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Automatic Timer Stove Module with Atmega 32p-PU and LPG Valve with OLED

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Abstract: *This article presents the solution for working-class people to save their cooking time as well as save LPG and prevent fire accidents. The main purpose of this work is to save our food from burning and prevent it from overcooking and give the food the perfect time to cook and absorb all the flavors and essence in your dish. Now here is a question: why do we need a timer gas stove when we already have a timer in induction and a microwave? (a) Because in the fiscal year 2020, the number of active liquefied petroleum gas customers across India was over 278 million, and it became the largest consumer of LPG across the globe. (B) For chefs, the smoky effect in any dish adds an extra essence to the dish one of the reasons still chefs prefer traditional cooking methods over new technology.*

Keywords: MOSFET, Arduino, LPG, Gas Stove, Solenoid

I. INTRODUCTION

Technological advancements make it easier to carry out various daily tasks. Technology can be used in a variety of activities, including household cooking. But according to the studies it is noted that the number of house fires caused by gas stoves is still high. To increase safety when using a gas stove, the use of a secured system for the cooking process is deemed necessary. Many studies have been conducted to improve the safety of gas stoves in general. Now there is an effort to make the LPG gas stove more efficient and safer. The design of this system consists of a timer for each gas burner. Here is an effort to make the LPG gas stove more efficient and safer. The design of this system consists of a timer for each gas burner, each gas which is connected to the main gas pipe connected to the main gas supply.

Indian LPG consumption in 2020 was at 27.41 million tons, 4.3% higher than a year earlier, according to government data. LPG cylinders blast is very common in our country caused by the gas leak. LPG (Liquid Petroleum Gas) cylinders are widely utilized in homes and, to a lesser extent, in factories. Despite safety precautions, deadly incidents do occur. The blast effect becomes destructive and lethal as a result of the emission of high-pressure LPG gas. The cooker's carelessness is primarily to blame for these mishaps. Proper technology is employed with the stove to avoid this. The servo motor is coupled to the spur gear and the stove knob, and the controller is powered by a 6V battery. A timer is also used to determine how long the food should be cooked.

Liquefied Petroleum Gas is abbreviated as LPG or LP Gas. Saturated hydrocarbons such as propane (C₃H₈) and butane (C₄H₁₀), which can be stored and transported separately or in combination, are included in this category. They exist as gases at normal room temperature and atmospheric pressure. It is called Liquefied petroleum gas because these gases liquefy under moderate pressure. They liquefy at moderate pressure readily vaporizing upon release of pressure. It is this property that permits transportation of storage of LP Gas in concentrated liquid form. LPG comes from two sources. It is made from the refining of crude oil and is usually in a pressurized state. LPG can also be derived from subsurface sources of natural gas or crude oil.

This method produces 60% of the world's LPG, whereas crude oil refining produces 40% of the LPG. The commercialized product is known as "propane" and "butane" is mostly made up of these saturated hydrocarbons, but during the extraction process, some allowed unsaturated hydrocarbons such as ethylene, propylene, and butylene, among others, are mixed in with the pure propane and butane.¹

A. Indian LPG Market

India is the world's second-largest consumer of LPG (Liquefied Petroleum Gas). LPG use by households has surpassed 19 million tonnes, with an annual growth rate of 10%, equating to 19 million tonnes (19,000,000 1000 kg). Because one normal LPG cylinder holds 14.2 kg of fuel, this equates to about 1338028169 cylinders consumed every year. Daily, the utilization is estimated to be 3665830 kg, which equates to about three cylinders each second.²

