Low cost electronics and electrical appliances power spike safeguard

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Abstract
Frequent brownout and blackout can cause power spike hazardous to any electronics and electrical appliances. This aimed to create electronics gadget that can safeguard electronics and electrical appliances specifically a refrigerator, freezer, cooler and the like from rush stream of power or power spike due to brownout and blackout. This model used various active and passive electronic components. These involved three testing with three trials in every testing. Testing the temperature, current and voltage were the most important factors to determine the effectiveness of the device. The input is the information related the fabrication of the voltage time delay device as to technical requirements in terms of designing, materials supplies used, and testing. The process included the procedure in fabricating the voltage time delay device, the preparation of materials, and analysis using the three testing with three trials to determine the function. Result showed a fluctuation of voltage, current, and power but is ideal based on the three percent voltage drop in a line. The mean temperature for the three treatments in all replicate was normal base on the maximum temperature of the magnetic contactor which is 100^0C. Technical requirements in the fabrication are rectifier circuit, relay circuit and time delay circuit.

Keywords: Power Spike Guard, Electronics and Electrical Appliances, Experimental Method, Brownouts and Blackouts

I. Introduction

Power surge protective device is a gadget that can protect an electronics and electrical appliances from damage due primarily from electrical spike after brownout and or blackout. A power spike is basically a surge of energy usually occurs very briefly in household electric current that may cause damage to electrical appliances. This occurs when power supply is high especially after blackout or brownout and that electrical appliances and other electronic device automatically switch on. In areas where frequent blackout occurs and nobody switches off the electrical breaker or electrical appliances, electric power kicks on. This is the source of power spike that usually damage electrical devices, consequently when building wiring is faulty the worst scenario is fire because of the inability to resist spike.

At the instant a power supply is switched on, a surge of current occurs, even with nothing connected to the supply output. This is because the filter capacitors need an initial charge, so it draws a large current for a short time. The surge current is far greater than the normal operating current. An extreme current surge of this sort can destroy the rectifier diodes if they

are not sufficiently rated and /or protected. This phenomenon is worst in high-voltage supplies and voltage-multiplier circuits. Diode failure as a result of current surges can be prevented in at least three ways: Use diodes with current rating of many times the normal operating level; connect several diodes in parallel wherever a diode is called for in the circuit. Current equalizing resistors are necessary. The resistor should have small, identical ohmic values. The diode should be identical; and use automatic switching circuit in the transformer primary. This type of circuit applies a reduced ac voltage to the transformer for a second or two, and then applies the full input voltage.

Energy consumers frequently experience brownout and blackout in Camotes Area. Many are posting in the social media that their electrical/electronic appliances were already threatened due to power surge that damaged electrical appliances usually refrigerators and freezers where the people failed to plug off the appliances during blackout or brownouts especially at night time. This can cause hassle and anxieties to the consumers.

There is available power surge protector in the market for the entire building specifically for natural surge such as generated by lightning that cost more or less US$1,000.00 that depends on the Joules Rating, the higher, the bigger, the more expensive that most of the wage earner and small agricultural/fisheries farmers cannot afford.

An innovation for a gadget that is affordable and yet efficient in terms of performance that can lessened or possibly prevent the aforementioned damage could be one of the solutions to these pressing problems. It is for this reason that the researcher wishes to produce a device that could protect power spike generated by blackout or brownout that is affordable but yet effective.

Related Literature

The study is anchored on the theory of Michael Faraday's discovery in 1821 that led to the invention of electric motors. Michael Faraday discovered that when a magnet is moved inside a coil of copper wire, a tiny electric current flow through the wire (Wilkinson, 2018). Nguyen (2018) posted one of Faradays greatest discoveries, the electromagnetic induction. This is about the generation of electricity in a wire by means of magnetic effect of a current in a wire that forms the basis of the electromagnetic technology that is widely used today.

