

Experimental Investigation on an Induction Motor to Work as an Alternator

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Abstract— This paper proposes a new and novel approach to an induction motor to serve as a synchronous motor with a modification. Also provides the different classification, operating principle, explains in detail how one of the classifications can serve the purpose as an alternator. These modifications are experimented and have obtained positive results.

Key words— Alternating Current (AC), Electro Magnetic Force (EMF), Rotating Magnetic field (RMF), Synchronous speed (N_s), Actual Speed (N), slip (s), Triple Pole Double Throw (TPDT).

1 Introduction

With the most universal adoption of AC system of distribution of electrical energy for light and power, the field of application of AC motors has widened considerably during recent years. As a result, motor manufacturers have trend over the last few decades, to perfect various types of AC motors for both single and three phase AC supply.

One such motor is an induction motor and are classified into various types. By using this we can make it to work as an induction generator and selecting one classification in particular, providing with few modifications it is made to work as a synchronous motor and as a synchronous generator.

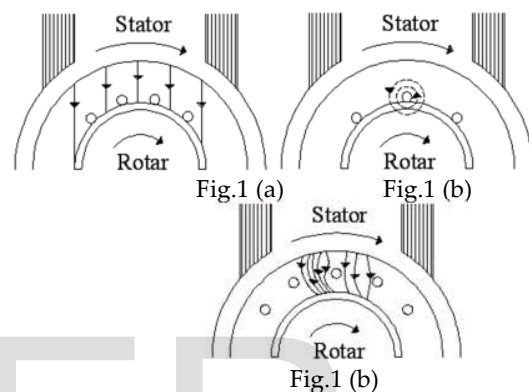
2 Induction Motor Classifications

These induction motors are classified on various types. The below classification is made on the basis of its rotor construction.

- i. Squirrel cage induction motor
- ii. Slip ring induction motor.
- iii. Compensated type induction motor.
- iv. Repulsion type induction motor.

2.2 Operating principle:

The stator is powered with alternating current (AC) and designed to create a rotating magnetic field (RMF) in time with the AC oscillations. The rotor has windings in the form of closed loop wires which depends on the rotor construction. The RMF in stator induces current in rotor, these currents in turn creates magnetic field in the rotor that interacts with the stator field. The setting up of torque for rotating for rotor is shown in below Fig. 1



In Fig.1 (a), the stator field is shown which is assumed to be rotating clockwise. The relative motion of the rotor with respect to the stator is anticlockwise. By applying right-hand rule, the direction of the induced EMF in the rotor is found to be outwards. Hence, the direction of the flux due to rotor current is alone as shown in Fig.1 (b). Now by applying left-hand rule or by the effect of combined field [Fig.1 (c)] it is clear that the rotor conductors experience a force tending to rotate them in clockwise direction. Hence, the rotor is set into rotation in the same direction as that of stator field.

By Lenz law, the direction of the magnetic field created in rotor will be such as to oppose the cause producing it. The cause of induced current in the rotor is the stator RMF, so to oppose this rotor will start to rotate in the direction of RMF.

2.3 Slip

The difference between synchronous speed (N_s) and the actual speed (N) of the rotor is known as slip. It is usually derived in terms of percentage (%).

$$\%slip = \frac{N_s - N}{N_s} \quad (1)$$

The conditions of slip are as listed below.

- If slip is positive i.e. when the motor runs at actual speed it works as motor.
- If slip is equal to zero i.e. when the motor attains synchronous speed the motor actually stops.
- If the slip is negative i.e. when the motor attains a speed greater than synchronous speed it runs as a generator.

3. Experimental Approach

Alternator works on the same fundamental principles of electromagnetic induction. The important difference between the DC generator and an alternator is that, in DC generator the armature rotates and the field is stationary, the arrangement in alternator is just the reverse of it.

Stationary armature in alternator has the following advantages

- The output current can be led directly from fixed terminals on the stator to the load circuit, hence high voltage can be obtained without any difficulty.
- The slip rings are subjected to low voltage, low power DC field circuit.