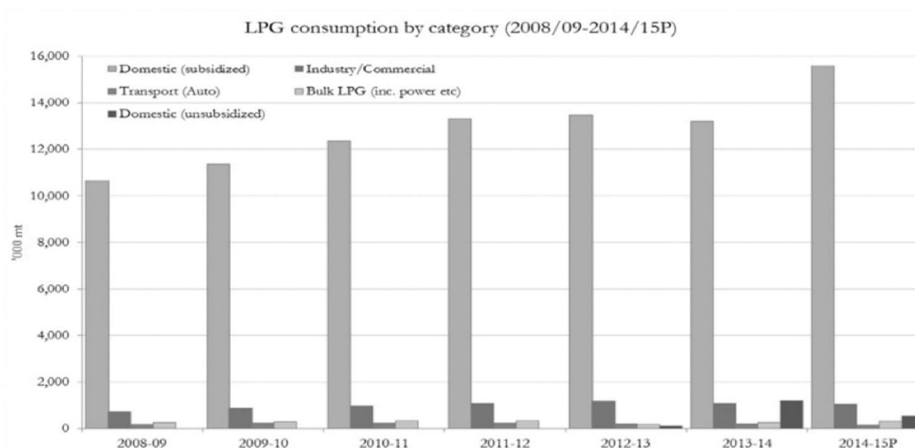


Fig 1.1. Statistics of Indian LPG Market ²

B. Components used in this experiment

- 1) Solenoid
- 2) Arduino Uno
- 3) MOSFET
- 4) Resistor
- 5) Switch

II. SOLENOIDS

Electric solenoids operate on the same electromagnetic principles as DC motors, except that they can use magnetic energy to push or pull something instead of turning it. Paintball arms, pinball machines, printers, valves, and even cars contain solenoids. A solenoid is a coil that generates a balanced magnetic field down through its center when it is energized. The armature will travel in and out of the coil by inserting a magnetic armature inside it. When we combine this with our Arduino, we have a lot of possibilities. The power of the solenoid (the force it may push or pull) is proportional to the coil windings and the current applied. This implies that as the number of coils increases, the magnetic fields and force increase as well. A minor design requirement for this type of coil is that it must be longer than it is large, ensuring that the magnetic field runs through the center and allowing the in/out movement mentioned earlier.

A. Solenoid Valve

A solenoid valve is an electromechanical valve used to regulate the flow of liquids such as water, air, oil, and gas.

There are two sections of them:

- 1) The solenoid is a system that regulates the flow of electricity through the solenoid (essentially consisting of a coil, core, core tube, shading coil, and spring)
- 2) A valve is a device that allows you to open and close (the body containing orifices in which the disc, diaphragm, or piston is positioned).

When energized, the solenoid is a coil that receives a current. A magnetic field is created by the current, which causes the core to travel up and down. The solenoid valve body is effectively opened or closed by this action. Fluid will pass through the valve if it is opened. Fluid would be obstructed if the valve is shut. ³

- a) The coil is made up of a spool wound with insulated copper wire and is the electrical component of the solenoid.
- b) When you turn on the coil, it creates a magnetic field.
- c) A magnetic force moves the core, which is a soft magnetic plug nut.
- d) The heart is kept in place by a spring.
- e) The sealing material on the disc holder that closes the seat orifice is referred to as a disc or a valve disc.
- f) The heart actuates the disc holder, which is part of the valve.
- g) The center opens and closes the pilot orifice, which is located in the diaphragm's middle.
- h) This is a specially formed border of the valve seat known as seating or valve seat. ⁴

