Eddy-Current Couplings For Variable Speed Drives In Paper Industry

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Introduction

D. C. and various A. C. Commutator Motors are used as conventional drives for speed control. Sq. Cage Motor with Eddy-current coupling is rather a recent development in the country and will definitely make its own way in the field of speed control for its simplicity, reliability and low cost.

What is Eddy-current coupling ?

By using a field member from the salient pole synchronous alternator and surrounding this with a smooth ring of steel or inductor and so supporting both members on bearings that they can rotate independently, a form of eddy-current clutch is obtained. As the drum rotates relative to the poles of the field, eddy currents are generated in the drum. These currents form a pattern of magnetic poles on the inner surface of the drum. Magnetic attraction between the field poles and the poles generated in the drum cause the development of torque, consequently the field tends to follow the drum in rotation. Increasing the rate of slip with constant excitation applied to the field generates stronger eddy currents, thereby increasing developed torque. By gradually increasing the direct current to the field member, a subsequent increase in torque developed may be obtained thereby gradually bringing the load upto speed.

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OPERATING CHARACTERISTICS :

(1) Speed Torque Characteristics: The output torque obtained from eddy coupling, (transmited from a Sq. Cage motor to the driven load) is the same as that of the Sq. Cage motor. It provides an adjustable speed drive that transmits the rated torque throughout the speed range. Thc torque-speed characteristic also depends on its external controls. These can be designed either for a constant torque or a variable torque, depending on the requirements of the application (Fig. 1 & 4).

(2) **Maximum Speed** :

A speed difference between the motor and the output shaft is necssary for a torque transmissions through eddy coupling. Hence the top speeds should be designed to be 80% of the synchronous speeds of the motor. The rated output power, therefore, should be taken 80% of the motor.

(3) Minimum Speed :

The minimum speed is approximately 1/20 of the top speed. For short time operation, it is practicable to achieve the speed strictly from zero rpm.

(4) Speed Regulation & Control :

Execellent speed control with good flexibility is easily obtained through the use of electronics, transistors, and magnetic amplifiers, Thyristors, due to the low excitation requirements. (A typical system diagram is shown in Fig. 2). Circuitry in most cases employs a tacho-generator mounted on the output shaft. The voltage from the generator is connected in series opposition with a reference or speed-setting voltage. The sum ef these two voltages is fed into the coil of the magnetic amplifier or into the firing circuit of appropriate thyratron or thyristor. Antihunt circuits are usually employed to help stabillze this electromechanical system. Control-system accuracy as close as 0.1 percent is possible from onequarter to full load with execellent long-term stability.

For paper mill Finishing House equipment like Reelers, Slitters and Cutter drives when the load

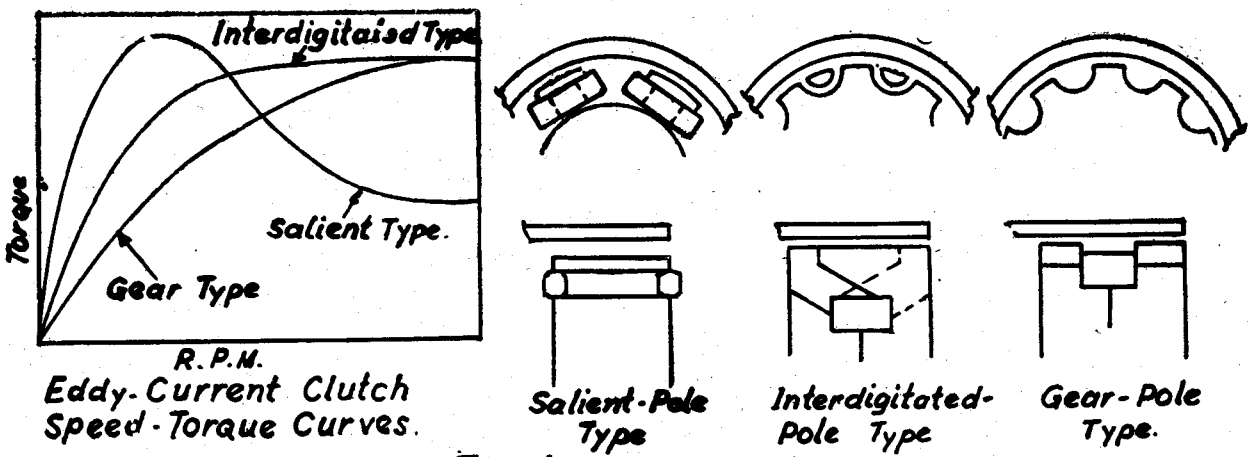

Fig. 1.

