UNIVERSAL MOTOR

There are small capacity series motors which can be operated on d.c. supply or single phase alternating supply of same voltage with same characteristics, called universal motors. The general construction of such motor is similar to that of a.c. series motor as discussed in last article. It is manufactured in two types.

i) Non compensated, low h.p ii) Compensated type, high h.p.

Non compensated type pole has 2 poles, having entire magnetic path as laminated. Armature is wound type similar to the normal d.c. motor. Such non compensated construction is shown in the Fig. 5.7.1

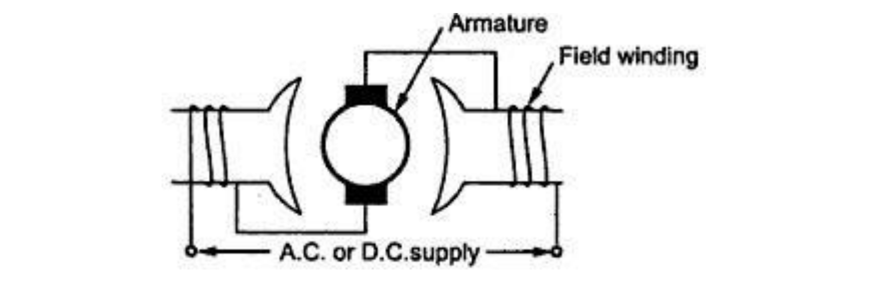

Fig.5.7.1 Cross-section of non compensated universal

While in compensated type, the motor has distributed field winding consisting of main field and compensating winding. This is some what similar to the stator of split phase single phase induction motor type construction. This also has a wound armature similar to the normal d.c. motor. Fig.5.7.2 shows the connection diagrams for both the types of universal motor.

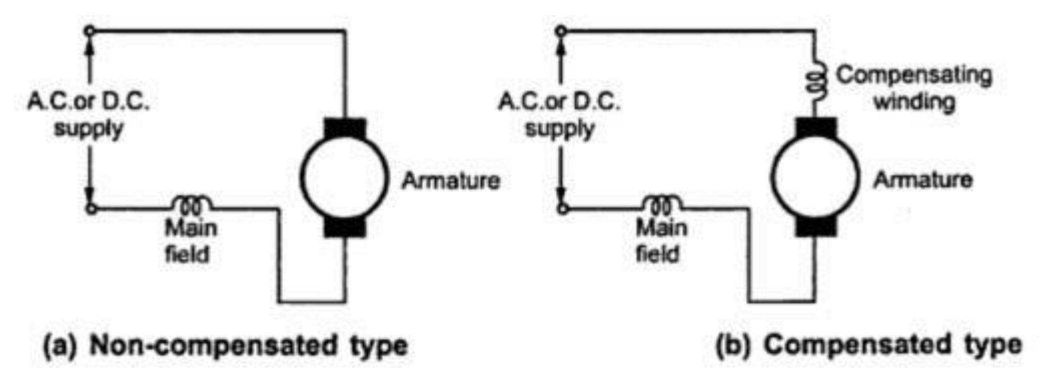

Fig. 5.7.2 Connection diagrams for a universal motor

Speed torque characteristics : The speed - torque characteristics for both the types of universal motor are shown in the Fig.5.7.3

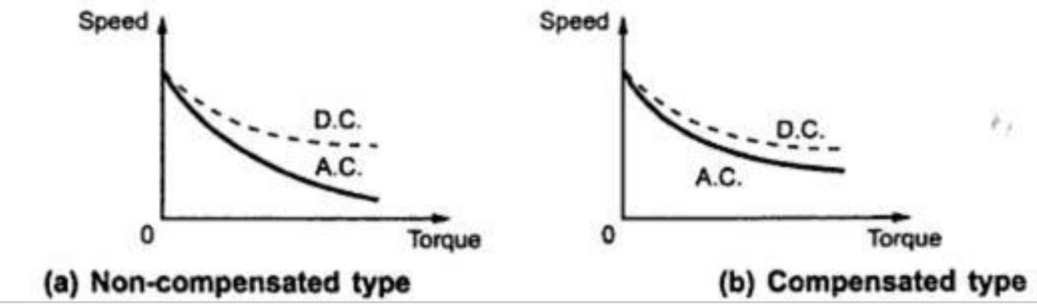

Fig.5.7.3 Speed-torque characteristic of universal motor

Compensated type universal motor has better speed - torque characteristics i.e. the characteristics are same for the operation of motor on a.c. or d.c. supply. The motors are generally designed for full load operation speeds ranging between 3000 to 20000 r.p.m.