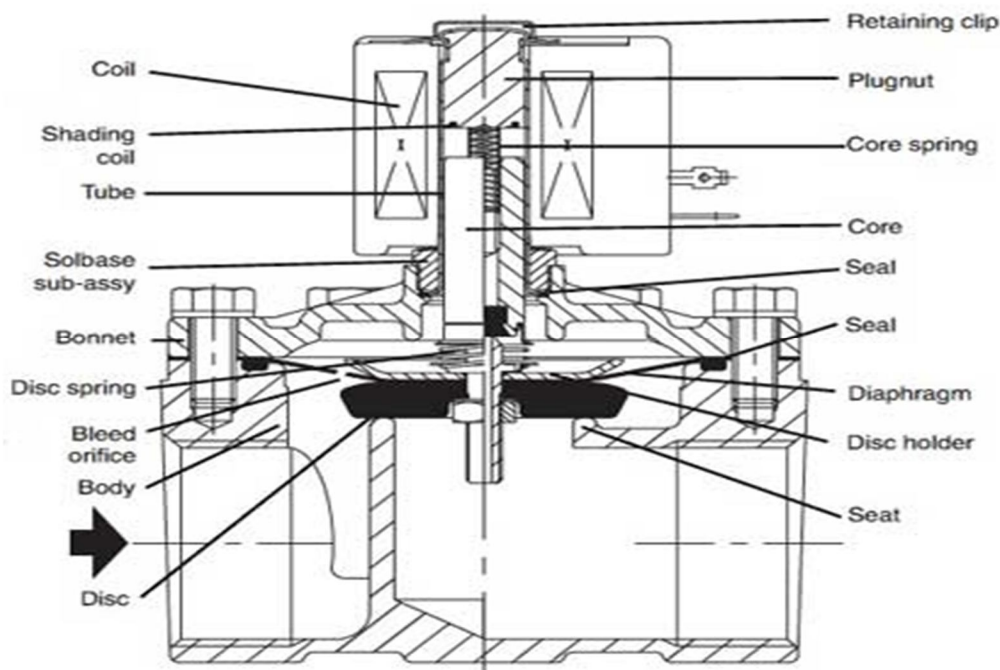


Fig. 3.1. Working of Solenoid ⁴

Valve design variants are many. Ordinary valves can have a large number of ports and pathways. For example, the 2-way valve has 2 ports; the valve is open, connecting both ports, and fluid can flow between the ports; if the valve is closed, the ports will be separated. While the valve is open, the valve is typically called open when the solenoid is not powered (N.O.). Similar to that when the valve is shut down without the power of the solenoid, the valve is typically called shutdown. The following:

There are also three-way designs and these are more complex.

There are 3 ports on a three-way valve that link one port to the next two ports (typically a supply port and an exhaust port).

Valve design variants are many. Ordinary valves can have a large number of ports and pathways. For example, the 2-way valve has 2 ports; the valve is open, connecting both ports, and fluid can flow between the ports; if the valve is closed, the ports will be separated. The valve is typically called open when the solenoid is not energized. Similar to that when the valve is shut down without the power of the solenoid, the valve is typically called shutdown. There are also three-way designs and these are more complex. There are 3 ports on a three-way valve that link one port to the next two ports (typically a supply port and an exhaust port).

III. ARDUINO

The Arduino / Genuino Uno microcontroller board is based on the ATmega328P microcontroller (datasheet). There are 14 digital input/output pins (six of which can be used as PWM outputs), six analog inputs, a 16 MHz quartz crystal, a USB link, a power jack, an ICSP header, and a reset button on the board. It comes with everything you'll need to get started with the microcontroller; simply plug it into a device with a USB cable or power it with an AC-to-DC adapter or battery. You can tinker with your UNO without fear of making a mistake; if anything goes wrong, you can swap the chip for a few dollars and start over ⁵.

A. What is Arduino?

Arduino is an open-source platform that may be used to create electronic creations. Arduino is made up of a hardware programmable circuit board (also known as a microcontroller) and software, known as an IDE (Integrated Development Environment) that runs on your computer and is used to create and upload computer code to the physical board.

The Arduino platform has grown in popularity among those who are just getting started with electronics, and for good cause. Unlike most prior programmable circuit boards, the Arduino does not require a separate piece of hardware (known as a programmer) to load new code into the board; instead, a USB cable is all that is required. Furthermore, the Arduino IDE makes programming simple by using a simplified form of C++. Finally, Arduino offers a standard form factor that separates the microcontroller's tasks into a more manageable packaging.

IV. MOSFET

The IRF540N is an N-Channel Mosfet. This MOSFET can drive loads of up to 23A and has a peak current of up to 110A. It also has a threshold voltage of 4V, allowing it to be easily driven by low voltages such as 5V. As a result, it is mostly used for logic switching with Arduino and other microcontrollers ⁶.

