



Technical Innovation on the Applications of a Three Phase Manual Changeover Device

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Abstract: The application that is technically innovated from a three phase electrical knives change over switch was achieved electrical technical understanding of the device and the knowledge of connectivity. Two electrical sources are involved, the mains and the generator supply. The manual switching part of the generator was made use of by extending the cables meant for the switch. Three main ends of terminals are now involved, two wires from the generator switch, three wires from the generator output and three wires from the mains output. Interconnectivity of these terminals were put in place so that the manual switching, power supply from the mains and power supply from the generator were done to effect the functions, which are to put off the working generator as soon as the power is changed over. This set up has only saved the stress of going round to put off working generator.

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1. Introduction

Electrical knife switch were made to perform certain functions in electrical circuit, they are manufactured in their different shapes and sizes, and it all depends on design specifications. The available poles for connections on electrical knife switch vary, there are two and three/four poles connection type, the contacts transmit current from the source to the load, and perform the switching off function on the generator when changed over to PHCN (Alase, 2013; Sunil, 2008).

Three or four terminals each on both sides depending on the manufacture. Knife switch is composed of mainly ceramic, hard plastic, silver and copper. Knives switch as in Figure 1 are also useful for commercial and industrial applications, particularly for controlling large lighting loads. One of their hallmarks is reliability (Alan and Wilhem, 1999). However, like any other device, they are not infallible. In most cases, the switch does not simply wear out from normal use if the rating is respected. When someone uses a lighting control switch in a motor application, that's a misapplication, these electrical knives switch have specific designs for specific purposes, I have therefore used a three phase electrical knife switch to achieve as follows: interconnectivity of three phase to single phase electrical power sources, switching off of generator when changed to Power Holding Company of Nigeria (PHCN).

Knife switch (Figure 1) exists and the operation of this setup is based on knife switch principles, the switch make and break manually depending on the intention of the user. Electrical changes over device are of two types, the manual and the automatic (Budhia *et al.*, 2010; 2011; Ransome-Wallis, 1959).

The manual electrical changeover also have two forms which are single phase and three phase, the single phase electrical change over switch (Figure 2) only have up and down each with two terminals that is a live and a neutral, the earth is directly joined or fixed to the metal body if any. The three phase electrical changeover switch (Figure 3) has three live connections and a neutral up and down, the phases are identified as red phase, yellow phase and blue phase, the neutral (Figure 4) is present but it is not referred to as a phase. The automatic changeover is available but it is not the bone of contention. Figure 5 is a skeletal of a three phase Knife Changeover switch. The issue here is how to use a three phase electrical changeover switch to serve as:

- i. Single phase device.
- ii. Switching device.
- iii. Terminal manipulation device.

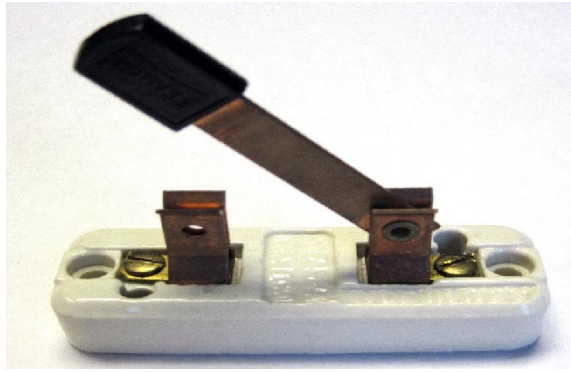


Figure 1: Knife switch



Figure 2: Single phase knife manual changeover switch



3: Three phase knife manual change over switch without neutral



Figure 4: Three Phase Knife Manual Changeover Switch with Neutral (Preferred)