Article XIV, Sections 10-13 of the 1987 Philippine Constitution emphasizes the importance of science and technology as tools in national development and progress. In agriculture and Fisheries industries, electrical appliances such as refrigerators and freezers are essential. It is used to store animal health products. Monitoring the temperature of refrigerators where animal health products are stored is essential; when temperature fluctuates the effectiveness of the products may become compromised (Fifeet al., 2013).

Electricity is a phenomenon of charged sub-atomic particles at rest or in motion (Technological Solutions, Inc., 2019). This phenomenon is associated with positively and negatively charged particles of matter at rest and in motion, either individually or in great numbers. Electric and magnetic phenomena are inextricably connected with each other; moreover, most, though not all, of the devices employed daily rely on a combination of electric and magnetic effects. Electricity is a necessity in modern day living. From the simplest household to the more elaborate dwellings up to the more complex offices and even

the most sophisticated edifices, electricity is one of the foremost requirements. It is used to power household appliances, office equipment, industrial and agricultural/fisheries machineries and other devices that need electrical power. Electricity becomes an essential part of human life. It provides many valuable things without which life on earth would prove difficult. It enables one to enjoy some comforts. It also facilitates the performance of certain task.

Low voltages, brownouts and blackout were often experience by the consumers that delay the many activities of the people involving electricity especially at night time.This is due to an existing power supply problems as to fuel supply, engine breakdown and maintenance operation. On this regard, there is a possibility that power surge will happen (A. Dalaguit &M.Dalaguit, 2016).

Power systems which is highly vulnerable to surge because of the environmental condition like lightning that leads to transient generated surge uses a design intended for low voltage power surge protection which keep the other devices from damage (Chen et al., 2016; Ahmed, 2018; Napolitano et al., 2014).

Failures of connected transformers were taken into account in voltage and frequency, the isolators, location of surge arresters and protections used near establishments. Transformer shows great impact in the entire system and to the immediate provider **(**Borghetti et al., 2017; Lafaia et al., 2018).

A power supply is required in virtually all mechatronic applications. It must be reliable and safe to use since it is the heart of the equipment. An unconditioned power supply can damage an electronic device (Onwubolo, 2015). The output of a power supply should be free of sudden changes that can damage equipment or components, or interfere with their proper performance (Western Power. 2016). In planning an electrical system, the first consideration is safety, and the next consideration is function. The functioning of a system should permit full and convenient use of both present and future electrical equipment. An effective and efficient home wiring system depends on: Sufficient circuits of adequately large wire to supply the various loads without uneconomical voltage drop, a satisfactory number of outlets to permit convenient use of electrical equipment, and high-quality materials and good workmanship.

The first law of electrostatic charges state that like charges repel each other (Ghosh, 2017). This means that when two electrons together or two protons together represents "like charges" being brought together move away from each other. While the second law: unlike charges attract each other. The negative electrons are drawn towards the positive protons in the nucleus of an atom. This attractive force is balanced by the centrifugal force caused by the electron's rotation resulted to electrons remains in orbit and not drawn into the nucleus.

The power in a Direct Current (DC) circuit is equal to the product of voltage and current (Keim & Elinoff, 2019). For example, voltage of 5 volts with the current of 10 amperes is equal to 50 watts. In other words, the electromotive force is multiplied to the flow of electronswill results watts in power.

Semiconductor devices in electrical and electronic system are very susceptible to transient overvoltage generically known as surges (Nahm, 2014). This is a very dangerous existence cause by lightning, high energy switching and high sparkover, Electrostatic Discharge (ESD), electromagnetic discharge and brownouts.

Benjanin (2018) said that there is a highly efficient lightning protection system that can be employed using underbuilt wires to arrest lightning but underbuilt wires can increase mechanical strains of overhead line towers and decrease of the line clearance to the ground which are not suitable for old lines with weak towers and for the lines crossing roads, rivers, buildings etc. where high clearances to the earth are needed. Guy wires can be applied to improve slightly the efficiency of underbuilt wires, or even line arresters, but not as a standalone protection system, further the efficiency of guy wires significantly depends on its grounding resistance, which varies with climate conditions and seasons.

