

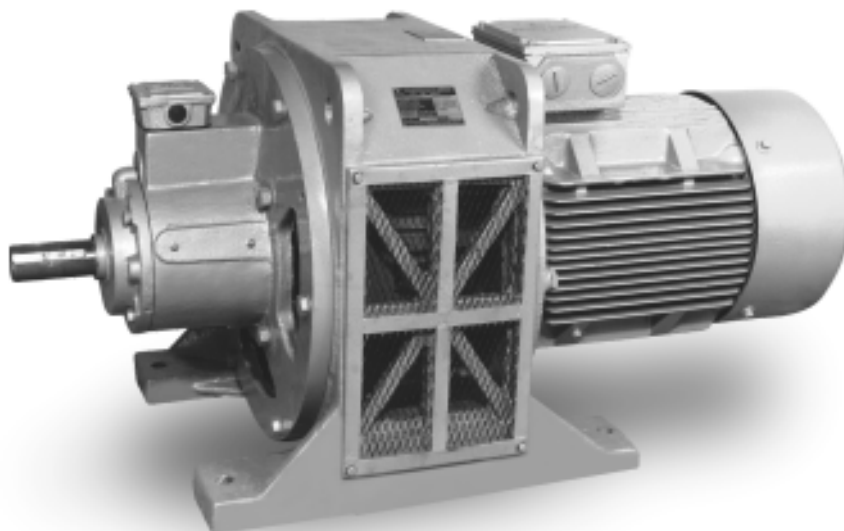
# POWERMAG

## OPEN SELF-VENTILATED AIR-COOLED EDDY CURRENT ADJUSTABLE SPEED DRIVE

When properly installed, operated and maintained, POWERMAG EC Drive will provide a lifetime of optimum operation. It is mandatory that the person who operates, inspects, and maintains the EC Drive thoroughly read and understand this manual.

POWERMAG EC Drive is an AC-operated variable speed motor which contains EC coupling (eddy current coupling) and three-phase squirrel-cage induction motor.

This manual primarily describes EC Drive, but contains some information related to EC Drive controller. For details of the operation of individual units, refer to their respective manuals.



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## 1. SAFETY PRECAUTION

High voltage and rotating parts can cause serious or fatal injury. The use of electric machinery, like all other utilization of concentrated power and rotating equipment, can be hazardous. Installation, operation, and maintenance of electric machinery should be performed by qualified personnel. Familiarization with your national electrical code, and sound local practice is recommended.

For equipment covered by this instruction book, it is important to observe safety precautions to protect personnel from possible injury. Among the many considerations, personnel should be instructed to :

1. Avoid contact with energized circuits or rotating parts.
2. Always disconnect electrical power at the motor controller, fuse box, or circuit breaker before handling electrical connections. Double check to be sure power is OFF, and that it cannot be turned ON while you are working on the equipment.
3. Be sure unit is electrically grounded and proper electrical installation wiring and controls are used consistent with local and national electrical codes.
4. Be sure equipment is properly enclosed to prevent access by children or other unauthorized personnel in order to prevent possible accidents.
5. Be sure shaft key is fully captive before unit is energized.
6. Provide proper safeguards for personnel against rotating parts and applications involving high inertia loads which can cause over-speed.
7. Avoid extended exposure in close proximity to machinery with high noise levels.
8. Use proper care and procedures in handling lifting, installing, operating and maintaining the equipment.
9. Be familiar with the equipment and read all instructions thoroughly before installing or working on equipment.

## 2. RECEIVING

This unit has been put through severe tests at the factory before shipped. After unpacking. However, check for the following.

<b>POWERMAG EC DRIVE</b>	
MODEL : FTAC	DUTY : CONTINUOUS
TORQUE : 3.6 Kg-M	RPM : 1200-120
MAX. EXCITATION	80V / 5A DC
BEARINGS	DE : 6309ZZ NDE : 6308ZZ
M/c No. : 01234	MONTH/YEAR : 04/05
MADE IN INDIA BY : <b>POWERMAG CONTROL SYSTEMS (P) LTD.</b> P.O. BOX 2093, COIMBATORE - 641 006.	

