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"Using Switch-Relays in Control Circuits"

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Abstract

In this experiment conventional control elements such as contactors, relays, and timers were used to control the operation of a three-phase induction motor and to design a control circuit of traffic lights. Simple steps were followed while doing the experiment. The operation of the each control circuit was clarified.

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Chapter 1

Introduction

Relays are electromechanical devices that use an electromagnet to operate a pair of movable contacts from an open position to a closed position.

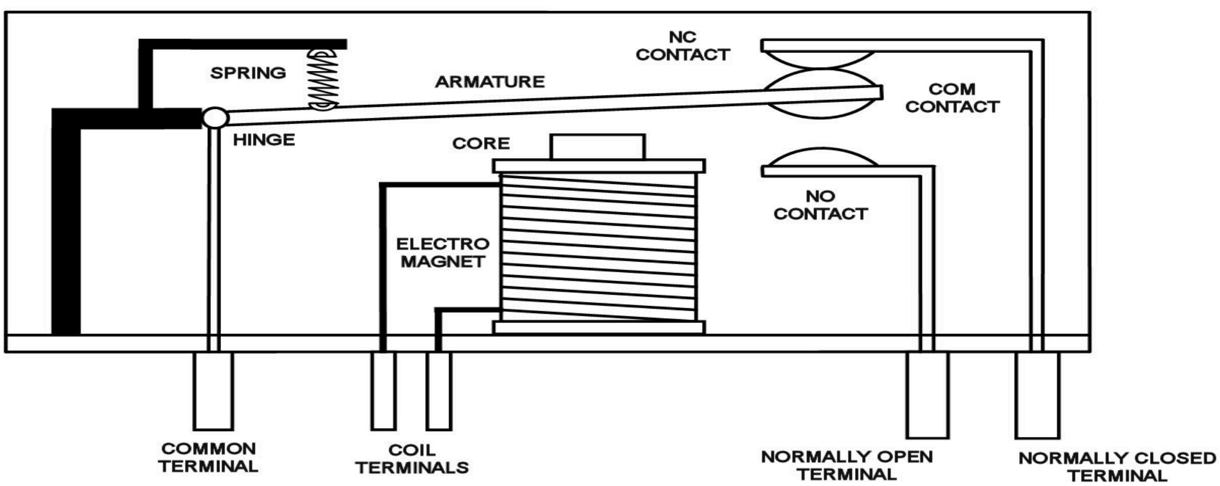

Fig. 1.1: Relay Structure

The advantage of relays is that it takes a relatively small amount of power to operate the relay coil, but the relay itself can be used to control motors, heaters, lamps or AC circuits which themselves can draw a lot more electrical power.

The electro-mechanical relay is an output device (actuator) which come in a whole host of shapes, sizes and designs, and have many uses and applications in electronic circuits. But while electrical relays can be used to allow low power electronic or computer type circuits to switch relatively high currents or voltages both "ON" or "OFF", some form of **relay switch circuit** is required to control it [1].

Chapter 2

Procedure and Discussion

In this Chapter, a qualitative approach is followed and discussed to reverse the direction of rotation of a three phase induction motor, starting a three phase induction motor using Y-Δ method , and in traffic light control circuit.

2.1 Reversing the Direction of Rotation of a Three Phase Induction Motor

In this section, the control circuit was firstly connected and then the power circuit and the same in all the following sections. Figure 2.1 shows the control and power circuits of a three-phase induction motor .When contactor 1 was energized, the normally open switch C_1 closed and the normally closed one was open in order to prevent the operation of the two branches simultaneously. As a result, the motor was rotating in clockwise direction.

On the other hand, energizing contactor C_2 made the motor to rotate in a counter clockwise sense. The On_1 and On_2 switches were connected in parallel with the normally open C_1 and C_2 so that the pressing on the switches need not to be done continuously.