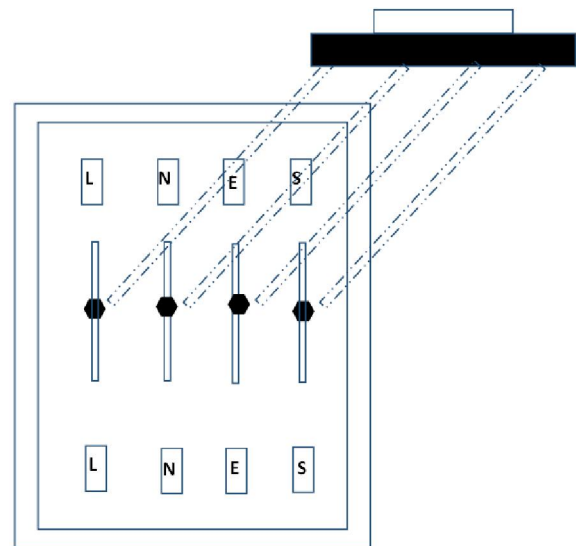


Figure 5: Skeletal of a three phase Knife Changeover switch

This innovation is very common but the applications of single and three phase changeover devices is everywhere. This technical application came as a result of mental research as in, what else could a device be used for apart from its original purpose of been manufactured. The three phase changeover device used here as a single phase has another function that it could not have been used for if its initial purpose was followed. As the case may be, electrical engineers, technologist and technical officers have produced manual and automatic changeover over time (Croft and Summers, 1987; Alase, 2013).

The combination of components/devices in Figures 6-13 allows the possibility of a Changeover been manual and automatic by operations. We will show how to wire and connect single phase and three phases automatic and manual changeover and transfer switches to the home distribution board to use the backup power supply such as batteries power with UPS and inverters or generator power in case of emergency breakdown and power outage. Now let's begin as follow. Figures 1-6 shows the different single phase and three phase connections for manual and automatic changeover and transfer switches (Davies and Alase, 2019). Let's explain one by one in detail as follow:

1.1 How to Wire Single Phase Manual Transfer / Changeover Switch

In Figure 6, different connection and wiring diagrams are shown for a two pole, single phase manual changeover switch. The upper portion of the changeover switch is directly connected to the main power supply while the lower first and right connections slots are connected to the backup power supply like generator or inverter. The left sides of lower slots are connected to the main board as load. In case of power failure, the manual changeover switch can be changed to the generator / inverter position. This way, power supply will continue to the load points through the inverter or generator (Schuylenbergeh and Puers, 2009). When power supply restores from the power house, simply switch back the changeover switch position to the "Main Power Supply".

1.2 How to Connect Single Phase Automatic Changeover / Transfer Switch (ATS)

If you are tired of manual operation of changeover switches, ATS is the best alternative to use then. In the following Figure 7, the backup power of batteries is connected to main distribution board through 2-Pole, single phase automatic changeover or transfer switch (ATS) and UPS / Inverter. The working and operation of this circuit as same as above expect the automatic changeover switch (ATS) will detect the utility power when restores from the power house and automatically transfer from the Generator / Inverter to the Main Power supply (Kainani and Zhengming, 2013; Alase, 2013)

In case when utility power is not available, the ATS will transfer the switching position to the Inverter, hence electrical appliances will be still in operation mode without interruption through the stored power in the batteries. Figure 7 shows that how to wire four poles, three phase manual changeover switch to the main distribution board. This is the same connection as we discussed above for single phase wiring expect that there are three phase wires instead of line and neutral. The three phase utility power as

(L₁, L₂, L₃ & N) are directly connected to the upper side of manual changeover switch, while the backup power of three phase generator is connected to the first four (right) slots of at lower side.

The left side four slots connection points are connected to the load then. Since the operation is manual, You have to change the changeover lever to the appropriate position manually to restore the power i.e. Change the lever position the "Generator Supply" when main power is not available and then back to the "Main Power" when utility power restores.

1.3 How to Connect Generator with ATS / Changeover Switch

We have shown in very details that how to connect a portable generator to the home supply with automatic and manual transfer switches. It is also shows the working and operation for different changeover switches wiring connections like, single phase manual changeover switch with generator, three phase manual transfer switch connection with generator as well as single phase and three phase automatic transfer switches connections to the 1 and 3 phase generators and main fuse board (Grover, 1964; Holm, 1958).

1.4 How to Wire UPS / Inverter with Transfer Switch / Changeover Switch

You will be able to know how to connect a UPS / Inverters and batteries to the home supply with the help of two poles, single phase automatic and manual changeover / Transfer switch in case of partial load and full load as well as how the system works at all? We have used Red for Live or Phase, Black for Neutral and Green for Earth Wire. You may use the specific area codes as indicated below:

1.5 IEC – International Single Phase 120V AC:

Black = Phase or Line, White = Neutral and Green/Yellow = Earth Conductor

1.6 Three Phase 208 AC:

Black = Phase₁ or Line₁, Red = Line₂, Blue = Line₃, White / Gray = Neutral and Green/Yellow = Earth Conductor

1.7 IEC: Single Phase 230V AC: Brown = Phase or Line, Blue = Neutral and Green = Earth Conductor

1.8 Three Phase 208 AC: Grey = Phase₁ or Line₁, Black = Line₂, Brown = Line₃, Blue = Neutral and Green = Earth Conductor.