A. Where to use IRF540N

The IRF540N is a Mosfet with N-Channels. This MOSFET can withstand peak currents of up to 110A and can drive loads up to 23A. It also has a 4V threshold voltage, allowing it to be easily driven by low voltages such as 5V. As a result, it's usually utilized for logic switching with Arduino and other microcontrollers. Because of its outstanding switching capabilities, this Mosfet may also be used to control the speed of motors and light dimmers.

So, if you're searching for a Mosfet to switch applications that use a lot of current with some logic level devices, this Mosfet is a great option.

B. How to use IRF540N

MOSFETs, unlike transistors, are voltage-controlled devices. They can be turned on or off by applying the appropriate Gate threshold voltage (VGS). Because the IRF540N is an N-channel MOSFET, the Drain and Source pins will be left open while the gate pin is not energized. These pins close when a gate voltage is applied. The circuit below shows how this MOSFET behaves when the Gate voltage (5V) is applied and when it is not (0V). Because this is an N-Channel MOSFET, the load (in this case, a motor) should always be connected above the drain pin.

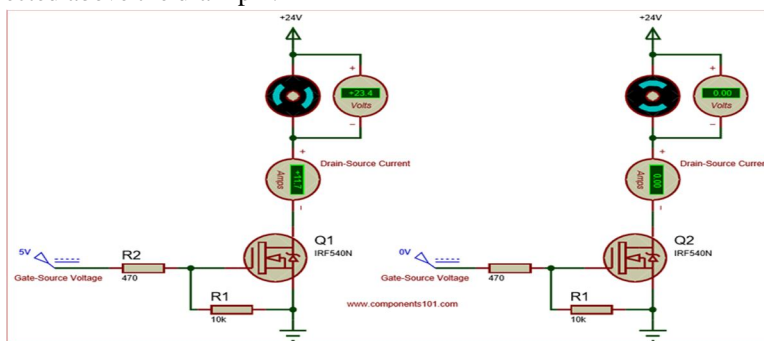


Fig. 5.1. Working of MOSFET ⁶

If you switch on a Mosfet by applying the proper voltage to the gate pin, it will stay on until you apply 0V to the gate pin. Always use a pull-down resistor (R1) to avoid this problem; in this case, I used a value of 10k. We would utilize a PWM signal for fast switching in applications like controlling the speed of a motor or dimming a light; in this scenario, the MOSFET's gate capacitance will create a reverse current owing to the parasitic effect. We should use a current limiting capacitor to deal with this, and I've used a value of 470 here. ⁶

V. LIQUEFIED PETROLEUM GAS (LPG)

LPG is a blend of commercial butane and propane that contains saturated and unsaturated hydrocarbons. LPG sold in India is governed by Indian Standard Code IS-4576 whereas test methods are governed by IS-1448.

A. Density

LPG is a gas that is 1.5 to 2.0 times heavier than air at ambient pressure and temperature. Under mild stresses, it easily liquefies. The density of the liquid is half that of water, varying from 0.525 to 0.580 at 15 degrees Celsius. Since LPG vapor is heavier than air, it tends to settle at ground level or in low-lying areas, accumulating in depressions.

B. Vapour pressure

At atmospheric pressure and temperature, LPG is 1.5 to 2.0 times heavier than air. It quickly liquefies when subjected to mild stresses. At 15 degrees Celsius, the density of the liquid is half that of water, ranging from 0.525 to 0.580. Since LPG vapor is heavier than air, it appears to accumulate in depressions at ground level or in low-lying areas.

C. Flammability

The explosive range of LPG in the air is 1.8 percent to 9.5 percent volume of gas. This is much narrower than other widely used gaseous fuels. This indicates the potential danger of LPG vapor accumulating in low-lying areas in the event of a leak or spill. LPG's auto-ignition temperature is about 410-580 degrees Celsius, so it won't light on its own at room temperature. During the pumping/filling-in process, entrapped air in the vapor can be dangerous in an unpurged vessel/cylinder. As a result, using air pressure to unload LPG cargoes or tankers is not recommended.