Power spike can create contact to the pole used as transmission line but with the application of good grounding system, on the other the hand because of the higher grounding value the voltage or current surge becomes lower (Aodsup & Kulworawanichpong, 2017).

Lightning is one factor that can result power surge or spike in any places where electricity is present and one kind of lightning arresters known as metal-oxide surge arrester to safe guard the distribution from damage to produce blackout or brownout. Therefore, determination of the prerequisite of lightning arrester is gratified to be assessed because of its necessity for adopting the proper protective measures for the whole systems (Araújo et al., 2015; Ahmad et al., 2018).

All this kind of destruction will undoubtedly affect the economic aspects or the return on investment that could be earned from PV power generation as well as the cost of repair or replacement to recover from the damage, all of which can be mitigated by implementing a Lightning Protection System (LPS) (Christodoulou. 2015). Internal lightning protection is to avoid the occurrence of dangerous parking within the PV system to be protected, due to lightning current flowing in the external LPS or in other conductive parts (Cooray, 2010). The protection of the current-measuring circuit is achieved by the installation of surge protective components (Barbosa & Nallin, 2015).

Power spike protection design is used to make available for surge protection for microelectronic products with more flexibility talking about applications. Once Down Conductors (DCs) in a building discharge a lightning current, induced power surges were observed to other circuits because of electric and magnetic coupling. It is found out that the connected capacitors can reduce the induced power surge voltages, but may not be effective(Chen & Ker, 2018; Du et al., 2016).

In conserving power, maintaining household wiring and inculcating in their mind the importance of being safety conscious. Many fire incidents had damaged millions of pesos and even lost many lives because of faulty wiring, hence there is a need to have safety precautions in order to prevent this to happen. The problems encountered by the community regarding the electric power supply distribution could be minimized if not totally solved through skills training in order to develop and enhance the skills of the electrical household consumers on energy conservation, safety practices and house wiring maintenance (A. Dalaguit &M. Dalaguit, 2017).

II. Objectives of the Study

The main purpose of this study is to fabricate a power surge protective device for protection of electrical appliances from power surge or spike due to blackout and brownouts at affordable cost, specifically attained the following objectives;

1. Gathered information related to the fabrication of the power surge protective device as to designing, material supplies needed and testing.
2. Determined the performance of the fabricated device.
3. Create a schematic diagram for fabricating power surge protective device.

II. Material and Methods

Development experimental design was used that employs the laboratory observation and procedures to create voltage time delay device for protection of electrical appliances from power surge or spike due to blackout and brownouts at affordable cost. This could be a basis for commercialization of the product.

This was conducted at the Cebu Technological University San Francisco Campus Technology laboratory. The tools, materials and equipment were directly purchased from the electronics or electrical supply.

Procedure in Fabricating the Device.

1. Preparing the printed circuit board (PCB). Preparation of the printed circuit board was done by cutting into a desired size, washing to remove surface dirt, covering the copper-clad board with masking tape where pattern was laid out, tracing the laidout pattern and immersing the board in etching solution. The board was taken off from the solution after the copper foil was completely washed out and rinsed to remove the masking tape and the adhering copper foil. Lead holes were drilled and the components were placed and soldered.

2. Fixing the magnetic contactor and over load relay. The overload relay was connected to the load side after determining the line side and load side of the magnetic contactor.

3. Fixing the timer. The timer was fixed to the magnetic contactor and set to a desired level of time.

4. Voltage Testing. Set the voltmeter to AC voltage to the highest range of the selector based on the expected output voltage and turns on the master switch and monitors the delay of the voltage output. Record the result.

Three replicates were made in order to come up with the most reliable output. There were three trials and testing done and evaluated based on its function and working condition. The same materials, tools, equipment and procedures were used throughout the experiment. The temperature, current and voltage were tested hence this is the most important factor to determine the effectiveness of the device. The function was determined by providing input voltage to the timer to turn on the magnetic contactor with a specific load or consuming device for testing. The data were subjected to statistical treatment using the weighted mean to determine average voltage, current, power and temperature.