1.9 Precautions

- i. Disconnect the power source before servicing, repairing or installing electrical equipments.
- ii. Use the proper cable in size with this simple calculation. Never try to work on electricity without proper guidance and care.
- iii. Work with electricity only in presence of those persons who has good knowledge and practical work and experience who know how to deal with electricity.

iv. Read all the instructions, user manuals, cautions and follow them strictly.

v. Doing your own electrical work is dangerous as well as illegal in some areas. Contact the licensed electrician or the power supply company before practicing any change in electrical wiring connection.

vi. The author will not be liable for any losses, injuries, or damages from the display or use of this information or if you try any circuit in wrong format. So please! Be careful because it's all about electricity and electricity is too dangerous.

2. Methodology

The components gathered to achieve the target were not the initial purpose of production; this was done to exploit technical importance of the three phase four pole Knife switch Changeover (Jaeque *et al.*, 2014; Hammond, 1968). The method begins with knowing and understanding the parts and components of the device (Figures 8 to 13).

2.1 Names of the Numbered Parts in Figure 7

1. Earth terminal of PHCN source.
2. Neutral terminal of PHCN source.
3. The switch load bar of the changeover switch.
4. The earth load bar of the changeover switch.
5. Fulcrum of the switch pole for terminal 1.
6. Connected cable from generator switch to changeover switch terminal (s)
7. Connected cable from generator switch to changeover switch pole. Not (s)
8. Zero (0) terminals, means there no connection.
9. Changeover switch handle.
10. Insulated part of the Changeover switch handle.
11. The knife switch pole that puts off generator.
12. The knife switch pole that links the earth of sources to the load.
13. The knife switch pole that links the neutral of both sources to the load.
14. The knife switch pole that links the live of both sources to the load.
15. Hard plastic where the components that formed the changeover are mounted.
16. The live load bar of the changeover switch.
17. The neutral load bar of the changeover switch.
18. Neutral contact point on the changeover switch for the generator.
19. Live contact point on the changeover switch for the generator.
20. Earth contact point on the changeover switch for the generator.
21. Live terminal of PHCN source.

22. Earth connected cable between changeover and PHCN source.

23. Neutral connected cable between changeover and PHCN source.

24. Live connected cable between changeover and PHCN source.

2.2 Connection Details

Below are the explanations to Figures 6-13 (Leandros *et al.*, 2015; Teci and Manna, 1995; Kusaka and Itoh, 2002).

1. This is the normal EARTH terminal that emanate from either transformer earthing point or the earthing locally made around a building.

2. This is the NEUTRAL terminal that emanate from transformer to electric poles, to fuse, to gear switch and then to the changeover switch.

3. This part is inside the changeover switch, when opened and it faces you, it is the first terminal from your left. On this number 3 is number 11 and fulcrum which allows the handle to freely move. Originally it was made to be used for three phase and a neutral connections, but the terminal is technically used for switching. It is common to both sides meaning that when the handle is moved up and down it makes contact with either source at a time, therefore, when the handle is hooked up it is capable of switching off the generator.

4. This part is inside the changeover switch, when opened and it faces you, it is the second terminal from your left. On this number 4 is number 12 and fulcrum which allows the handle to freely move. Originally it was made to be used for three phase and a neutral connections, but the terminal is technically used for earthing. It is common to both sides meaning that when the handle is moved *up* and *down* it makes contact with either source at a time.

5. Fulcrum is a turning point that allows the handle to freely move up or down. It is also connected to the load contact point.

6. This is the wire that links generator switch to the changeover switch (S)

7. This is the wire that links generator switch to the changeover switch pole.

8. Zero terminal means free or unused component of the changeover on the generator side.

9. To avoid electric shock, it is proper to obey manuals from manufacturers. Use the handle when changing over.

10. This is the insulated part that did not allow the three phase poles to bridge.

11. This is the pole that makes and breaks to switching of the generator.

12. Where there is a supply there should be a load, this part of the changeover is referred to as the **earth load** contact pole.