D. Combustion

In addition to producing heat, the LPG combustion reaction increases the number of products. For full combustion, LPG needs up to 50 times its volume of air. When LPG is burned in enclosed spaces, adequate ventilation is required; otherwise, asphyxiation due to oxygen depletion, as well as the formation of carbon dioxide, may occur.

E. Odor

Since LPG has such a faint odor, it is important to add an odorant so that any escaping gas can be easily detected. For this reason, ethyl Mercaptan is widely used as a stenching agent. As per IS: 4576, the amount to be added should be sufficient to enable detection in the atmosphere at 1/5 of the lower limit of flammability or odor level 2.

F. Colour

LPG is colorless both in the liquid and vapor phase. During leakage, the vapourization of liquid cools the atmosphere and condenses the water vapor contained in them to form a whitish fog which may make it possible to see an escape of LPG.

G. Toxicity

LPG, although slightly harmful, is not poisonous in the vapor phase; but, since it displaces oxygen, it can cause suffocation in high concentrations. As a result, the vapor has moderate anesthetic properties.

VI. PRODUCT DESIGN

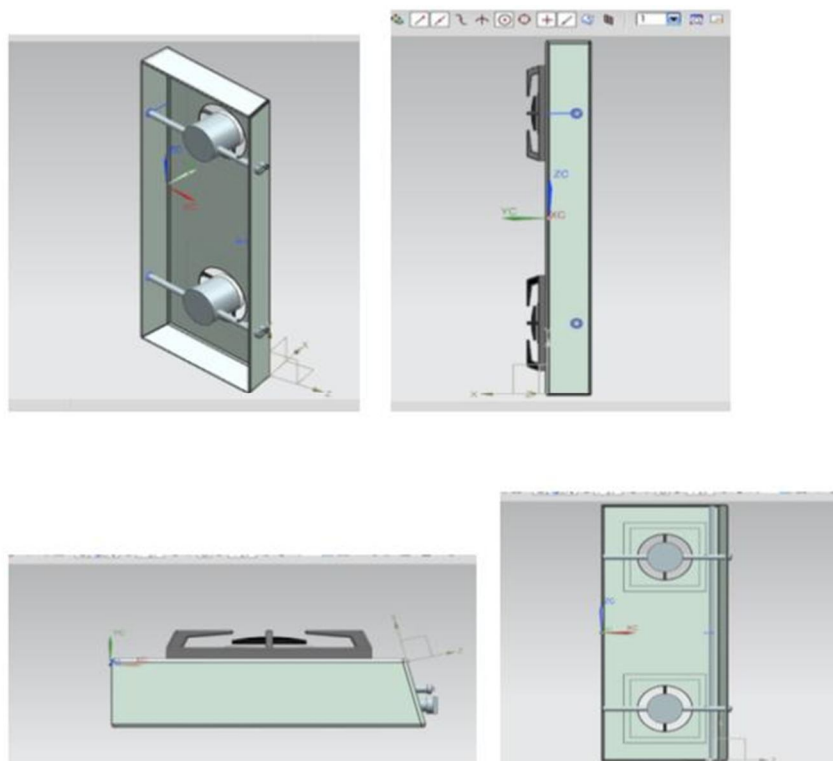


Fig. 7.1. 3D structure of a household gas stove

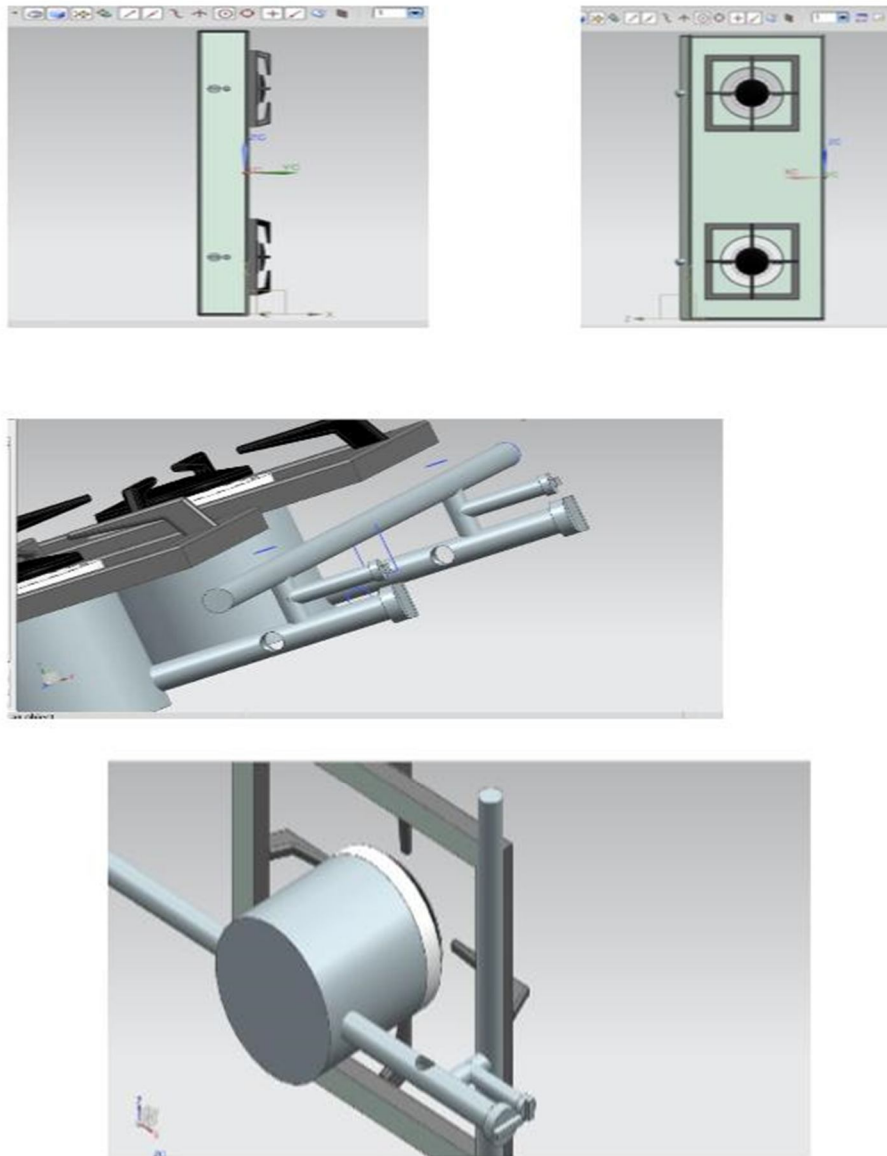


Fig. 7.2. The point where the solenoid is installed in gas stove

VII. WORKING OF THE SYSTEM

A. Input Voltage - 12 Vdc

As stated before microcontroller Arduino is used and it interfaced with the circuit with 4 switches one is the reset button, 2nd is the decrement of the button, 3rd is the set button and 4th is the plus (+) button which is the increment for the timer.

Here, the digital pins in Arduino are defined as follows: -

- 1) Pin 9 - Increment (+) Button
- 2) Pin 8 - Decrement (-) Button
- 3) Pin 7 - Set Button (To Run)
- 4) Pin 6 - Reset (To reset timer)

The MOSFET acts as a switch for driving the solenoid which is an inductive load via a digital circuit. The output pin of the circuit goes as the input to the MOSFET Gate for switching the solenoid on. The source and the drain of the MOSFET are then respectively connected to the solenoid.

The 100k Ohm resistors act as pull-up resistors for the pushbuttons.

