Electromagnetic Change over Switch: An Investment Protection Option in Industrial Environment

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Abstract:- **Industrial loads are exposed to surge, poor contact, phase reversal and line failure through direct application of mechanical switches. This paper is aimed at implementing change over operation using electromagnetic contactors. Phase sequence relay is incorporated to protect the load from phase reversal, line failure and voltage drop. This change over switch is repairable, maintainable, and easy to operate and protects the entire investment from risk of damage.**

Keywords: **Surge, Phase Reversal, Change over, Electromagnetic Contractors, Phase Sequence Relay.**

I INTRODUCTION

The Power generating/distributing companies are the major tool for converting and transporting electrical energy in any country (In Nigeria it is the PHCN). These companies by some standard have the sole responsibility to ensure a high degree of system reliability. The inability of the supply authority to meet the public expectation of uninterruptible power supply necessitates the desire for alternative energy options, which are predominantly standby generators in developing countries.

When separate energy sources are available, the application of change over switch is necessary to select an option to deliver power to the load (Menta, 2004).

The conventional change over switch is mechanical in nature and characterized by some problems, which are:

(i) insensitivity to line failure
(ii) insensitivity to phase sequence
(iii) insensitivity to voltage drop
(iv) contact rupture and failure
(v) poor maintainability and reparability
(vi) insensitivity to voltage fluctuations
(vii) spring failure

When any or a combination of these problems arise, it provides an unhealthy environment for industrial load, thereby causing damage to three-phase electric drives as well as expose the entire investment to risk.

Electromagnetic changeover switches will respond to phase reversal, voltage drop and line failure. It is also maintainable and reparable.

II AIMS AND OBJECTIVE

It is aimed to carry out change over operation using Electromagnetic contactors and Phase failure relay as a sensing/control device. The objective is to isolate the load in the event of line failure and phase reversal.

III METHODOLOGY

The methodology deployed in this operation is to arrange six sets of electromagnetic contractors to function as the contacts of the change over switch. One pair of the electromagnetic contactors is used per phase. For each pair, one functions as Power generating company source while the other as Generator terminals. The phase failure relay used the Neutral as the hold-on contact.

IV PHASE SEQUENCE RELAY

The phase sequence relay is a device which receives a signal which causes it to operate (David, 1984); and to effect the operation of the contactor circuit. The three-phase sequence of electrical supply; Red – Yellow – Blue sequence serves as the operating signal. This device will respond to abnormal conditions of line outage, voltage fluctuations and phase reversal. The relay comprises a three-phase input. A normally closed contact form part of the relay assembly. The relay becomes energized as a result of the three-phase supply in R-Y-B sequence until there is an abnormal condition.

V ELECTROMAGNETIC CONTACTOR

The electromagnetic contactor, which is essentially a plunger device, possesses three main contact, set of low current rating auxiliary contact and a magnetic coil (Bandvopadhvov, 1998).

The main contacts of the contactor are always closed as long as the coils are energized (David, 1984). Contactors are designed to carry very large currents. In this application the current carrying part will be large enough to meet the capacity of the load demand.

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VI INDICATING INSTRUMENT

The indicating instrument introduced to monitor the circuit include three sets of voltmeters to measure the line-to-line voltages (Weedy, 1988); R-Y, Y-B, B-R. Frequency meters are also incorporated to measure the frequency of operation. The frequency meter is connected between Line – Neutral.

Three pairs of Ammeter/current transformers are also used to monitor the load current. It helps to ascertain if the loads are balanced.

VII CIRCUIT MODELLING

Contactor and copper bars are arranged as shown in figure 2 and figure 3 respectively. The maximum current rating of change over switch is three times the rated value of the contactor. The copper bars are selected to meet the load rating.

The symbol N and G represent supply from Power supplying company and generator respectively. The control circuit and power circuit are presented in figure 4 and 5 respectively.

VIII MODE OF OPERATION

Generator Mode: - Switch S is turned to pole one, cable no 1 link Neutral to push button. Single phase supply from generator circuit is fed to normally open main terminal of contactor C1. From the neutral via cable number 1 the normally open terminal of the push button P interrupts the direct command of the supply.

On pressing push button P1, cable 2 and 3 connect contactor coil A1 and A2 to 220*V* supply. Contactor C1 is energized. Normally open terminal of C1 is closed. Contactors CG1, CG2 and CG3 are energized to feed the load.