Considering the construction and working of an alternator a slip ring induction motor with the modified approach as shown in Fig.2 can be made to work as an alternator. A slip ring induction motor can be made to work as an alternator by two different methods they are back to back prime mover and driven by an external engine.

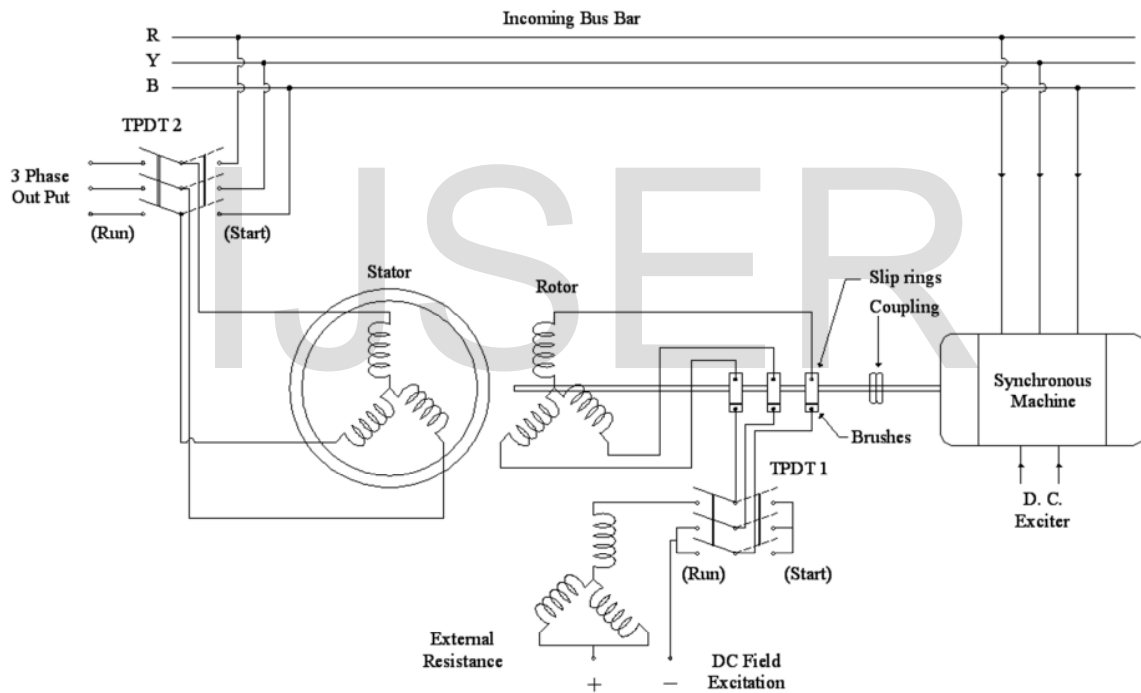


Fig.2 (a) Back to back prime mover

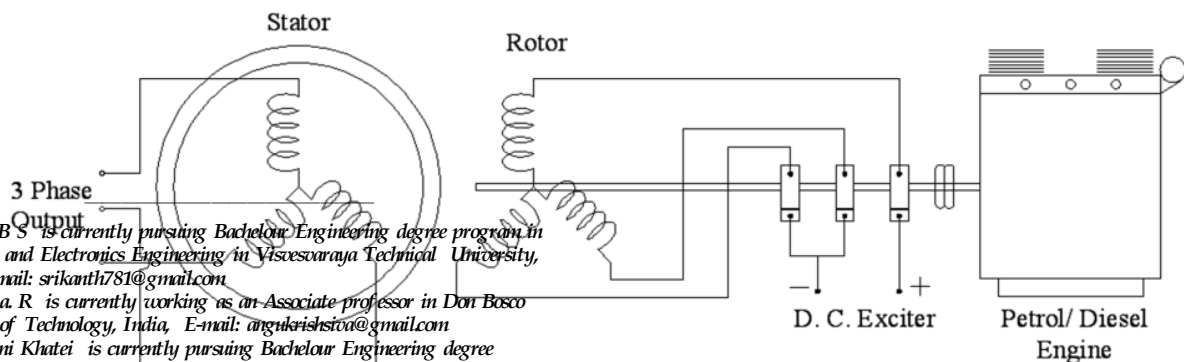


Fig. 2 (b) Driven by petrol/ diesel engine

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4. Results and Discussion



The study of alternator shows that the rotor resistance is large when compared with slip ring induction motor. (i.e. alternator rotor resistance is 65Ω and slip ring IM rotor resistance is 1.2Ω) The rotor resistance of alternator is more because it has to withstand the applied field excitation.

4.1 Start Mode:

In Fig.2 (a) it shows the two AC motors i.e. slip ring induction motor and synchronous motor is used to generate power. Initially while starting the synchronous motor it is subjected to 3 phase supply and driven by a slip ring induction motor which acts as prime mover, the TPDT switch 1 & 2 are positioned to start, where induction motor acts as a squirrel cage induction motor and drives the synchronous motor. When this synchronous motor attains a sub-synchronous speed its field is excited by an external

DC supply and thus the motor is pulled to synchronism. It is as shown in Fig.3 (a)

Gradually the voltage is applied to stator terminals with the help of auto transformer, 415V and it takes a current of 4 Amps and reaches the sub-synchronous speed of 1489 RPM and field excitation of 130V DC is given to synchronous motor.

4.2 Run Mode:

TPDT switch 1 & 2 are opened and now the induction motor is in free running which is driven by the synchronous motor. Hence the name back to back prime mover. Now, the induction motor is excited by a 130V DC supply through slip rings via external resistance by closing the TPDT 1 to run mode, later close the TPDT 2 to run mode as shown in the below Fig.3 (b). Due to faradays law of electromagnetic induction an EMF is induced in the stator windings and it is available at stator terminals. And can be used directly to the load. Now a slip ring induction motor is actually working as an alternator. The generated EMF and the capacity is determined by the name plate details of that induction motor which is given by the manufacturer based on its construction.

The Fig.2 (b) gives another modified approach where the slip ring induction motor is driven by an external petrol/ diesel engine and the slip terminals are excited by the DC supply. Hence due to faradays law of electromagnetic induction than EMF is induced in stator winding and is available at stator terminals.