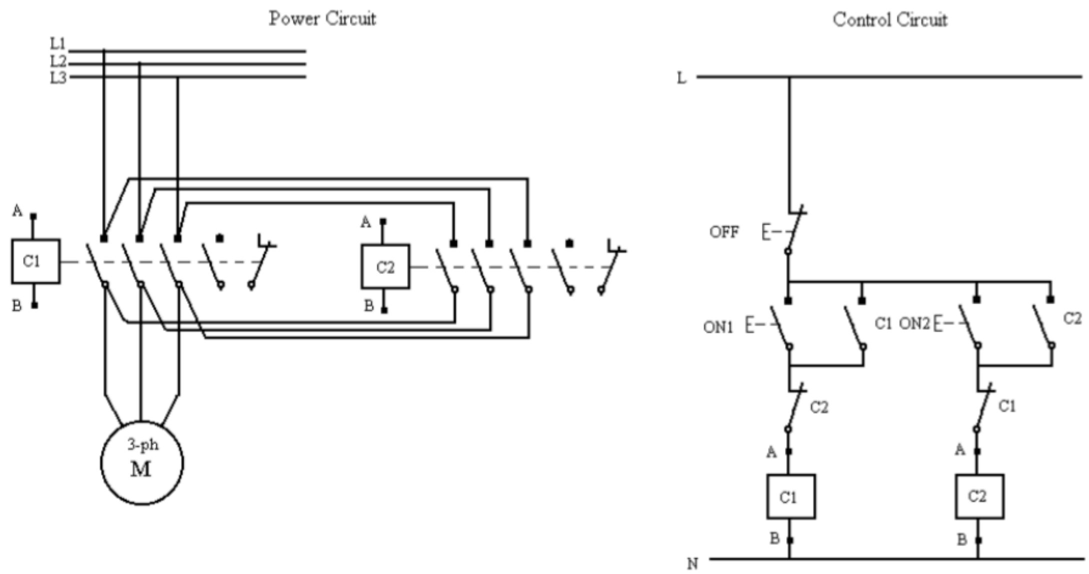

Fig. 2.1: The control and power circuits of a three-phase induction motor

2.2 Starting a Three Phase Induction Motor Using Y-Δ Method

The phase coils are designed to be connected in Delta for running, but they are connected in Y to start the motor. Most induction motors are started directly on line, but when very large motors are started that way, they cause a disturbance of voltage on the supply lines due to large starting current surges. To limit the starting current surge, large induction motors are started at reduced voltage and then have full supply voltage reconnected when they run up to near rotated speed. Y-Δ method is used in an attempt to reduce the start current applied to the motor during start as a means of reducing the disturbances and interference on the electrical supply component. The currents through the winding are $1\sqrt{3} = 0.58$ (58%) of the current in the line. this connection amounts to approximately 30% of the delta values. The starting current is reduced to one third of the direct starting current.

This claim can be proved as follows:
Line current in Δ connected I.M:

$$I_{L,\Delta} = \frac{\sqrt{3}V_L}{Z} \qquad (1)$$

Line current in *Y* connected I.M:

$$I_{L,Y} = \frac{V_L}{\sqrt{3}Z} \qquad (2)$$

$$\frac{I_{L,Y}}{I_{L,\Delta}} = \frac{1}{3}$$

where V_L is the line-to-line voltage in [V], Z is the impedance of the windings in [Ω],and $I_{L,\Delta}$,$I_{L,\,Y}$ are respectively the line currents in Δ and *Y* configurations.

Figure 2.2 shows the control and power circuits responsible for Y-Δ starter of a three phase induction motor:

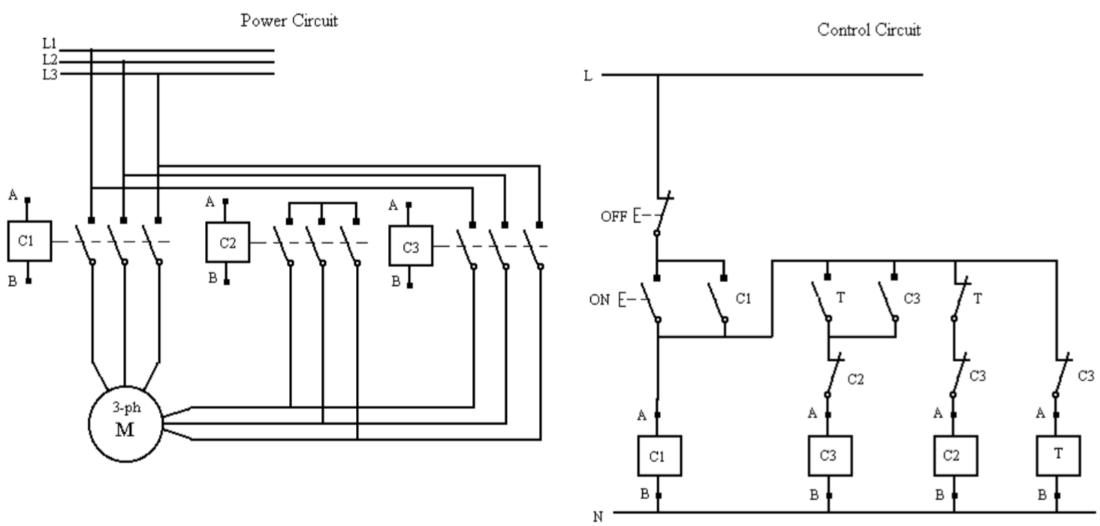

Fig. 2.2: The Control and power circuits responsible for Y-Δ starter of a three phase induction motor.

