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DESIGN AND DEVELOPMENT OF NODAL SAFETY SWITCH

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Abstract: **In energy utilization, it is important to control when, how and where to use the energy in order to conserve energy. Safety is of great importance when dealing with electricity, thus, switches are provided to supply the flow of electrical current when needed and disengage when not required. The most familiar form of switch is a manually operated electromechanical device with one or more sets of electrical contacts, which are connected to external circuits. Each set of contacts can be in one of two states: either "closed" meaning the contacts are touching and electricity can flow between them, or "open", meaning the contacts are separated and the switch is not conducting. The mechanism actuating the transition between these two states (open or closed) can be either a "toggle" (flip switch for continuous "on" or "off") or "momentary" (push-for "on" or push-for "off") type. When the breakers fail to resolve overload, under load and short-circuit problems, the appliances and the users become the victim of its failure. The worst case scenario is fire outbreak. The conventional switches cannot be safe enough for their users, both domestically and industrially, wherever there is high current demand, energy conservation and power protections beyond conventional breakers at the distribution boxes become necessary to safeguard appliances, house and property from the risk of fire outbreak. The Nodal safety switch, is designed to help conserve electrical energy and protect electrical appliances and equipment at the nodes or points of engagement against any power surge resulting from line short-circuits and lightening power surge especially when the switch is deliberately or inadvertently left in the ON position after the previous power supplied was interrupted.**

Keywords: **Electricity, Switch, Safety, Nodal, Conserve, Energy.**

I. INTRODUCTION

A switch is an electrical device that can make or break an electrical circuit, interrupting the current or diverting it from one conductor to another. The mechanism of a switch may be operated directly by a human operator to control a circuit (for example, a light switch or a keyboard button), it may also be operated by a moving object such as a door-operated switch, or may be operated by some sensing element for pressure, temperature or flow. Switches can be categorised into two (2), mainly; Mechanical Switches and Electrical Switches (E-Switch, 2021).

Mechanical Switches

Mechanical switches require physical or manual contact with switch for operation. These are switches in which two metal plates touch each other to make a physical contact for the current to flow and separate from each other to interrupt the flow of current. There are different types of Mechanical switches which can be additionally categorized on the basis of power handling capacity, namely; Single Pole Single Through (SPST), Single Pole Double Throw (SPDT), Double Pole, Single Throw (DPST), Double Pole Double Throw (DPDT), Two Poles Six Throw (2P6T) and Momentary Operation Switch / Momentary Control Switch (Ravi, 2017). Plates 1 to Plate 4 are examples of SPST and DPDT.

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Plate 1: Knife Switch (SPST) **Plate 2: Knife Switch (DPDT)** **Plate 3: Rocker Switch (SPDT)** **Plate 4: Rotary Switch (3P3T)**

Momentary Operation Switch are mechanical switches categorised as Push button, Pressure switch, Temperature switch, Toggle switch and Rotary switch. The contact material is chosen while considering that the metal oxides, which are produced due to corrosion, are mostly insulator and layers of such oxides on the switch plates will hinder the normal operation of the switch.

Push Buttons Switch: These buttons are used in many electronics circuits and can handle a small amount of current. They mostly come as Normally Closed or Normally Opened. When a user presses the button, its metal plates either connect with each other to complete the circuit, or detaches the contact of the pins, whereas, when the user removes its finger from the button, contact of the pins are either detached or connected. This system of operation is not suitable for single-press continuous current supply (Theraja and Theraja, 2005).).

Plate 5: Push Button

Toggle Switches: Toggle switches are actuated by a lever angled in one or more directions. This switch is stable in state and remains in that state unless or until the lever is pushed in another direction. Most of all household applications have toggle switch and it can fall into any category as mentioned above e.g. SPST, DPDT etc (Theraja and Theraja, 2005).