III. Results and Discussion

The data gathered in this study were arranged as follows; design of the fabricated voltage time delay device, materials supplies used in the fabrication of the voltage time delay device for rectifier circuit, analyses the fabricated voltage time delay device for the temperature for testing one followed by testing two and three.

Technical Requirements

As to technical requirements this involves the three designs and the supply of materials being used during the fabrication.

Designing. The design and functions of the different circuits used in the fabrication of the fabricated voltage time delay device for electronics technology instruction.
This indicates the design, number of components and function of the voltage time delay device. As revealed the rectifier circuit was a combination of 7 passive and active electronics components that could convert alternating current to direct current. The anode terminals of the diodes in the circuit will collect the positive charges from the secondary output of the power transformer while the cathode terminals of the diodes collect the negative charges from the secondary output of the transformer. As the pulsating direct current (DC) becomes the output of the circuit, there should be a filter capacitor installed in parallel to the anode and cathode to a pure (DC). Another is the relay circuit which a combination of another passive and active electronics components that could trigger the switch for the supply of the timer. The relay circuit is an electronics circuit that can delay the incoming voltage from the source in a few second to avoid possible damage of the timer. And the time delay circuit the combination of three electrical parts which delay the incoming voltage of the consuming devices. This circuit delays the supply voltage in five minutes or more depending on the desired setting of the user to avoid possible electrical surge or spike that will occur during sudden turn on of the supply voltage.

Materials Supplies Used

Materials Supplies Used in the Fabrication of the Voltage Time Delay Device for Rectifier Circuit. As reflected this shows the materials intended for the rectifier circuit. One power transformer rated 10 amperes and 12 volts alternating current, serves as the heart of the rectifier circuit. Four rectifier diodes with the value of 1N4001 which was used to convert alternating current to direct current. And last, one electrolytic capacitor with the capacitance of 2200 micro farad with 25 volts voltage rating serves as the filter for the rectifier circuit.

Materials Supplies Used in the Fabrication of the Voltage Time Delay Device for Relay Circuit. This exhibits the different materials used in the fabrication of the voltage time delay device for the relay circuit. One 100K ohms trimmer resistor used to set the amount of time in seconds to turn on the relay switch. One 1K ohms ½ watt fixed resistor, two 39K ohms ½ watt fixed resistor, one 8.2K ohms ½ watt fixed resistor, one 620 ohms ½ watt fixed resistor are components in the circuit whose function is to limit the current passing to the capacitors and other components. The 2N5060 which is a silicon-controlled rectifier (SCR) is used to control the operation of the relay which connects the line one to the terminal two of the timer from the moment the power is switched ON. The 1N4742A one watt 12 volts zener diode fixes the voltage across the circuit to 12 Volts Direct Current (VDC) which is the required voltage of the relay circuit. The 1N4148 switching silicon signal diode is used to prevent the SCR from possible break down. One electrolytic capacitor with the capacitance of 16 micro farad and the voltage rating was 16 volts and one .01 mylar capacitor are used to charge current and voltages in the relay circuit. The 12 volts 3 amperes relay with socket is used to connect the line one going to the timer and to the magnetic contactor holding coil.

The two packs of ferric chloride with 5 grams per pack is for etching during making the Printed Circuit Board (PCB).

Materials Supplies Used in the Fabrication of the Voltage Time Delay Device for Time Delay Circuit. As revealed the materials used in the fabrication of the voltage time delay device were the following, one 220 volts 9 ampere magnetic contactor which is for triggering the source voltage connected to the consuming device. The overload relay with the current rating of 9 ampere is for the excessive current that might occur in the circuit, therefore it becomes open. For the 220 volts timer is for the setting of the time to which the magnetic contactor will be turn on.

