control equipment. It is available in three types of section type O, type C, and type G. din rail is a standard component.



Fig. 19: Representation of Supply from Relay to Applications

Function :

- Used for securely mounting electrical components and industrial control components, such as circuit breakers, terminal blocks, etc.

Specification :

Standard DIN Rails are available in 35mm (7.5 and 15mm deep), 32mm and 15mm widths and are supplied in 1 m (3'3") and 2 m (6'6") lengths.

9. Indicator Lamp

Indicator Lamp is a widely used in the ship, machine tools, machine equipment, switch cabinet, power distribution cabinet[17].Indicator lamp, it indicate whether power is on or a equipment device is for showing the operating condition of some system.indicator consisting of a light to indicate whether power is on or a motor is in operation. pilot lamp, pilot light.



Fig. 20: Indicator Lamp

Function :

- It is a device which showing the operating condition of some system.

VIII. PRINCIPLE OF OPERATION.

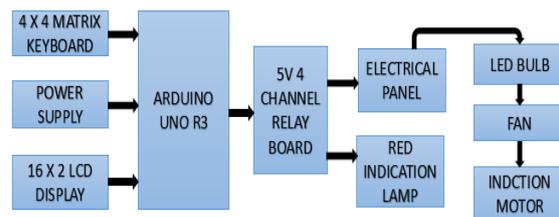


Fig. 21 : Block Diagram of System.

The main components in the circuit is Arduino UNO R3 microcontroller and Power Contactor. In this project, a 4×4 keypad is used to enter the password[7]. The password which is entered is compared with the predefined password[7]. If the entered password is correct, then the corresponding electrical line to RELAY1 is turned ON or OFF. In this project, a separate password is provided to operate in a different situation. Activation and deactivation of the electrical line are indicated by the applications. (LED, fan and induction motor).

IX. WORKING

- Initially, LCD displays “Enter Password” and the user is supposed to enter a predefined password into the system.
- System is given with a specific password by 4x4 matrix keypad which is verified by the microcontroller and on acceptance it operates the
- RELAY1 and RELAY2 operates corresponding to RELAY1.

- Two specific passwords is required by the system one to put the system under maintenance and another for taking the system back into normal operation.

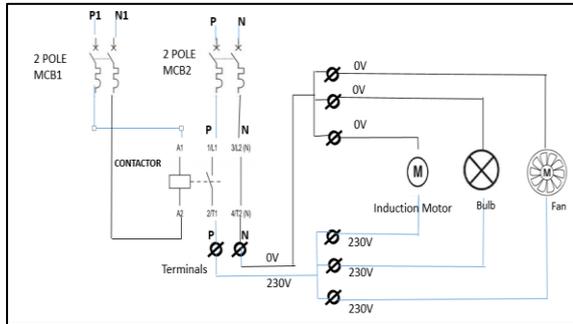


Fig. 22: Representation of Supply from Relay to Applications



Fig. 24: Model Photo When Under Maintenance.

- When the RELAY1 is turned ON it passes the signal further to the MCB1 and triggers the Power Contactor which energizes its coil and closes the circuit and the external supply passes to the terminals through MCB2. All the applications connected to the terminals are turned ON and all the applications are under normal operating condition and LCD displays “Supply ON”. At the same time, RELAY2 IS OFF while keeping the indication lamp OFF.
- Similarly, When the RELAY1 is turned OFF no signal passes to Power Contactor through MCB1 and the coil does not get energized which tend to breaks the circuit and all the applications are turned OFF connected to the terminal as the external supply is cut and the Circuit is broken. The LCD displays “Under Maintenance” and the indication lamp is turned ON.
- The maintenance staff can easily carry out maintenance work without any risk until RELAY1 is operated through a specific password by maintenance staff.



Fig. 23: Model Photo When Supply is ON.

X. COSTING

SR no.	Components	Qty	Cost
1.	Arduino Uno	1	450
2.	4 x 4 Keyboard	1	150
3.	16 x 2 LCD	1	150
4.	I2C module	1	120
5.	Jumping wires	-	100
6.	Bread board	1	80
7.	4 Channel Relay Module	1	220
8.	2 Pole MCB	2	200
9.	Terminal	15	50
10.	Schneider Contactor	1	800
11.	LED Bulb	1	90
12.	Fan	1	250
13.	Red Indication lamp	1	20
14.	Polycab Wire 1.5 sq mm	1	350
15.	Adapter(5V- 1A)	1	150
16.	0.5 HP Induction motor	1	3000
17.	Din Rail	3	60
			Total Cost - 6240

Table no-15: Costing

XI. ADVANTAGES

- Avoids electrical accidents to line man carrying maintenance.
- Project is simple and easy to operate.
- Project uses commonly available components.

XII. LIMITATIONS

- i. If somehow, a power failure occurs during operation, the programme burned in Arduino microcontroller gets reset and runs from the initial stage but, this can be solved by the use of UPS as an alternative power source as input supply to Arduino.

XIII. FUTURE SCOPE

A buzzer can be connected to RELAY 3 so if a user enters a wrong password then it will start buzzing denoting “wrong password entered” on LCD.

XIV. CONCLUSION

To conclude with the project it's that the proposed system is a simple designed and low budget economical system. As we stated earlier the safety and protection of lineman is our first priority. Hence we tried to develop a system that can ensure it with full accuracy. The project completed as per the requirement. Finally the aim of the project i.e. to avoid fatal accidents for a lineman.

It can work on a single given known password. The password to operate can be changed and the system can be operated efficiently with the changed password. No other person can operate the breaker once the changed password is given into the system other than the person who had changed it.

It gives no scope for password stealing. It is effective in providing safety to the working staff. It is economical. It can be easily installed.

APPENDIX A

ACKNOWLEDGEMENT

The success and outcome of this project required a lot of guidance and assistance from many people, and we are extremely privileged to have got this all along the completion of our project. All that we have done is only due to such supervision and assistance and we would like to thank them. We are glad to present this project report and we express our gratitude to all who directly and indirectly helped us to execute this project - “Circuit Breaker System for Electrical Control Panel Based on Password System Using Power Contactor”. Thus, success of our project group clearly is a blend of co-operation, dedication, and commitment of staff members during the project work. We express our deepest gratitude and heartfelt thanks to our project

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