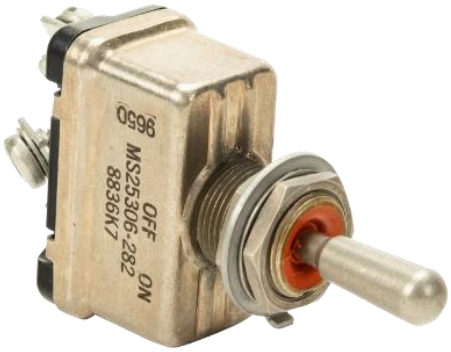

Plate 6: Toggle Switch (SPST)

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Electrical and Electronic Switches

Electrical switches turned out to be faster in switching response than mechanical switches and can be switched automatically by an electronic circuit like a microcontroller or microprocessor. Electrical switches do not require physical or manual contact, the have the ability to perform operation. Electrical switches mostly operate under the action of semiconductors. They are also categorized on the basis of current and voltage rating like mechanical switches (Ravi, 2017).The most widely used electronic switches are Transistors, Mosfets and Relays

Transistor as a switch: Transistors can be used in different modes of operation but we are going to discuss the transistor as a switch. If we apply a large amount of current at the base of the transistor (keeping in mind the maximum allowed current for this type of transistor) then we can run this transistor in deep saturation mode i.e. this transistor can be used as a switch.

Mosfet as a Switch: Mosfets can also be used for switching purposes at high frequencies. They can operate at Mega-hertz (MHz) frequencies. Mostly, Mosfets used for PWM (pulse width modulation). Meanwhile, similarly to the transistors, using such components will require more circuiting and keeping in mind base voltage and current to avoid quick damage of the component.

Relay as a Switch: A relay is a switch that is operated by electricity as an electromechanical device, which consists of electromagnet components. These switches are made to handle a wide range of voltages and currents; very large switches may be used to isolate high-voltage circuits in electrical substations. When a current is flowing through the coil, it becomes electromagnet, and this electromagnet can be used for switching purposes. Their contacts can fall into any category, e.g SPDT, DPDT etc. Therefore, if only mechanical switches are used, then there should be one person present, who at all times makes the device turn ON and OFF before and/or after use, or getting an indication message from a circuit for the next activity. Also, failure within the switch due to melting of the casing causes partial contact in the switch which is harmful to its users, either causing burn due to heat, shock and/or being electrocuted due to leakage. In order to eliminate this problem, electronics switches are used then. They are very much fast and accurate as compared to mechanical switches. Electronic switches are small in size and do not make noise while switching operation and they make sure the stability and reliability of the system.

The operation of the Nodal Safety Switch is based on switching principle of an AC relay to either connect the load(s) or isolates the load(s) from the power source, which the conventional switch usually experiences partial contact due to insulator overlap, and high presence of mechanical activities during operation. Whenever there is desire to ON light or load connected to this switch, the start button is pushed, which automatically switched ON the load by energized AC relay through its coil. The retaining current of the relay in its energizing state was achieved through the common contact (CC) and normally open contact (NC). When one desired to isolate the load from the power source, the relay coil will be de-energized by pressing the push button connected on the main (live) via the fuse with adequate protective rating. This invention is designed to remain turned OFF immediately powers source goes OFF either by the lightening, accident or by power providers. Thus, the Nodal safety switch helps to conserve electrical energy and protect electrical appliances and equipment at the nodes or points of engagement against any power surge resulting from line short-circuits and lightening power surge especially when the switch is deliberately or inadvertently left in the ON position after the previous power supplied was interrupted.

II. METHODOLOGY

The methodology followed engineering design procedure starting from concept to circuit simulations and analysis leading to the selection of a matching design, drawings, component selection and fabrication. The product was designed to operate on a single phase power supply, the standby power supply sources must have an effective ON and OFF key and must have an efficient battery to enhance its self-starting. The connecting wires must be electrically sound and the contactors and relays used must be well sized to meet their current rating requirement for an effective operation. During design some levels of tolerance were made to enhance future expansion, this maximum rating must not be exceeded to avert total system breakdown. A phase selector was incorporated as a modification to ensure availability of power supply to the user from any of the lines that has power. The normally open and close of the relay were identified with the aid of a digital meter to avoid wrong connection of the relay contacts. The output of the power supply unit which powers the relays was tested by making the relays to change-over immediately the power is supplied. With a generator, the system was tested with public supply

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sources. A single electric bulb was used for the testing. When the public supply source was ON and the source of the generator OFF the bulb which is the load comes up, when the source of public supply sources is OFF and the generator switched ON the load, the same result will be obtained.