Three-phase output of the load point serves as the input to phase sequence relay. The relay auxiliary contact functions as the hold on contact. The circuit continues to function until there is an abnormal condition or the system is switched off. The normally closed auxiliary contact of the Power company source contactor serves as an interlocking device for generator mode (Gupta, 2006).

Power supplying company Mode: - Switch S is operated to pole 2. Single phase supply from Power supplying company is connected to normally open terminal of contactor C2, cable no. 1 connects push button P (when operated) contactor C2 is energized cable 2, 4 and 5.

C2 energized command contactor CN1, CN2 and CN3 to energise simultaneously. The circuit is maintained as the phase sequence relay function as hold on contact. The series connected normally closed auxiliary terminal of contactors CG1, CG2 and CG3 serve as am interlock.

IX TECHNICAL FEATURES OF THE DEVICE

L = length, B =breath and H = height

Size of casing L 120cm, B 110 cm H 40 cm

Description of sizes of Copper bar
Power output section
Red phase L 700cm, B 50 cm H 5 cm
Blue phase L 700cm, B 50 cm H 5 cm
Yellow L 700cm, B 50 cm H 5 cm
Power input section (i.e. from the power company side)
Red phase (quantity = 2) L 150cm, B 50 cm H 5 cm
Blue phase (quantity = 2) L 150cm, B 50 cm H 5 cm
Yellow (quantity = 2) L 150cm, B 50 cm H 5 cm
Neutral bar L 500cm, B 30 cm H 5 cm

Link arm between conductors
(quantity = 9) L 600cm, B 30 cm H 5 cm

Link arm between input and contactor
(quantity = 8) L 150cm, B 20 cm H 5 cm

Bus bar insulator (for $\geq$ 1000 AMPs insulation)
L 150cm, B 20 cm H 5 cm

Contactor sizes

For 350 A, 415V (quantity = 6)

and 15 A, 220 V (quantity = 2)

CT (current transformer) corresponding ampere meter of 0 – 1000 Amps

Voltmeter of 0 – 500Volts
Phase failure relay is RYB phase sequence
Flat sheet insulator at rated current value
L 600cm, B 50 cm H 5 cm
L 400cm, B 50 cm H 5 cm
L 200cm, B 50 cm H 5 cm

X CONCLUSION

This paper has shown the application of contactors as change over switch. It has the ability to protect three-phase induction motor from single phasing and double phasing; the Phase Failure Relay will trip under these conditions. It is sensitive to line failure, low voltage and abnormal phase sequence. However, it suffers from abnormal tripping resulting from voltage dip.

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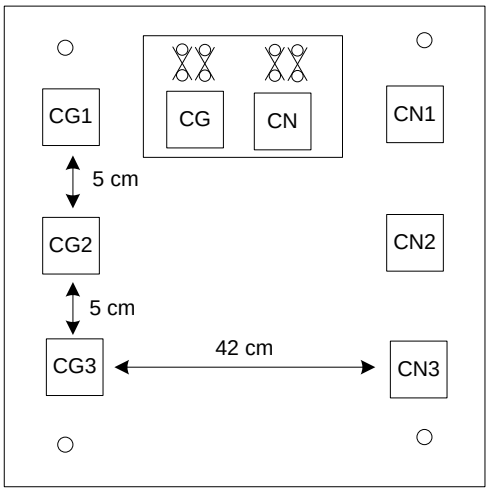