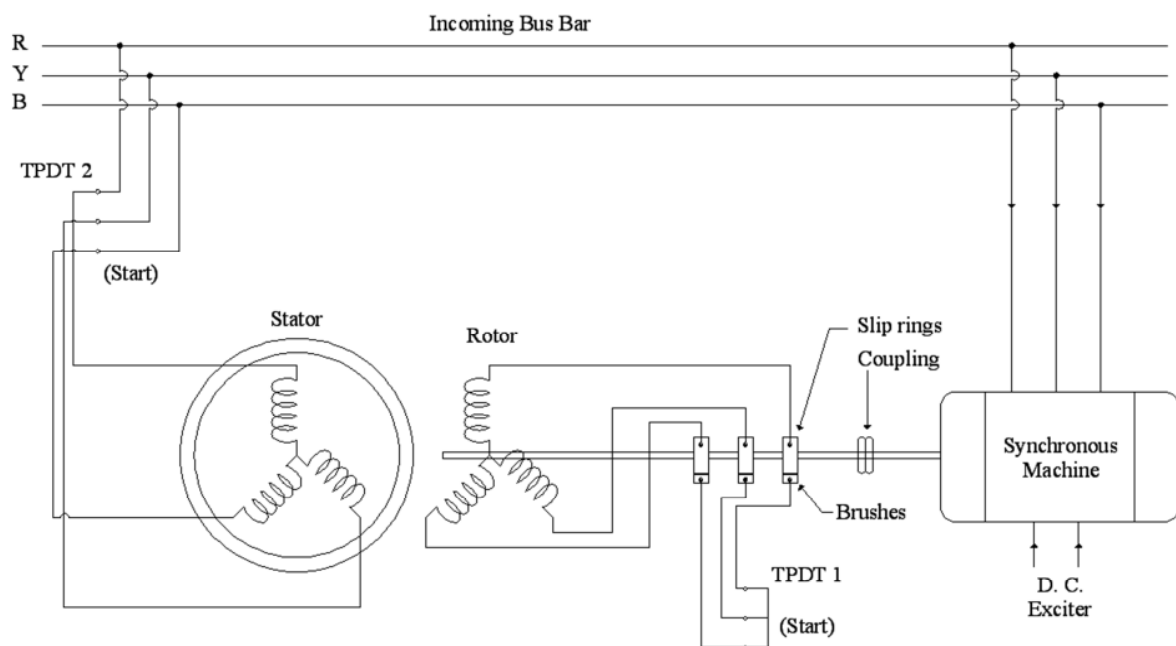


Fig.3 (a) Start Mode

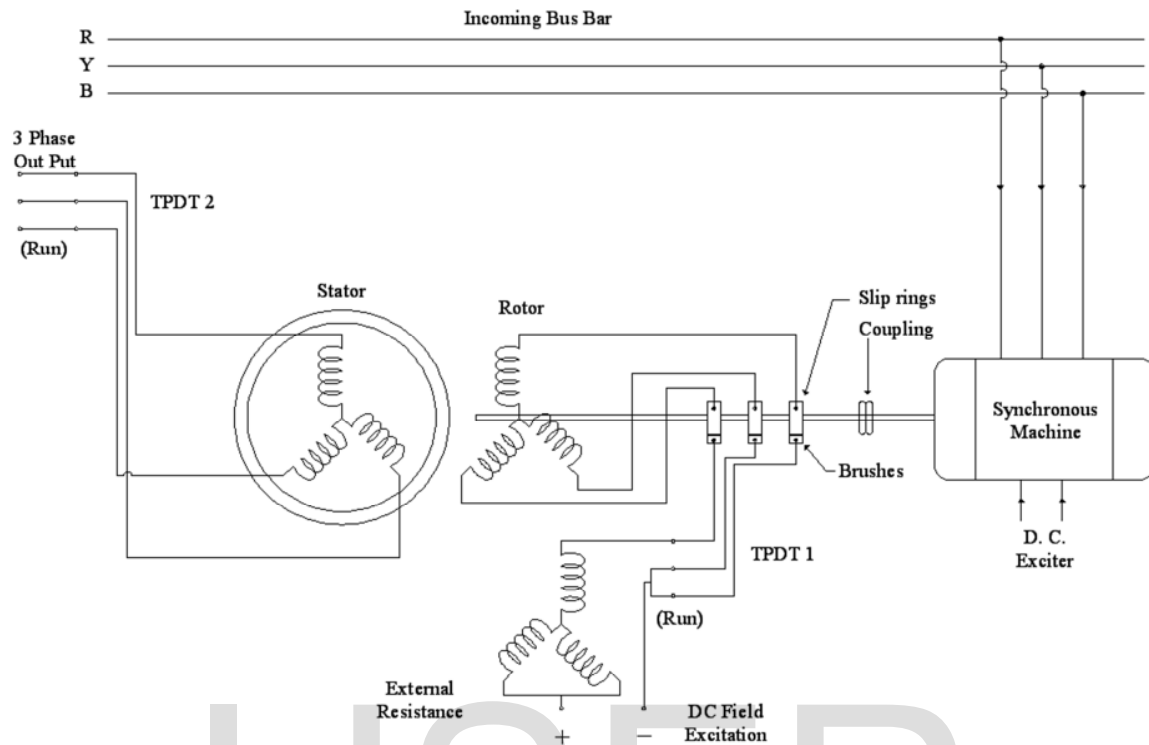


Fig.3 (b) Run Mode

5. Conclusion

The results of this approach indicated that a slip ring induction motor can be made to work as an alternator. In industrial applications this can be used as a supplementary back up, acting as an alternator in case of emergency during blackouts. It also increases the significance of slip ring induction motor for its dual function and cost effective compared to synchronous motor.

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