III. NODAL SAFETY SWITCH

As shown in Figure 1, the power is supplied into the system through a fuse, which is then connected to the terminals of: resistor to supply regulated voltage to the LED bulb, one terminal of the Stop Push Button Switch (SW2) for actuating the Stop Relay, and to the Common Contact terminal to supply power to both the Start Relay and Load through the Normally Closed Contact terminal of the Stop Relay so as to easily interrupt power when actuated. A connection is made between the Normally Closed Contact terminals of the Stop Relay to the Common Contact terminal of the Start Relay. Whereas, the Start Button is then connected to the Normally Closed Contact terminal of the Start Relay, receiving power so as to actuate the Start Relay. Both the Start Relay live terminal, load live terminal and Normally Open Contact terminal are connected together, thus, it keeps the Start relay actuated for continuous supply of power to the load when Start Push Button switch is pressed.

Figure 2 shows the connections between the Supply Cables (), Fuse (), Start and Stop Relay-DPDT (), Start Push Button (NO) (), Stop Push Button (NO) (), and the Load Point (). Although, the LED light is constantly on, indicating the availability of power supply. Power supply must pass through a fuse which serves as the first point of protection before going into any other component. The neutral terminals of the Relay-DPDT, Push Buttons and the Load are connected directly to the neutral supply. Whereas, each of the live terminals of the relays are connected to a terminal of each of the Push Buttons so as when pressed, it will complete the circuit of its assigned relay to actuate. Therefore, when Start Push Button is pressed, it supplies power to the Start Relay. Since the Live and Normally Open Contact terminals of the Start relay are connected together, the relay remains actuated as connection is been switched to Common Contact and Normally Open Contact terminals. This current state of the relay is been maintained until power is interrupted, charging the state of connection of the terminals between Common Contact with Normally Open Contact to Common Contact and Normally Closed Contact. Thus, when power is restored, there will not be power supply to the load unless the Start Push Button is pressed again. Hence, making it safer for loads connected, to prevent them from effect of transient and uneconomical energy consumption.

Meanwhile, when the Stop Push Button is pressed, it actuates the Stop Relay to isolate the connection between the Common Contact and Normally Closed Contact terminals which supplies power to the Start Relay and load. Thus, interrupting power supply to deactivate the Start Relay and keeps it deactivated even when the Stop Push Button is released.The product was designed to operate on a single-phase power supply, and requires the consent of the user to press the Start Push Button switch to supply power to load whenever there is any power interruption.