- Its nameplate rating meets your requirements.
- After removing the shaft clamping block of the motor, if equipped, hand-rotate the shaft to see that it rotates freely and that no binding exists.
- It has sustained no damage while in transit.
- Bolts and screws are not loose.

If any part of the unit is damaged or lost, immediately notify your Powermag representative, giving full details and nameplate data.

## 3. HANDLING

This unit is rigidly constructed of the finest material available. Care must be exercised in handling it properly. Dropping, jarring or pounding on a shaft can cause serious damage to bearings and other components. Caution should be used to avoid damaging the air discharge grilles on the motors.

Complete motors can be lifted with a crane through hooks or slings in the eyebolt(s) or hanger(s). Motor must be disconnected before lifting. The eyebolts or hangers are designed to safely carry the weight of the whole machine. When lifting motors having two hangers, both hangers must be used. Failure to do so will result in damage to the motor and the hanger as well.

## 4. STORAGE

If the unit is not to be installed immediately. It must be stored in a clean, dry indoor place below 40°C and protected from high humidity, corrosive gases and liquids, and be free of ambient vibration.

When placed in storage or prolonged shutdown for a period in excess of three months, hand-rotate the output shaft every three months to redistribute bearing grease and to prevent bearings from becoming brinelled.

When starting after long storage, thoroughly clean the motor interior as described on page 23 and check the insulation real resistance on page 23.

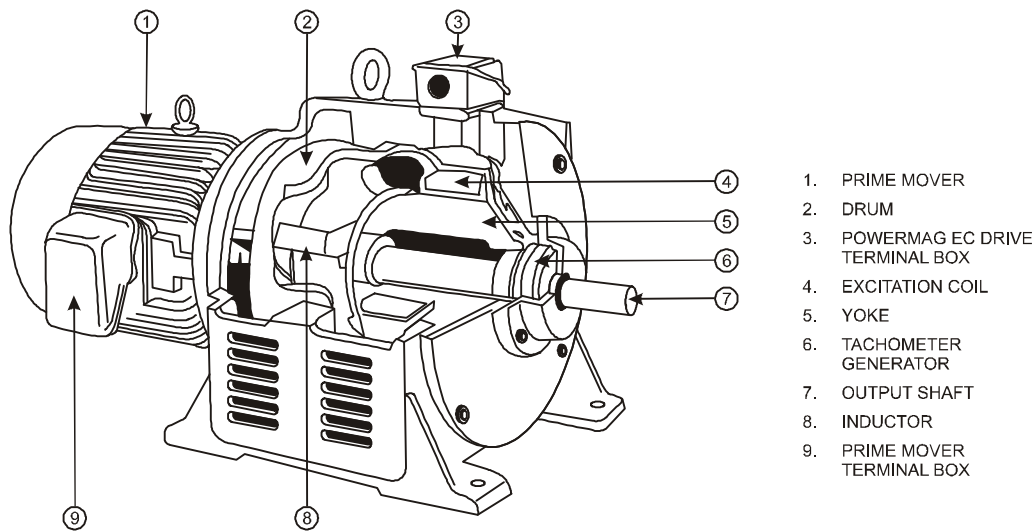
**5. CONSTRUCTION**

The standard POWERMAG EC DRIVE, the drive motor (Special), a totally enclosed, fan cooled, flange type three phase squirrel cage induction motor is mounted on to an eddy current coupling, having a protected, self-ventilated common frame design.

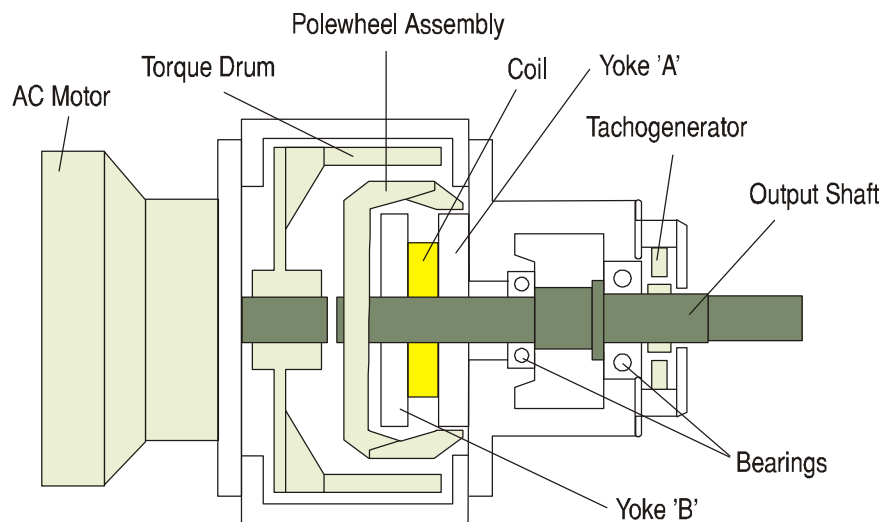
Eddy current coupling consists of an inductor, drum, frame and coil and is cooled by the fan integrated with drive motor. Refer Fig. 2 & 3