13. Where there is a supply there should be a load, this part of the changeover is referred to as the **neutral load** contact pole.

14. Where there is a supply there should be a load, this part of the changeover is referred to as the **live load** contact pole.

15. Some of these changeover casing are metals to enable proper earthing but the ones with Hard plastic body do get their earthing terminals connected outside the device. In the course of this technical innovation, one of the device terminals has been used for the purpose of earthing.

16. Common to both electrical sources is referred to as the load. This is the live load bar of the changeover switch.

17. Common to both electrical sources is referred to as the load. This is the neutral load bar of the changeover switch.

18. The **neutral** contact point for the generator.

19. The **live** contact point for the generator.

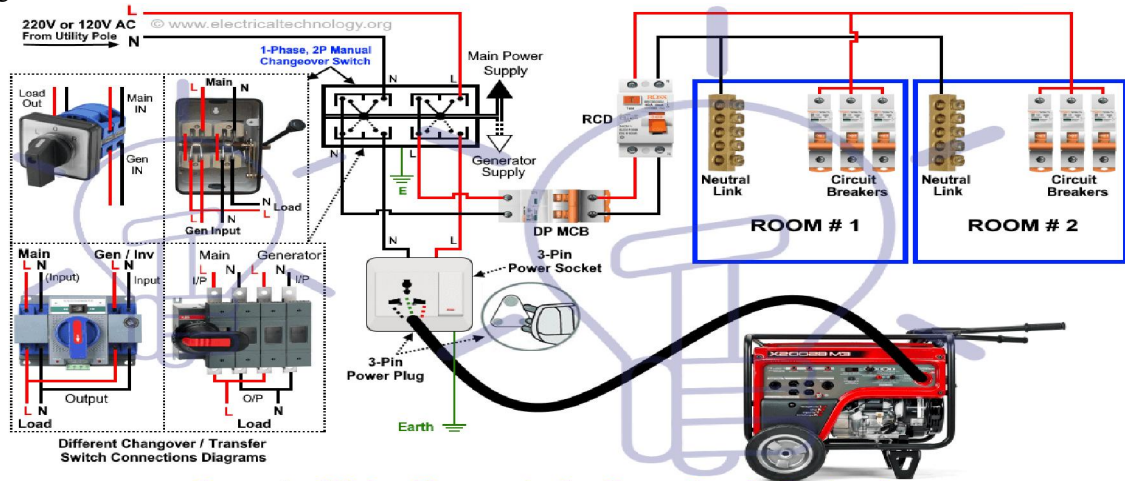
20. The **earth** contact point for the generator.

21. The live supply of PHCN.

22. **Earth** connected cable between changeover and PHCN source.

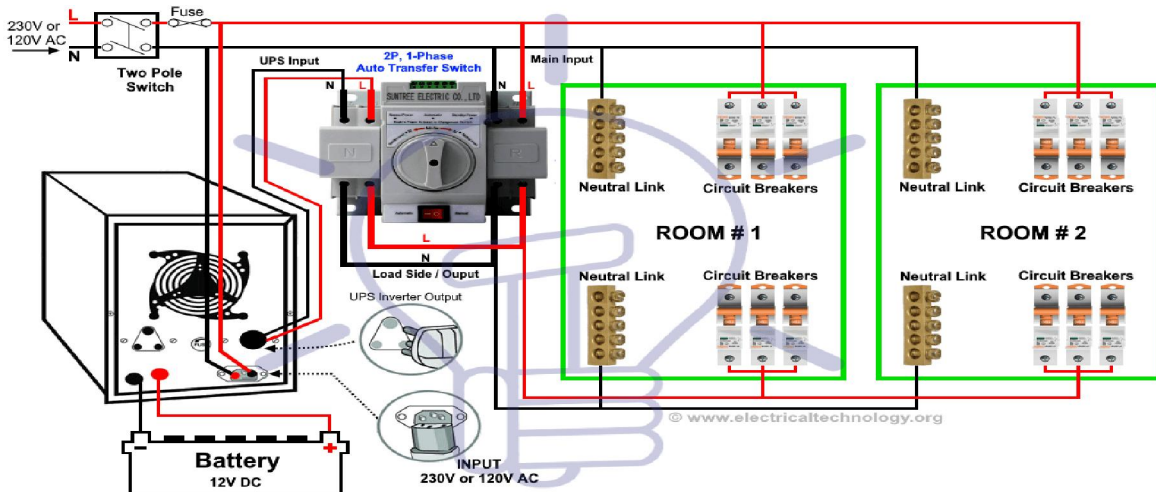
23. **Neutral** connected cable between changeover and PHCN source.