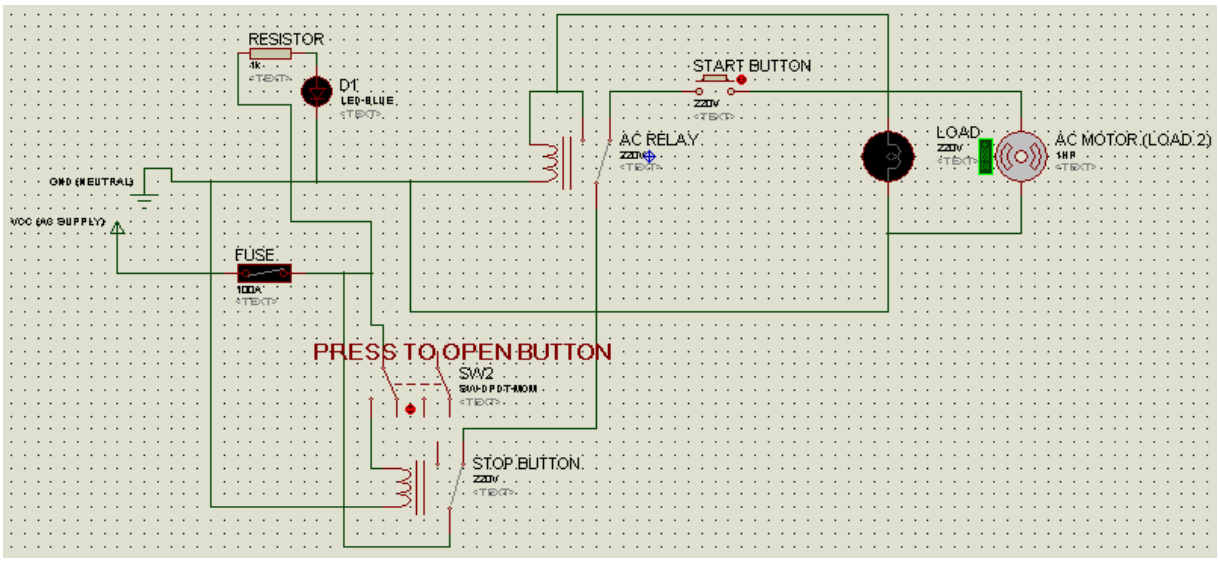

Figure 1: Circuit Diagram of a Nodal Safety Switch

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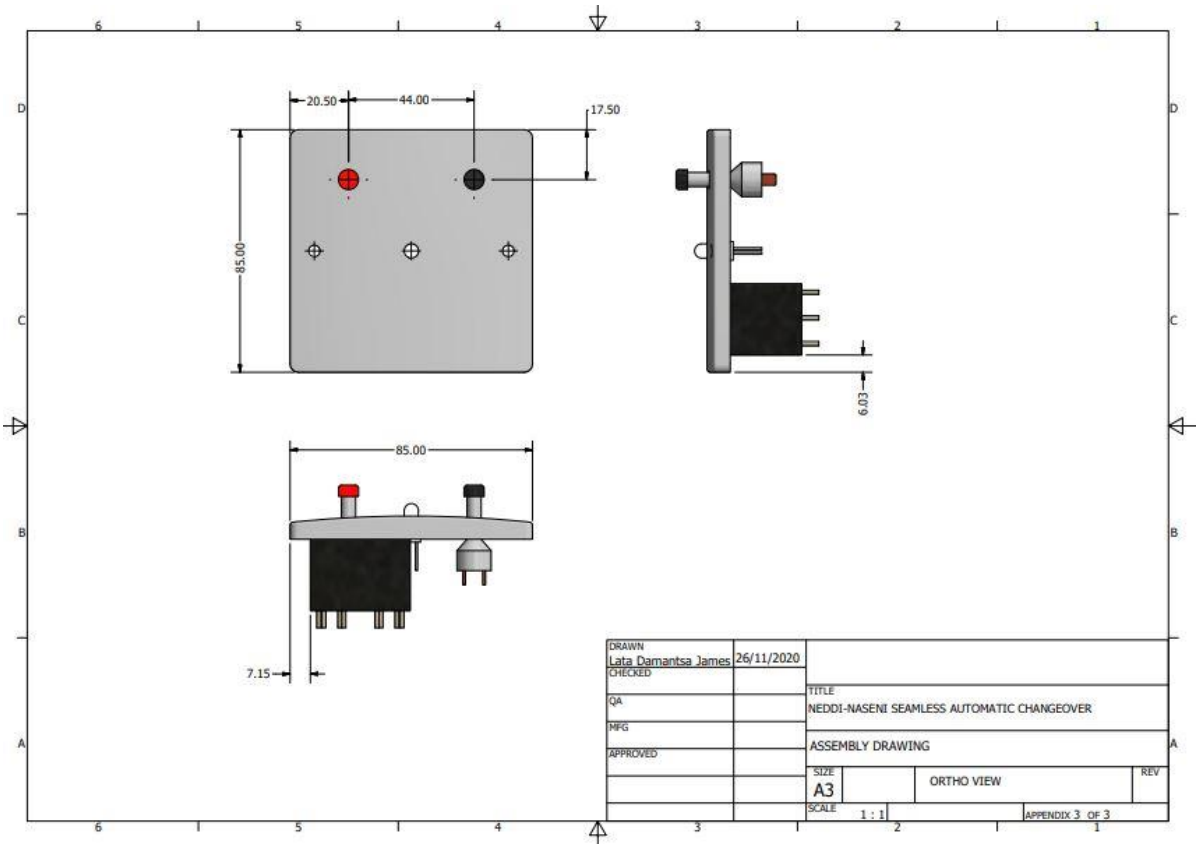