The control circuit has one timer, when C_1 is energized the normally open switch C_1 is closed and the power reaches the coil of C_2, the normally closed C_2 is open now so the motor is Y-connected. When the timer reaches the pre-set time value, the contactor C_3 became energized and thus the normally closed switch C_3 was opened to disconnect the Y-connection and turns to Δ configuration in order to recover the high value of torque and power to the motor.

2.3 Traffic Light Control Circuit

Figure 2.3 shows The control circuit of a traffic light :

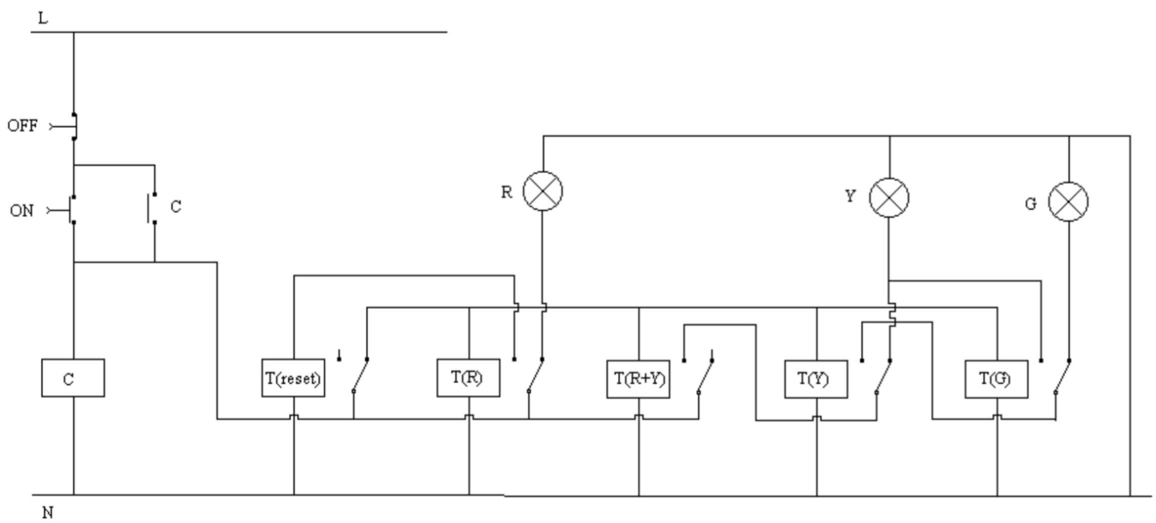

Fig. 2.3: The control circuit of a traffic light

The timers were set so that the red light lasts for 10 sec, red and yellow for 5 sec, green for 5 sec, yellow for 5 sec and the process repeats. The On button is pressed; the power reaches the red light only. After 10 sec, the T(R+Y) timer closes its terminals so that the yellow light is on as well as the red light , 5 seconds later ,T(R) operates and the red light turns off, at the same time , T(Y) operates as a consequence the yellow turns off and the green light turns on. After another 5 sec , the T(G) operates and as a consequence , the green light turns off and the yellow light turns on for 5 sec. The sequence is repeated continuously by the T(reset) timer , it again resets the timers to repeat the previous timing sequence.

Conclusion

Several control circuits were introduced in this experiment. First, we investigated how to reverse the direction of rotation of a three-phase induction motor. Then, how to start the induction motor using Y-Δ starter circuit method. Finally, we examined the circuit used to to control the sequence of traffic lights.

Conventional control elements were used in the mentioned circuits, which included timers, contactors and relays. The use of the mentioned elements have alleviate the process of power control and made the circuits easier to handle and more efficient.

References

[1] Nantao Huang, "COMPARATIVE STUDY OF INDUCTION MOTOR STARTERS USING MATLAB SIMULINK," Milwaukee, Wisconsin, 2013.

[2] Burlington Butterworth–Heinemann, "*Power electronics handbook devices, circuits and applications"*, 3rd ed., 2011.