24. **Live** connected cable between changeover and PHCN source.



Generator Wiring Diagram to the Home Supply System by using Manual Changeover Switch or Transfer Switch (ATS)

Figure 6: Generator Changeover wiring



UPS / Inverter Wiring Diagram with Automatic Changeover Switch

Figure 7: Automatic Changeover switch

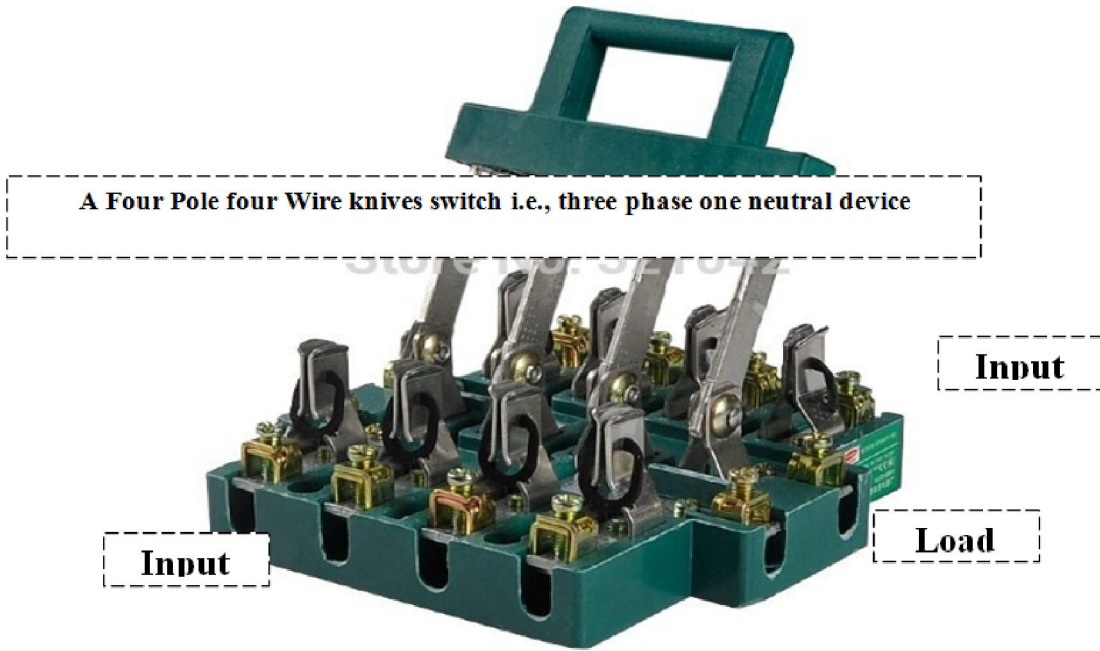


Figure 8: skeletal picture of the main device

Three Main Section of the Set Up



Figure 9: mains Supply block

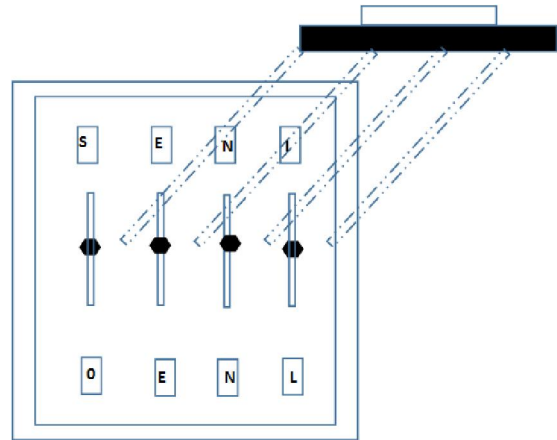