VIII. FINAL PRODUCT

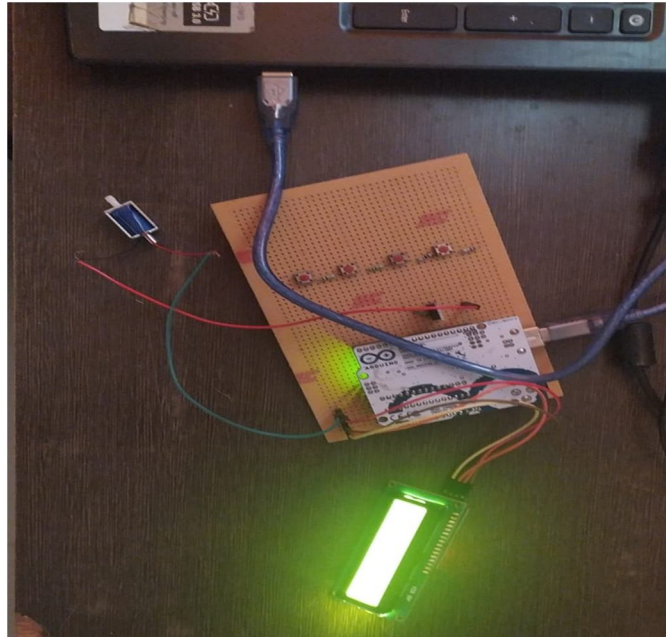


Fig. 11.1. Final Model

The switches, MOSFET, Arduino, led display diode is soldered to board. Here, the time is programable, we were able to achieve the time variation from 1 sec to 60 mins i.e. we can control the gas flow for around one hour.

A. Code

```
Code –
setup(){
  setPin;
  resetPin;
  lowPin;
  highPin;
  count;
}
loop(){
  if(isSetPin){
    setMosfetGateOn(count); // sets the mosfet in open state for count time
  }
  If(isResetPin){
    resetController();
  }
  If(isHighPin){
    incrementCounter(count); // increment the timer value
  }
  If(isLowPin){
```

B. Block Diagram

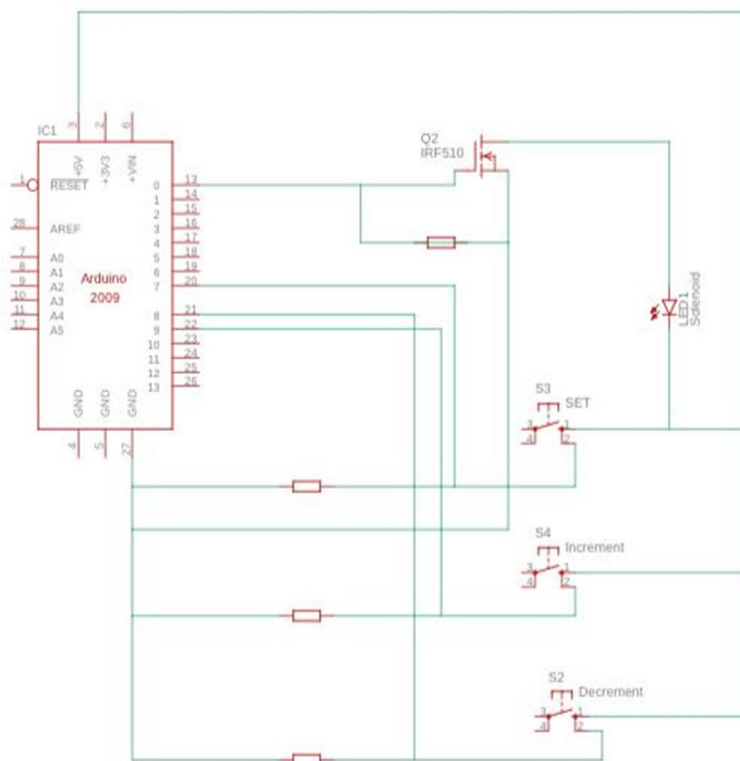


Fig. 11.2. Final Block Diagram

IX. RESULTS

The normally closed solenoid we have used shuts the gas flow off for normal condition and allows the gas to flow when the signal is provided to it for the fixed period. Thus, the system lets the user control the time for which the gas flow stays open from the LCD screen and shuts the gas flow off automatically after the user decided the period.

X. ACKNOWLEDGEMENT

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