CG: Contactor for Generator side
CN: Contactor for PHCN side

Fig. 1: Contactor arrangement on a flat plate

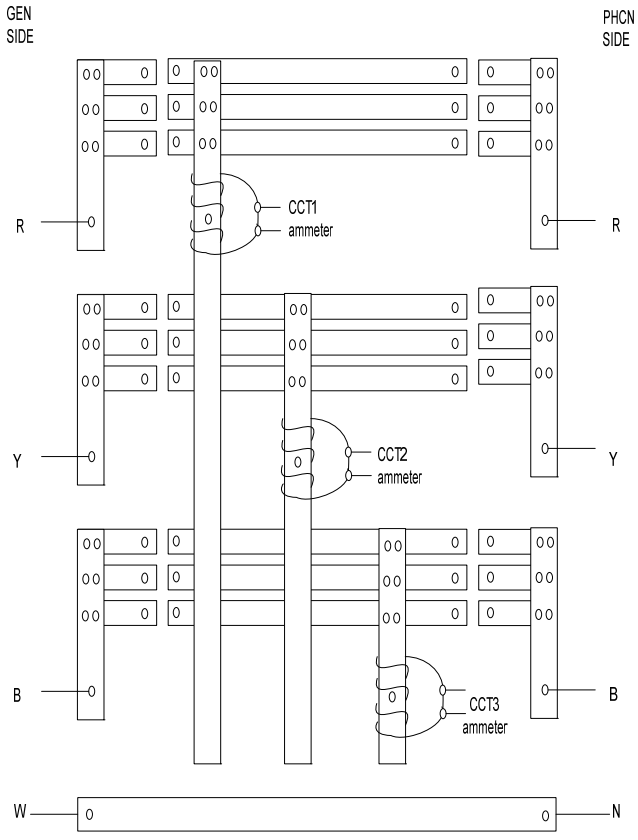

Fig. 2: Arrangements of Copper bars

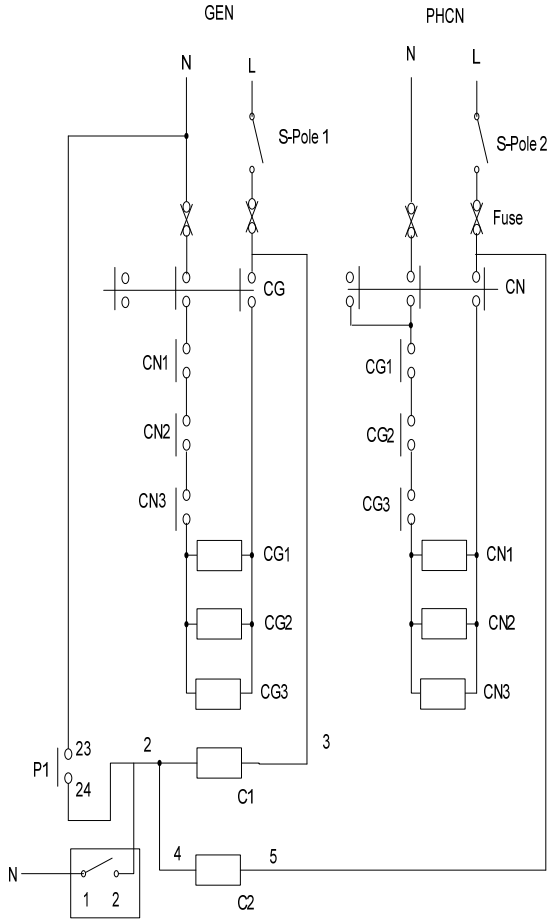

Fig. 3: Control Circuit

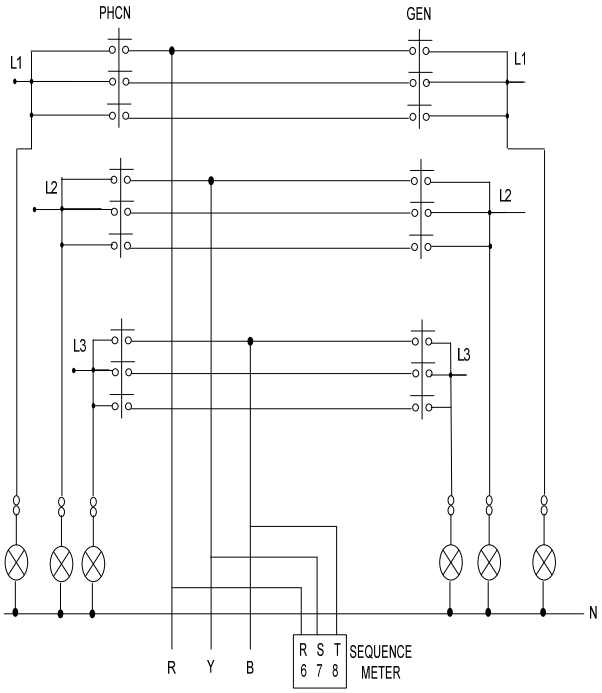

Fig. 4: Power Circuit (Power company & GEN)

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