Materials Supplies Used in the Fabrication of the Voltage Time Delay Device for the Accessories/ Materials. It displays the accessories/ materials as used in the fabrication of the voltage time delay used during the fabrication. The 220 volts alternating current (VAC) neon switch serves as the control switch of the entire device. The rubber grommet is to prevent the wire cord for 220 Volts Alternating current from scratch. The male plug is used to attach the wire for 220 VAC connections. One 2" X 3" copper clad board for making a printed circuit board to which different electronics components were attached. The alternating current outlet for metal is for the line to which the electronics or electrical consuming devices were connected. Fuse holder was used to hold the fuse. The10 amperes fuse was for protecting the circuit in case there is short circuit will occur. The casing for the voltage time delay device encloses the components for protection. Five meters solder for fixing permanent connections without the application of a screw. Six meters extension wire number 16 was for the cord connected to the 220 VAC. And the last were fourteen 1/8 X ¾ bolt and knot for fixing the power transformer, relay socket, timer, overload relay and magnetic contactor.

Testing

This is to determine the function of the fabricated voltage time delay device as to the different trials with different consuming devices as a load. This includes testing one, testing two and testing three.

First Testing

The testing of the fabricated voltage time delay device for three trials with the load of a one refrigerator, three computers with printer and copier and one air condition unit.

Testing the Fabricated Voltage Time Delay Device for the Temperature for Testing One. Based on ambient temperature the decision was normal for the three trials with the voltage of 220 Volts Alternating Current (VAC) for testing one, 212 VAC for the second trial and third trial. For the supply voltage which was 212 as reflected for trial two and three, this indicates an ideal voltage supply based on 3% allowable voltage dropped in line. This indicates that the fabricated voltage time delay was efficient for electronics technology instruction during testing. Trial one for testing one, the load was one refrigerator, the current was 0.81 amperes, the power was 178.2 watts, the length of time was 8 hours and the temperature was 36^{o}C. For trial two of the same testing, the load were three computers with printer and copier, the current was 0.89 amperes, power was 188.68 watts, length of time is 8

hours and the temperature was 34^{o}C. The last trial which was the trial three, the load was one air condition unit, the current was 6.16 amperes, the power was 1305.92 watts, the length of time was 8 hours and the temperature was35^{o}C.The mean temperature for the three trials under testing one was 35^{o}C and the decision was normal based on the maximum temperature of the magnetic contactor which is 100^{0}C.

Second Testing

The testing of the fabricated voltage time delay device for three trials with the load of a one refrigerator, three computers with printer and copier and one air condition unit.

Testing the Fabricated Voltage Time Delay Device for the Temperature for Testing Two. Based on ambient temperature the decision was normal for the three trials with the voltage of 215 Volts Alternating Current for trial one, 220 VAC for the second trial and 218VAC for the last trial. For the supply voltage which was fluctuating as reflected for trial one and three, this indicates an ideal voltage supply based on 3% allowable voltage dropped in line. This indicates that the fabricated voltage time delay was efficient for electronics technology instruction during testing. Trial one for testing one, the load was one refrigerator, the current was .72 amperes, the power was 154.8 watts, the length of time was 8 hours and the temperature was 34^{o}C. For Trial two of the same testing, the load were three computers with printer and copier, the current was .7 amperes, power was 154 watts, length of time is 8 hours and the temperature was 32^{o}C. The last trial. which was the trial three, the load was one air condition unit, the current was 6.02 amperes, the power was 1312.36 watts, the length of time was 8 hours and the temperature was32^{o}C. The mean temperature for the three trials under testing two was 32.67^{o}C and the decision was normal base on the maximum temperature of the magnetic contactor which is 100^{0}C.

Third Testing

The testing of the fabricated voltage time delay device for the three trials with the load of a one refrigerator, three computers with printer and copier and one air condition unit.