D-C power is applied to a ring-shaped excitation coil located between frame and bracket. Tachogenerator mounted on the output shaft of Powermag EC Drive, generates the voltage and frequency proportional to the shaft speed.

**SECTIONAL VIEW OF POWERMAG EC DRIVE**

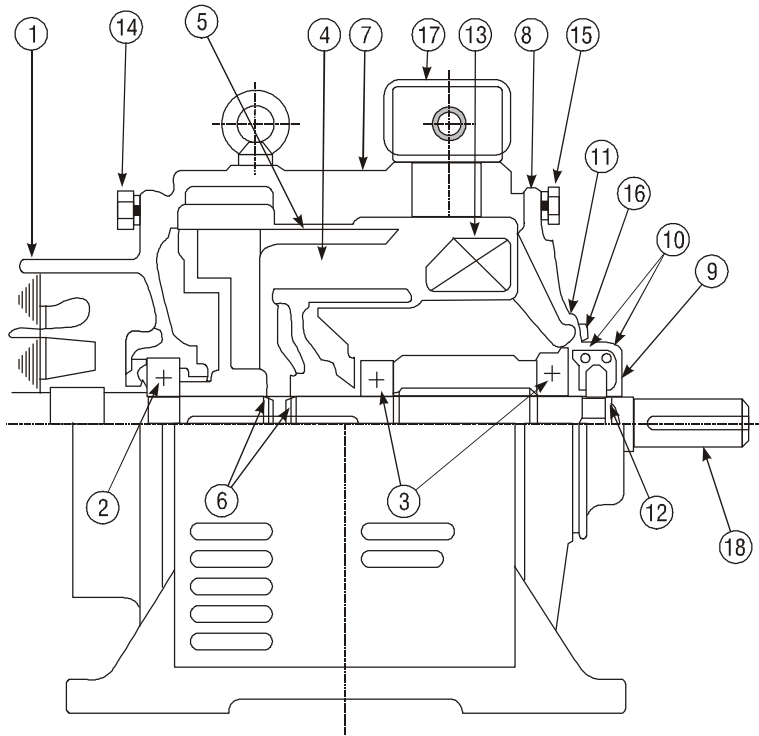


**Fig. 1-A. Sectional View of Powermag EC Drive - 0.37kW to 11kW**



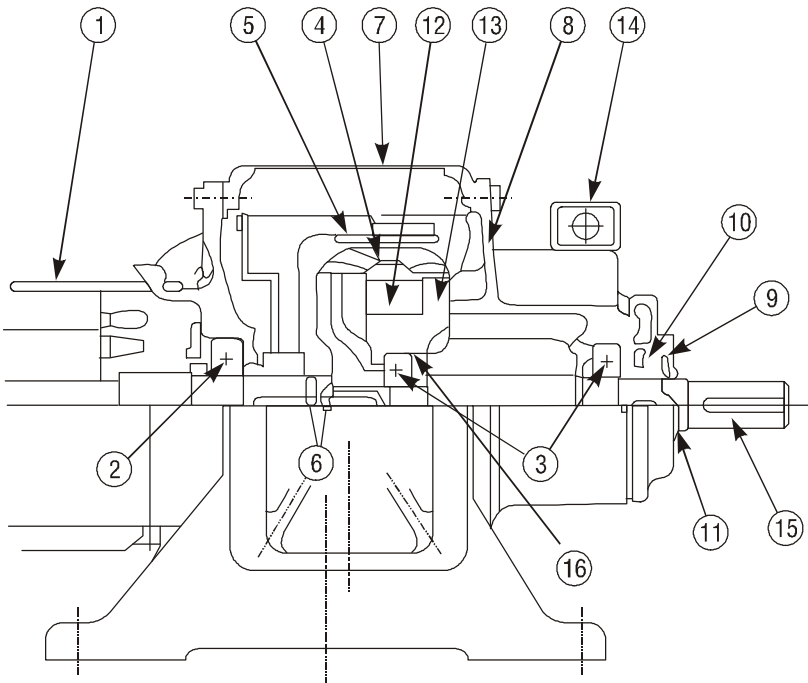
**Fig. 1-B. Cross Sectional View of Powermag EC Drive - 15kW to 90kW**