Figure 2: Orthographic View of the Nodal Safety Switch

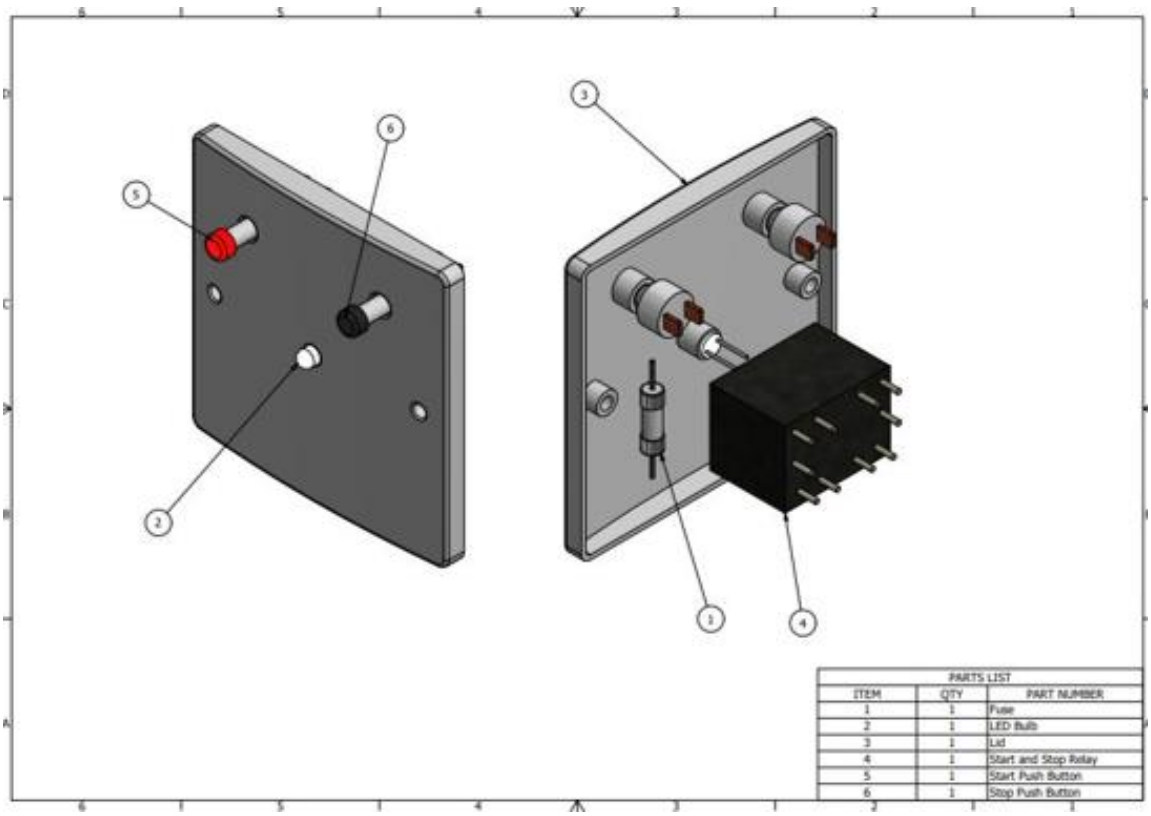

Figure 3: Labelled Parts of the Nodal Safety Switch

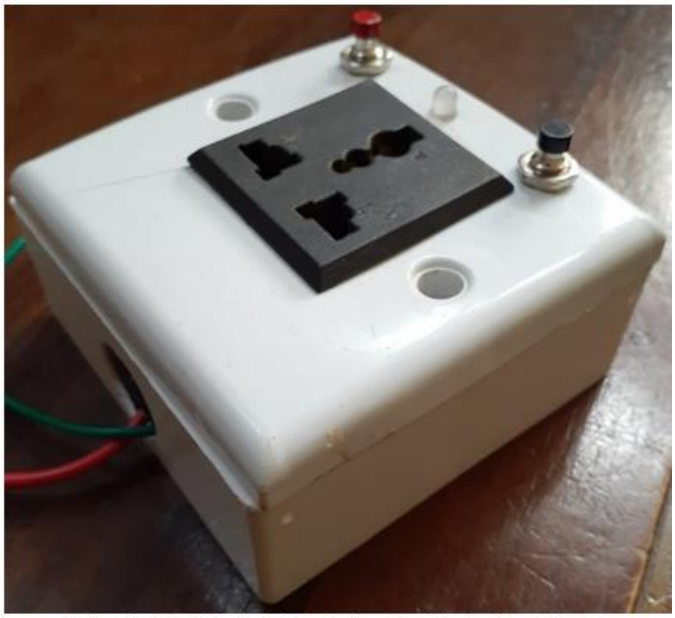

Plate 7: Nodal Safety Switch Socket

Plate 8: Nodal Safety Wall Switch

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