Testing the Fabricated Voltage Time Delay Device for the Temperature for Testing Three. Based on ambient temperature the decision was normal for the three trials with the voltage of 200 Volts Alternating Current for trial one, another trial was 220 VAC for the supply voltage and for the last trial the supply voltage was 206 VAC. For the supply voltage which was fluctuating as reflected for trial one and three, this indicates an ideal voltage supply based on 3% allowable voltage dropped in line. This indicates that the fabricated voltage time delay was efficient for electronics technology instruction during testing. Trial one for testing one, the load was one refrigerator, the current was .83 amperes, the power was 182.6 watts, the length of time was 8 hours and the temperature was 35^{o}C.For trial two of the same testing, the load were three computers with printer and copier, the current was .79 amperes, power was 173.8 watts, length of time was 8 hours and the temperature was 35^{o}C. The last trial which was the trial three, the load was one air condition unit, the current was 6.75 amperes, the power was 1390.5 watts, the length of time was 8 hours and the temperature was36^{o}C. The mean temperature for the three trials under testing three was 35.33^{o}C and the decision was normal. As to the supply voltage for trial three which was 206

VAC which was beyond the 3% voltage dropped in a line the implication for the temperature was still normal base on the maximum temperature of the magnetic contactor which is 100^0C.

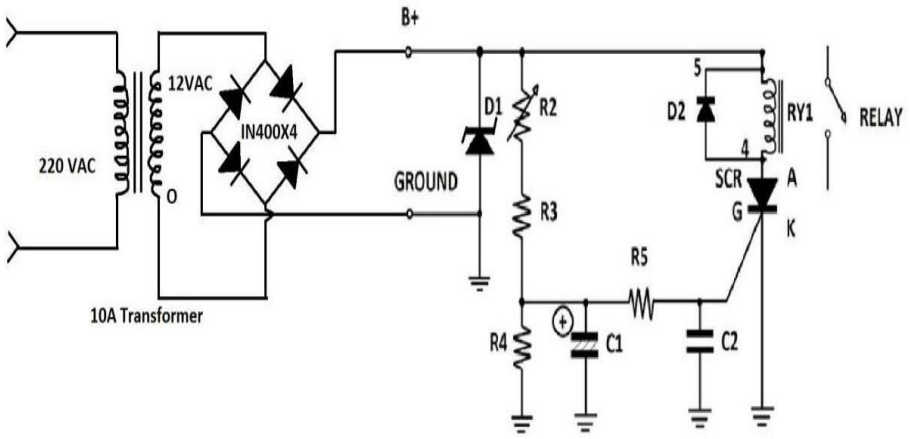

Fig. 1. Schematic Diagram of the Delay Device for Relay Circuit with Power Supply

The diagram is the representation of the different electronics components either passive or active components. It is represented by symbol known as electronics symbols rather than realistic pictures. Those divided into two main schematic diagrams, schematic diagram for the power supply and the schematic diagram for the relay circuit. Power supply circuit is an electronic circuit that supplies electric energy to the load. The primary function of a power supply is to convert alternating current to direct current or sometimes referred to as AC converters. The relay circuit is an electronic circuit that turn off or on the relay to which the supply voltage of the magnetic contactor is being connected. The supply voltage of this type of relay circuit is 12 volts direct current.

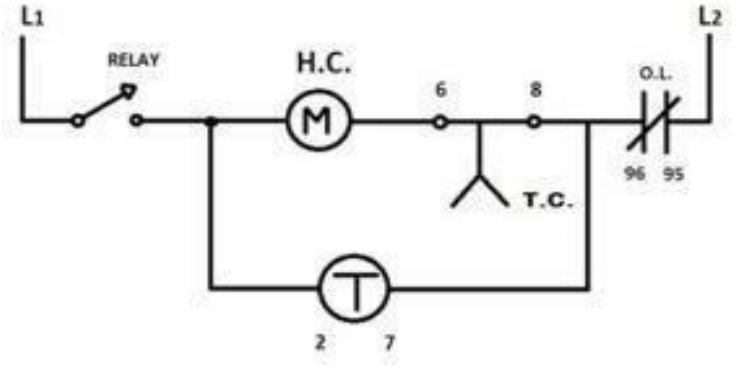

Fig. 2. Schematic Diagram for Time Delay Circuit

Diagram for time delay circuit is the schematic diagram of the circuit in which the function is to delay the time. This is the circuit in which the load is being connected during operation. This circuit includes the different components such as relay, magnetic contactor, timer and the overload relay. There is no foil pattern involved in this schematic diagram because the

different terminals are directly connected by the use of a wire so there is no need to have a printed circuit board (PCB).