SECTIONAL VIEW OF POWERMAG EC DRIVE



- 1. Squirrel cage induction motor
- 2. Motor Bearing
- 3. EC Drive coupling bearings
- 4. Inductor
- 5. Drum
- 6. Circlips
- 7. Frame (Yoke)
- 8. Bracket
- 9. Bracket Cover
- 10. Tachogenerator
- 11. Bearing Cover
- 12. Circlip
- 13. Excitation Coil
- 14. Prime mover clamping bolt
- 15. Bracket clamping bolt
- 16. Bracket cover clamping bolt
- 17. Terminal Box
- 18. Output Shaft

Fig. 2 . Sectional View of 0.4 - 11 kW Powermag EC Drive



- 1. Squirrel cage induction motor
- 2. Motor Bearing
- 3. EC Drive coupling bearings
- 4. Inductor
- 5. Drum
- 6. Circlips
- 7. Frame
- 8. Bracket
- 9. Bracket Cover
- 10. Tachogenerator
- 11. Circlip
- 12. Excitation Coil
- 13. Yoke
- 14. Terminal Box
- 15. Output Shaft
- 16. Grease Valves

Fig. 3 Sectional View of 15-90 kW Powermag EC Drive

## 6. SPECIFICATIONS

Ratings (HP)	0.5, 1, 2, 3, 5, 7.5, 10, 15, 20, 30, 40, 50, 60, 75 & 100
Synchronous Speed	1500 RPM
Ventilation	Open self-ventilated, air-cooled
Coil Voltage	85 VDC max. for short time, 0-45VDC continuous
Coil Current	2.5A max. for 0.5 HP - 15 HP, 5A for 20 HP - 100 HP
Ambient Temperature	-5°C to 40°C max.
Operating altitude	Below 1000 Mts.
Service factor	1
T.G. Voltage	20V r.m.s / 1000rpm for 1500rpm drives

### Tachogenerator

Classification	Single phase, integral mouting
Application	0.5-100 HP
Wattage	2-3 Watts
Frequency / 1000 RPM	400 Hz
No. of poles	48
Linearity (Voltage)	0.5%
Standard output voltage / 1000 RPM	20V AC

### Basic control unit specification

Input Voltage	220/240V AC ( $\pm 10\%$ ), 1 $\Phi$ , 50 Hz. (Phase & Neutral)
Output Voltage	0-85VDC
Output Current	2.5A for models upto 15HP, 5A for models from 20HP to 100HP
Speed control range	10:1
Ambient Temperature	-5°C to 40°C
Altitude	Below 1000 meters
Damping	Speed control is specified for a load, which is atleast 10% of the rated load. Hunting and instability may result if load torque is less than 5% of the rated torque.

**SPECIFICATION CHART FOR 1500 RPM DRIVE**

Drive Rating (HP)	Rated Torque (kg.m)	*Coil Resistance (□ ±10%)	*TG Resistance (□ ±10%)
0.5	0.24	22	19
1	0.5	22	19
2	1.0	22	19
3	1.45	22	19
5	2.4	22	19
7.5	3.6	22	19
10	4.9	22	19
15	7.13	22	13
20	9.7	12.8	13
30	14.2	12.8	13
40	19.4	12.7	13
50	23.75	11.2	13
60	28.9	11.2	13
75	34.9	11.2	13
100	49.0	11.2	13
120	57.0	11.2	13