Figure 10: knife switch skeleton



Figure 11: Generator Supply block

The Connections

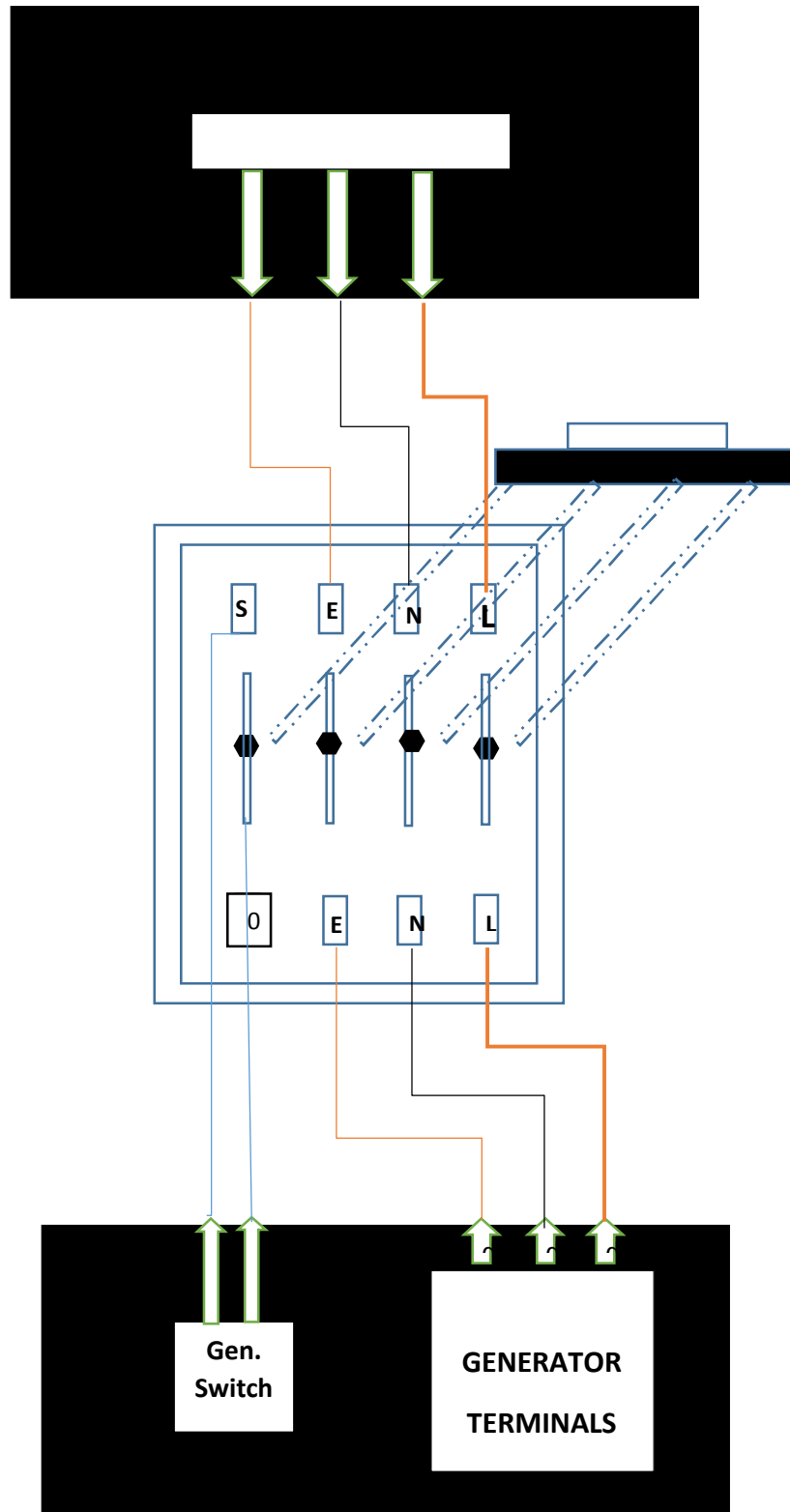


Figure 12: Electrical Connections of the set up

Parts of the Device

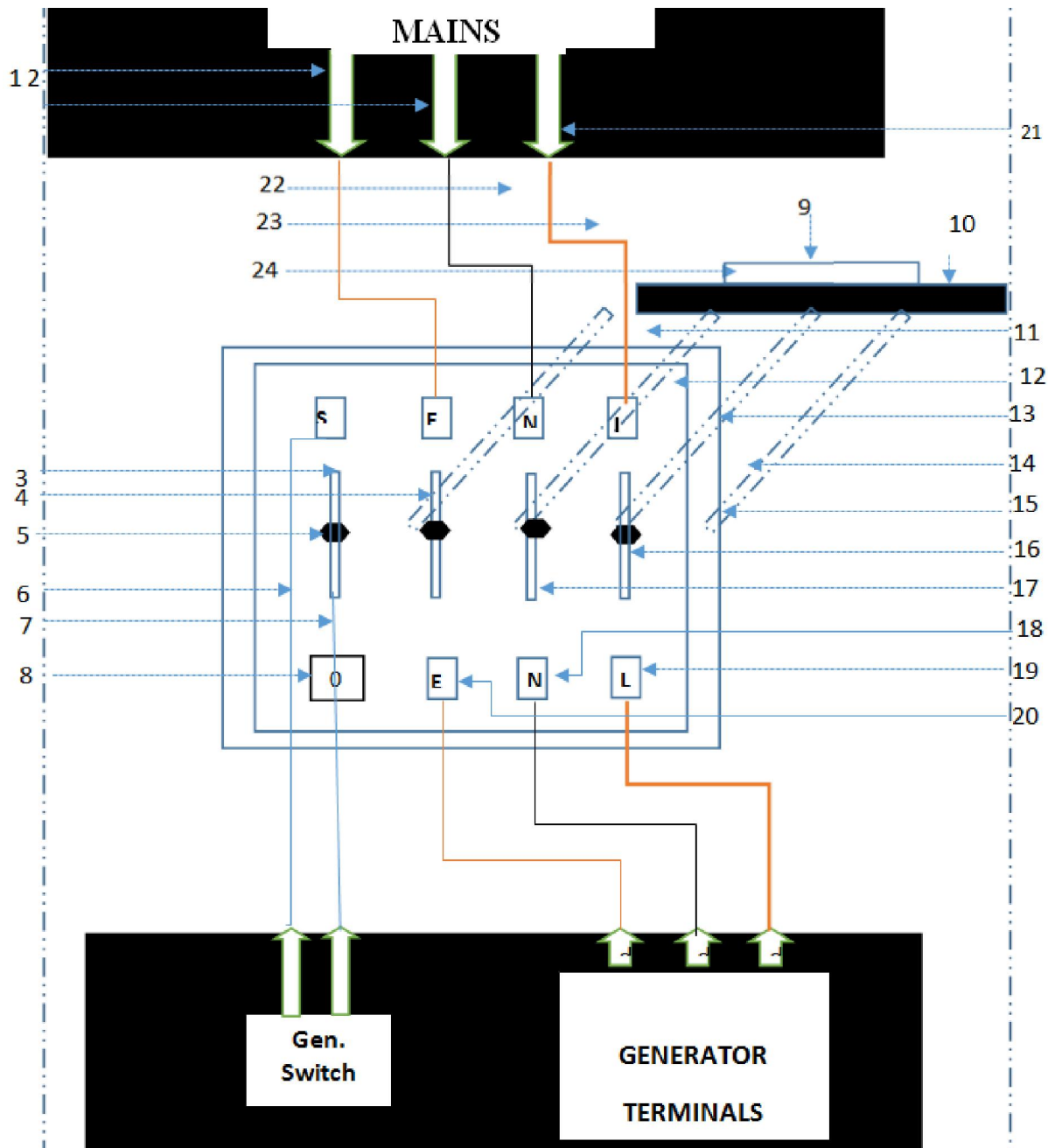


Figure 13: Labeled parts

3. Summary

Electrical changeover device either manual or automatic is unavoidable in homes where two or more electrical power sources are to be used. It may be single phase type or three phase four wire type used here as a single phase device plus other functions as introduced.

It is possible to use a three phase four wire changeover switch as a single phase device, as a

manual control switch device for single Phase generator. It is also very important to understand the functions of each components of the set up for maximum manipulations.

4. Conclusion

Developer may improve on this work in the area of indicators that would inform observer about the

present supply. The disadvantage here is that the set up cannot be used for three phase connections.

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