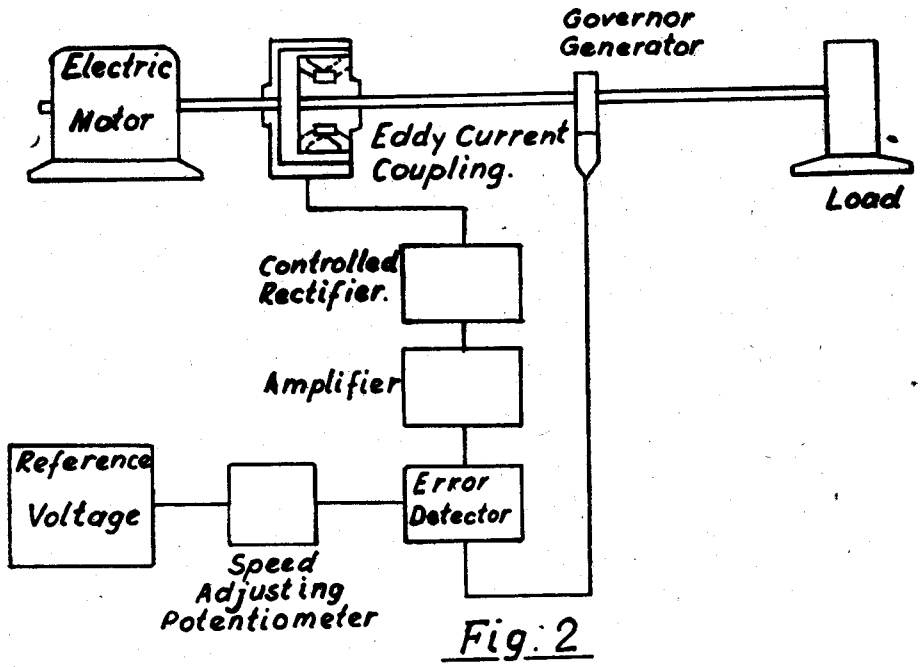

Fig. 2

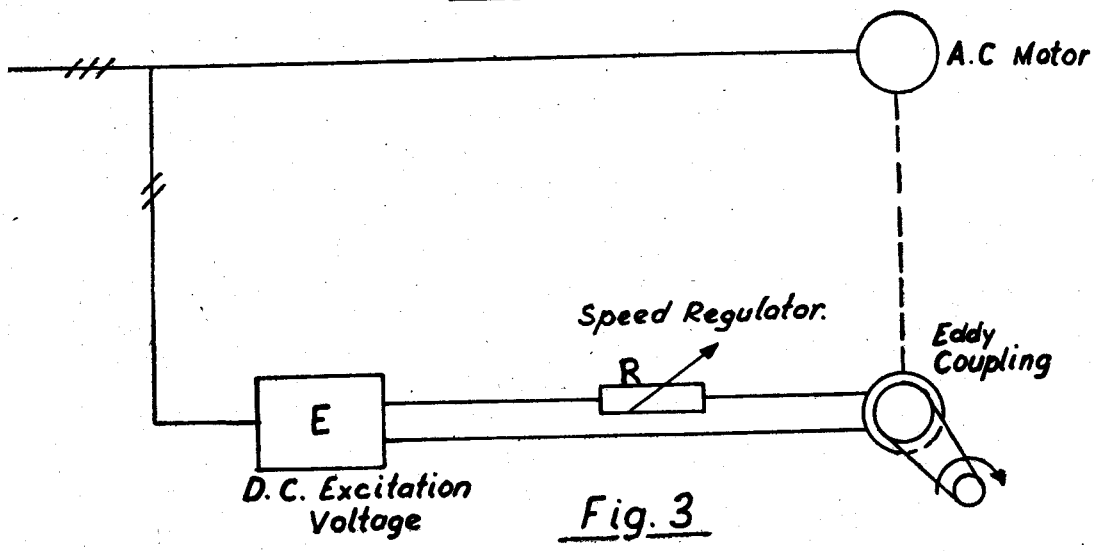

Fig. 3

is fairly constant a single Rheostate Control is sufficient and no feed back is necessary (Fig.3).