\*Subject to change

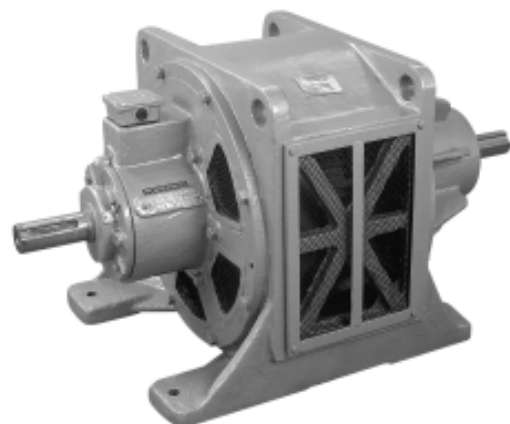
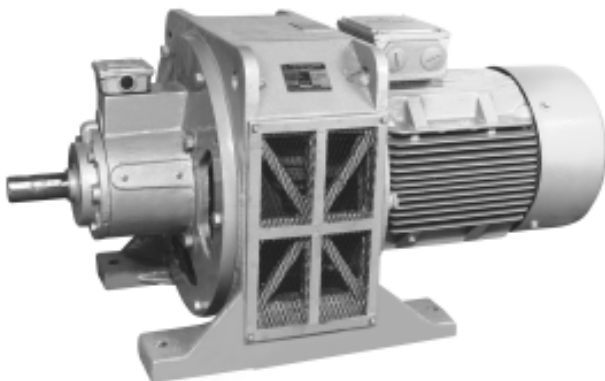
**GENERAL DESCRIPTION**

**INTEGRAL DESIGN**

In this construction, a special induction motor, flanged to the eddy current coupling, forms an integral part of the eddy current drive. While this construction offers an advantage of size compactness, the motor used is not according to I.S. standards of shaft and flange dimensions.

**MODULAR DESIGN**

The eddy current coupling, in this case, is of independent, foot mounted construction, has an input shaft, which can be coupled to any standard foot-mounted AC induction motor. The induction motor can be aligned on a common bed-plate and coupled to the input shaft of the eddy current



coupling through a suitable coupling. Mounting flexibility and variations are possible. For instance, the motor can be conveniently positioned on the side, top or below the eddy current coupling, the input shaft of which can be coupled to the motor shaft by means of V-belts.

### TACHOGENERATORS

All drives are supplied complete with built-in-48 pole AC tachogenerator, mounted on the output shaft of the coupling. The tachogenerator consists of a moulded stator, carrying the active windings, located in a graded aluminium housing. The moulded rotor assembly, which rotates inside the stator, consists of a permanent magnet providing 48 alternating poles around its periphery.

### ELECTRONIC CONTROLLERS

Refer respective instruction manual for controls

### 7. CHARACTERISTICS

Characteristics of Powermag EC Drive when used in conjunction with control for equipment are tabulated in Table 2.

Powermag EC Drive consists of a EC coupling and a prime mover. Specifications of Powermag EC drive as a whole unit, EC coupling and Prime mover are shown respectively.

#### PRIMEMOVER (MOTOR)

- Time Rating : Continuous
- Direction of Rotation : Clockwise or Counter-clockwise
- Installation : Horizontal or vertical
- Connection to load : Direct drive
- Ambient Temperature : -20°C to 45°C

#### EC COUPLING

- Enclosure : Open Ventilated
- Speed Range : 10:1
- Installation : Class F
- Allowable Temperature Rise : 80°C  
(by resistance method)

Controller	Type PM-07
Speed Regulation due to 90% load change	Where allowable voltage fluctuation of AC source is -15% to + 10% 2% (adjustable between 2-20%)
Speed Range	10:1 (1200 to 120 rpm, 50Hz)
Output	80% of output of drive motor at max. rated speed
Load Characteristics	Constant torque or torque reduced in proportion to speed squared

Table 2 Characteristics of Powermag EC Drive

### SELECTION OF EC DRIVE

The rating of Powermag EC Drive is basically selected based on the following parameters

Prime mover speed	Output Speed	
	Max.	Min.
1500	1200	120

### ELECTRICAL CONNECTIONS

A four way terminal block is provided on top side of the eddy current drive for connections of drive coil and tachogenerator. Terminals for coil are marked as E1 and E2. Terminals for tachogenerator are marked as F1 and F2. These terminals should be connected with respective terminals of associated control equipments.