OPERATIONAL MANUAL

As to the operational manual there are various problems indicated with possible solutions. It serves as guide to solved minor problems in case of trouble will occur. Manual is important in a device because this serves as the operating guide by the users. You can determine the function of the unit if you have knowledge base on the operational manual (Dalaguit, A.B. & Dalaguit. M.A., 2017).

1- Power Switch
2 - Convenience Outlet
3 - Fuse
4 - AC Cord

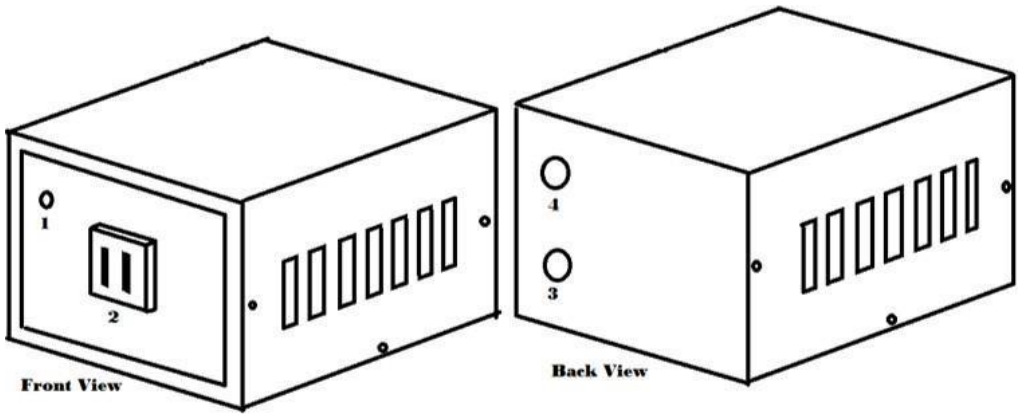

Fig. 3. Schematic Diagram for Time Delay Circuit

Procedure.

- Connect the AC cord (4) of the voltage time delay device to the convenience outlet of the building.
- Connect the load (refrigerator) to the convenience outlet of the voltage time delay device.
- Turn on the power switch of the device.
- Wait several minutes until the magnetic contactor is turn on.
- When the magnetic contactor is on, switch on the load (refrigerator).

Technical Problems

Problems	**Possible Solutions**
No Power	▪ Check the Supply Voltage ▪ Check the AC Cord

	▪ Check the Fuse ▪ Check the Power Switch
With Power but the Magnetic Contactor will not turn ON.	▪ Check the Wiring Connections ▪ Check the Fixing of the Relay ▪ Check the Fixing of the Timer ▪ Check the Soldered Area of the Relay Circuit
The Voltage Time Delay Device is Good but the Load would not Function	▪ Check the Convenience Outlet of the Device ▪ Check the Load

IV. Conclusion

Based on the findings, it is safe to conclude that frequent power interruption can shorten the life span of any electronics and electrical appliances such as refrigerators/ freezers, coolers and the like where food products are stored and that the present power surge protective device can effectively and efficiently protect power spikes caused by unexpected power interruptions such as frequent brownouts and blackouts that resulted to power surge. It can delay the voltage for a specific period of time set on the device to stabilize and normalized the power voltage thus protect the electrical device from damage, the device can lengthen the life span of any electronics and electrical appliances connected in it.

V. Recommendations

Based on the findings and conclusion in this study the following recommendations are suggested:

1. Use the power surge protective device to lengthen the life span of any electronics and electrical appliances.
2. Follow the procedure as indicated to prevent damage of the different electronics and electrical components in the circuit during testing.
3. The device made is recommended for commercialization.

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