Applications : Though compensated type characteristics are better, the non compensated type are more preferred for low h.p. applications. While compensated type of universal motors are preferred for h.p. applications. High starting torque is the important feature of universal motors.

The universal motors are used for domestic applications like vacuum cleaners, food processor and mixers, hair driers, coffee grinders, electric shavers etc. Their other applications are blowers, portable tools like drilling machines and small drivers.

Reversal of Rotation of Universal Motors

By reversing the flow of current through the armature or field windings, the direction of rotation can be reversed for salient pole non compensated type universal motor. This is possible by interchanging the terminals on brush holders as shown in the Fig. 5.7.4

In case of compensated type, the armature or field loads are interchanged and brushes are shifted against the direction of rotation of motor, to achieve the reversal of direction.

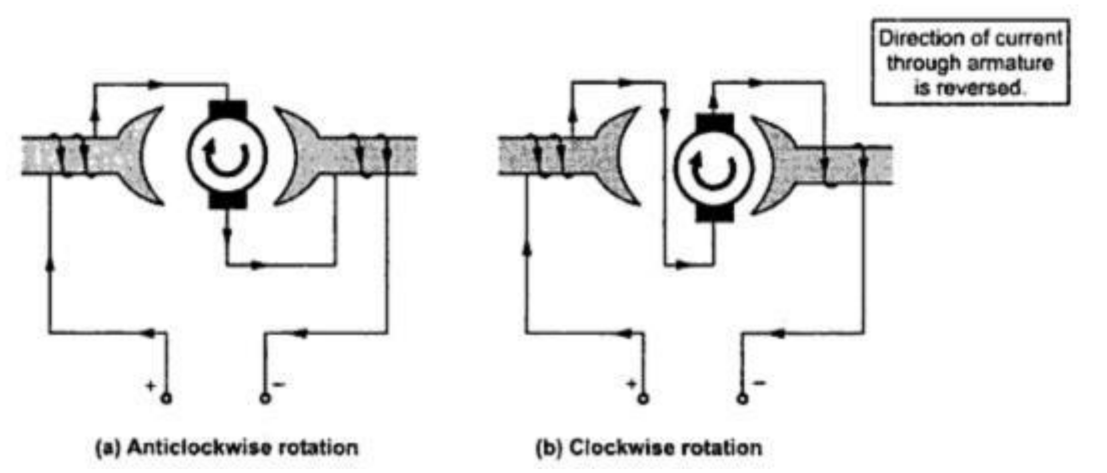

Fig.5.7.4 Reversal of rotation of universal motors

A.C. SERVOMOTOR

Construction

The a.c. servomotor is basically consists of a stator and a rotor. The stator carries two windings, uniformly distributed and displaced by 90^o in space, from each other.

On winding is called as main winding or fixed winding or reference winding. The reference winding is excited by a constant voltage a.c. supply.

The other winding is called as control winding. It is excited by variable control voltage, which is obtained from a servo amplifier. The winding are 90^o away from each other and control voltage is 90^o out of phase with respect to the voltage applied to the reference winding. This is necessary to obtain rotating magnetic field.

The schematic stator is shown in the Fig. 5.7.5

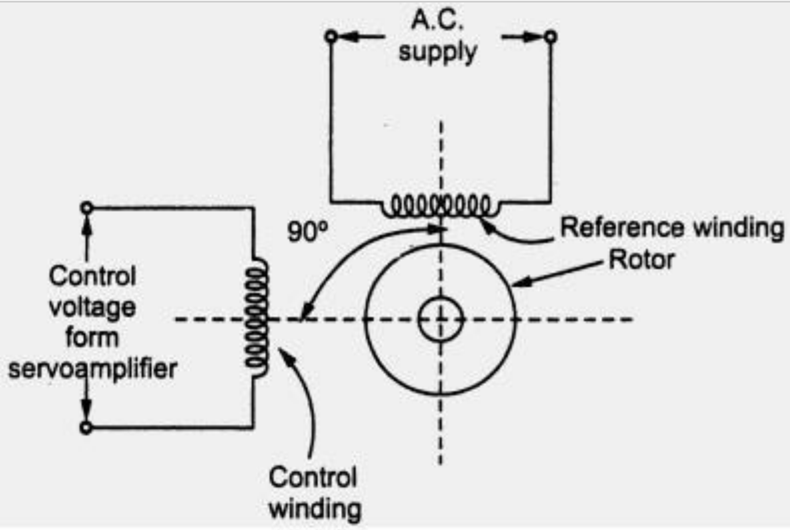

Fig. 5.7.5 Stator of a.c. servomotor

To reduce the loading on the amplifier, the input impedance i.e. the impedance of the control winding in increased by using a tuning capacitor in parallel with the control winding.