415volts, 3-phase supply should be connected to a separate terminal block provided on side of the induction motor. Necessary short-circuit protection, overload protection, starter etc., should be provided (for motor) by the user as per standard engineering practice.



- Coil input : E1 and E2
- Tacho output : F1 and F2

# POWERMAG

## 8. STARTING

Powermag EC Drive is started by starting only the induction motor, with the Eddy Current coupling not energized, that is started on no load. Across the line starting is employed for Powermag EC drive as no load starting makes starting time short and minimizes shock to power supply during starting.

## 9. INSTALLATION

### 9.1 LOCATION

Powermag EC drive should not be used under the following conditions:

- Exposed to excessive dust.
- Exposed to corrosive gases.
- Outdoors
- Exposed to inflammable or explosive gases.

### 9.2 ENVIRONMENT

The protection category of the Powermag EC drive has to be selected based on the environment of operation. Air cooled

types can be used where the harmful pollutants to the EC drive like moisture, dust, water, chemicals etc. are not present above the harmful limit. Otherwise Fin-cooled types have to be used.

Type of Cooling	Model	Protection Category	Rating (kW)
Air cooled	Integral Foot Mounted	IP 34	0.4 to 90
	Modular Foot Mounted	IP 34	0.4 to 90
	Integral Flange Mounted	IP 34	0.4 to 11
Fin Cooled	Integral Foot Mounted	IP 54	0.4 to 11
	Modular Foot Mounted	IP 54	0.4 to 11

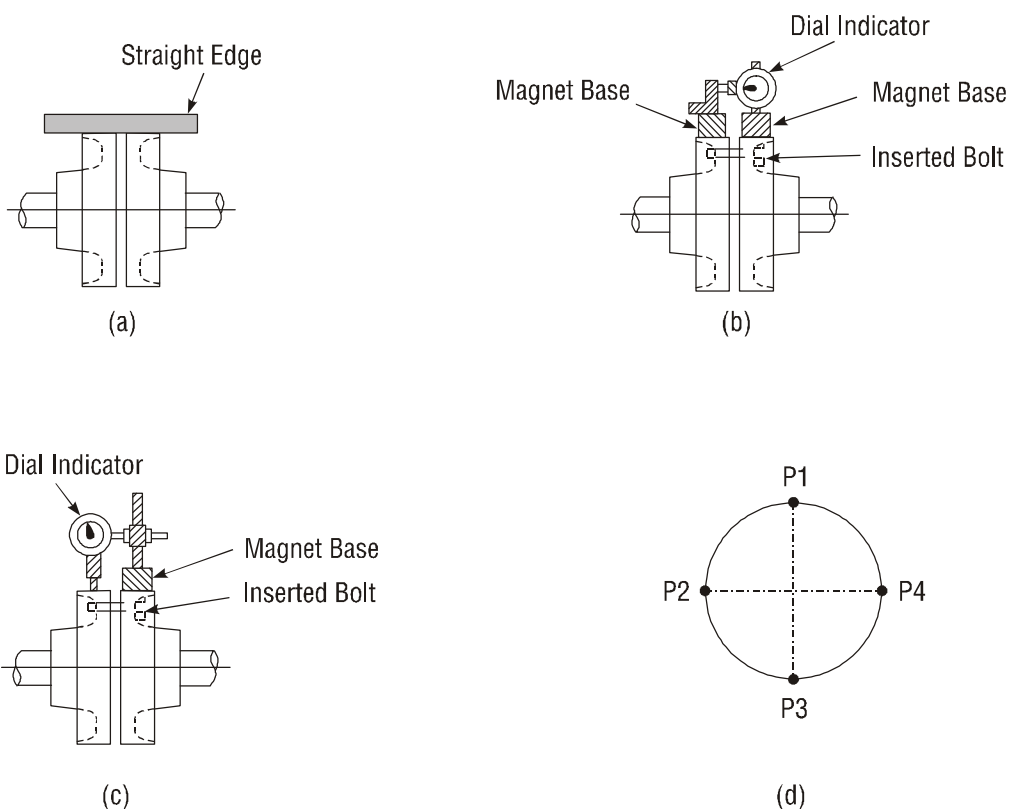


Fig. 5. Shaft alignment



9.3 MOUNTING

Powermag EC drive may be mounted on a sloped base if it is protected from thrust from the driven machine.