Economics of Efficiency and Running Cost :

The major component of the total "coupling loss" is the slip power apart from standard losses like friction, windage, field coil energy. Therefore, increase in slip reduces the efficiency of an eddy current motor.

The effiiciency of eddy-current couplings is approximately the equivalent of a wound rotor motor with similar operating conditions, and in some cases it exceeds that of d-c equipment at higher output speeds. With regard to efficiency at full load and speed, better than 96 per cent can be obtained. Excitation requirements are small, usually not more than 2 per cent of the total power handled, depending upon the size of the machine. These have added advantage over Thyristor controlled D. C. Motors as harmonics and line surges due to chopped waves are totally absent.

Reliability :

Because of the total absence of slip-rings, commutators, carbon brushes, the mechanism becomes very simple. The control units of alternative systems like thyristor controlled D. C. motors, inverter fed induction motor, are completely absent. Therefore, chances of failure are less. In areas where reliability and flexibility are more important than efficiency, eddy current couplings have a decided advantage over other conventional drives.

Application :

Many control variations, such as torque limit, controlled acceleration, and controlled tension, are available. Torque limit is accomplished by incorporating a current transformer in one leg of the drive motor, the signal of which is fed into the control system. Tension control incorporating eddy-current coupling is noted for its high degree of smoothness and is applied in the paper and chemical industry. Multiple-drive systems are easily coordinated. In Paper Industry examples are as following.

(1) Helper drive for paper machine.

(2) Follower drvies (speed follower like dandy).

(3) Fan pump drives.

(4) Drive of Rewinder, cutter etc.

(5) Calender drives.

(6) Rewinders with Tension Control.

The present range of manufacture in India is limited to 40 KW and these are likely to be more suitable for driving paper converters in finishing House and other similar applications for the time being.

TORQUE–SPEED CURVES 7.5 kw.

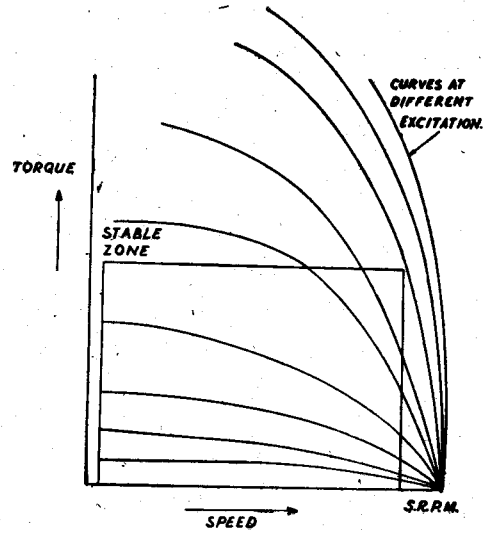

Fig. 4

Comparative assessment of conventional variable Speed motor vs Eddy current speed control

	Eddy Coupling	D. C. Motor	A. C. Commutator Motor
Price	Low	High (with power source)	High.
Minimum Speed	Zero	Crawl	Comparatively high
Speed control range	0 to 80% of srpm of motor	20 : 1 by armature control	4 : 1
Stability and control	Easy	Easy	Manual or pilot operated brush shifting gear is required
Maintenance	Easy, highly reliable	Standard commutator and carbon brush trouble	A lot of commutation trouble
Repair	Simple	Rewinding is costly	Very complicated winding for repair
Efficiency	Low at lower speed but at higher speed comparable to D. C. Motor	Good	Inferior to D.C. Motor
Overall economy	Upto 50 H. P. where the equipment is run for most of the time above 50% of srpm. It is highly recommended.	Initial cost is comparatively higher	Higher initial and recurring maintenance trouble

N. B. Drives with variable frequency power source (cycle-converters) and Sq. Cage Motor have not been considered here for its limitation of speed range and cost. However, cycle convertors are popular in Machine Tool drives.