Rotor

The rotor is generally of two types. The two types of rotors are,

1. Squirrel cage rotor
2. Drag cup type rotor

Squirrel Cage Rotor

The usual squirrel cage rotor has aluminimum bars which are shorted at the ends with the help of the end rings. The overall construction looks like a cage. The construction is similar to the squirrel cage rotor used for the three phase induction motors.

This has small diameter and large length. This is because to reduce the inertia. Aluminimum conductors are used to keep weight small. Its resistance is high to keep torque-speed characteristics as linear as possible. Air gap is kept very small which reduces the magnetism current. The cage type of rotor uses the skewed bars as shown in the Fig. 5.7.6

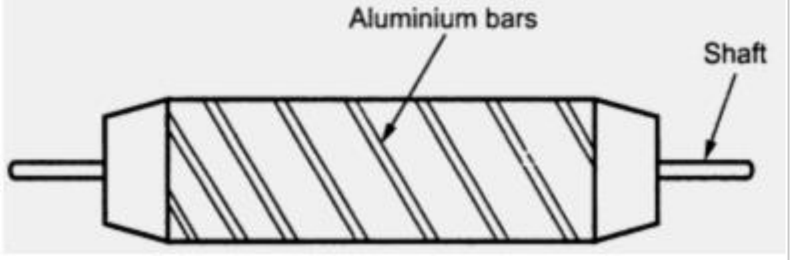

Fig. 5.7.6 Cage type rotor

To reduce the inertia further, a drag cup type of rotor construction is used. There are two air gaps in this construction. The drag cup is made up of nonmagnetic material like copper, aluminium or an alloy. The slotted rotor laminations in this construction. These are wound for as many number of poles as possible so that operating speed of motor is very low. Such a construction is used in very low power applications. A drag cup type rotor construction is shown in the Fig. 5.7.7

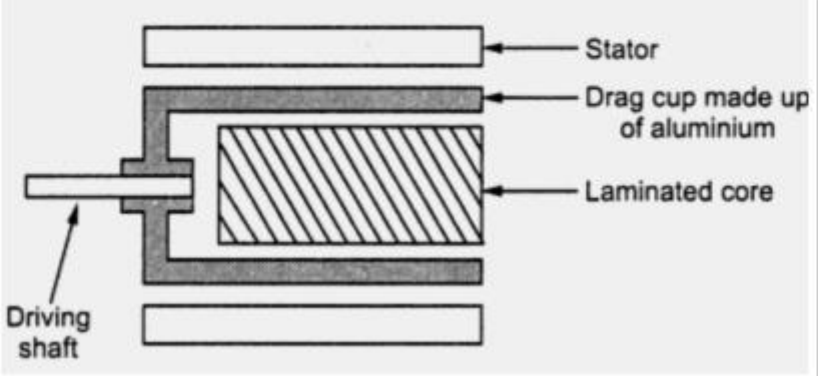

Fig.5.7.7 Drag cup type rotor construction

Operating Principle

The operating principle of two phase a.c. servomotor is same as that of normal three phase induction motor. The control voltage applied to the control winding and the voltage applied to the reference winding are 90^o out of phase. Hence the flux produces by current through control winding is also 90^o out of phase with respect to the flux produced by the current through the reference winding. The resultant flux in the air gap is hence rotating flux sweeps over the rotor, the e.m.f. gets induced in the rotor. This e.m.f. circulates the current through the rotor. The rotor current produces its own flux called as rotor flux. This flux interacts with the rotating magnetic field, producing a torque on the rotor and rotor starts rotating.

In the two phase a.c. servomotors, the polarity of the control voltage determines the direction of rotation. A change in the sign of the control voltage reverses the direction of rotation of the motor. Since the reference voltage is constant, the torque and the angular speed are the functions of the control voltage.