9.4 SHAFT ALIGNMENT FOR COUPLING

The shaft of Powermag EC drive and the driven machine should be correctly aligned. Misalignments cause undue stress to bearings and vibration during operation even when the connection is made by means of flexible coupling.

9.4.1 ROUGH CHECK

As shown in Fig 5 (a), apply a straightedge to the upper, lower, right and left side of the coupling hubs and align the centres of both shafts until run-out cannot be observed visually.

9.4.2 ACCURATE CHECK

Check for angular misalignment

To Check for angular misalignment, attach the dial indicator to one coupling hub and place the finger of the indicator against the radially rising auxillary plate rigidly supported on the other hub, Fig. 5(b).

Rotate both shafts simultaneously keeping the finger of the indicator at one point on the auxilliary plate supported on the hub, and register the readings on the indicator dial at each ine-quarter revolution.

Angular misalignment of the shafts should not exceed 0.05mm (0.002 of an inch) for total indicator reading.

It should be noted that distortion of the indicator support may cause errors in measurements.

Check for-run-out

After the shafts are aligned within the limits mentioned above. check the shafts for run-out between the shafts.

Attach the dial indicator on one coupling hub and place the finger of the dial indicator on the other coupling hub as shown in Fig. 5 (c).

Rotate both shafts simultaneously keeping the finger of the indicator at one point on the hub and register the readings on the indicator at each one-quarter revolution. The total or run-out between the hubs should not exceed 0.015mm (0.00059 of an inch.)

Angular misalignment is  $(P_1 - d_f) - (P_3 + d_f) \times \frac{1}{2}$

Axis misalignment is  $(P_2 - P_4) \times \frac{1}{2}$

Where  $P_1 - P_4$  : Indicator readings

$d_f$  : Error due indicator support distortion.

$d_f$  is obtained as follows : Mount the indicator on heavy steel Plate, Fig. 6 and register reading on the indicator positioned as in Fig. 5(a) and (b). The difference between these two readings will be 0.03 to 0.03mm,  $d_f$  is half this difference.

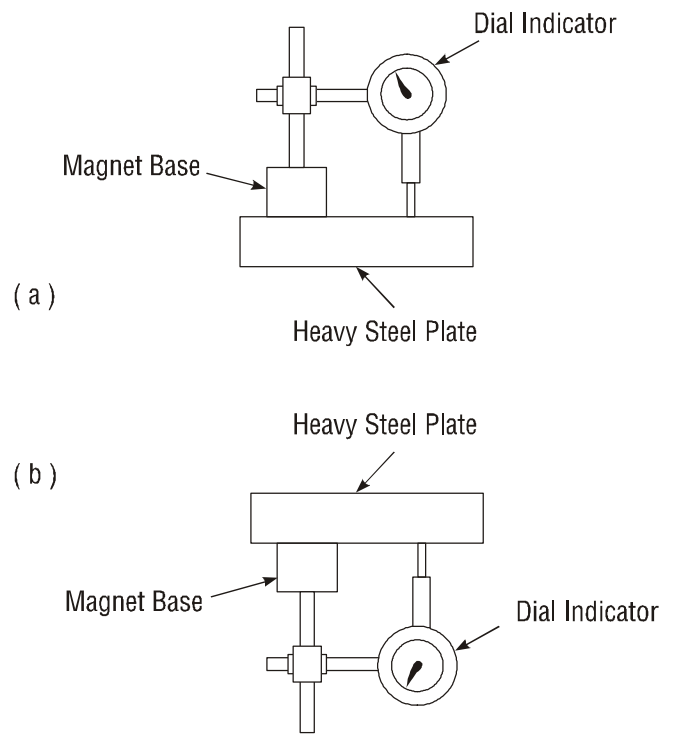
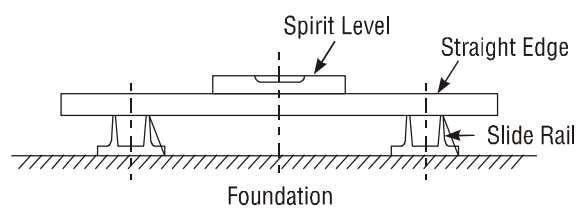


Fig. 6. Measurement of Distortion Error

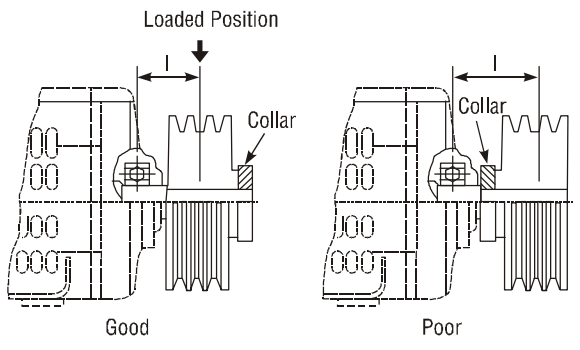
## 9.5 V- BELT DRIVE

- For V-belt drives, the motor will be mounted on a single or two slide rails. When two slide rails are used, leveling must be made as to each rail first, and then on two rails putting a straightedge across the rails and setting the spirit level on it as shown in Fig. 7.1. It is important that the level check be made with all foundation bolts tightened securely.



7.1 Leveling across Two slide rails

- Locate the motor on the leveled slide rails
- When V-belt sheave is mounted on the shaft, the distance (l) between the centers of bearing and V-belt sheave should be made as short as possible to decrease the load exerted on the motor bearing. Fig 7.2



7.2 Mounting of V-belt Sheave

- To check alignment, place a straightedge, or apply a piano wire. Align the motor so that the straightedge contacts both sheave faces squarely, as shown in Fig. 7.3

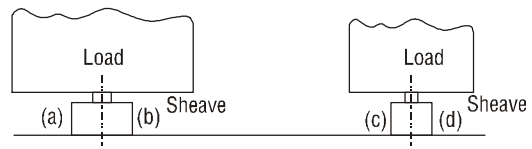
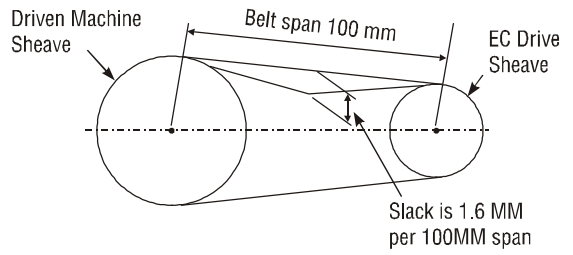


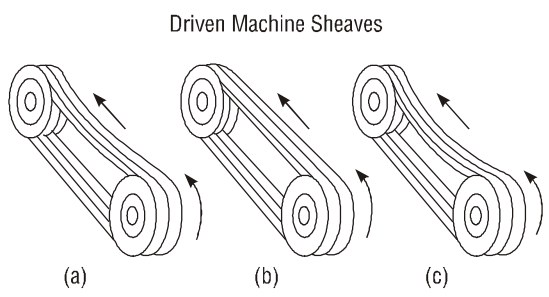
Fig. 7.3 Correct Alignment of Two sheaves

- Apply proper belt tension by using belt-adjusting screws on the slide rails. Too tight belts will cause rapid wear of the belt and shorter bearing life, and not tight enough, belt slip. Belt tension can be easily checked as follows: Press down on each individual belt until the slack becomes 1.6 mm per 100 mm of the belt span.



7.4 Checking for Proper Belt Tension

- After correct wiring and adjustment, operate the unit for a few minutes to see if belt tension has been set properly. An optimum belt tension gives a slight bow on the slack side at full speed as shown in Fig. 7.5(a)



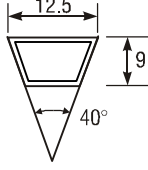
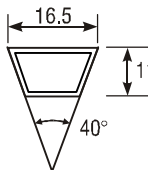
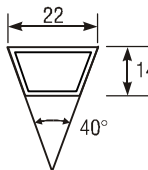
Powermag EC Drive Sheaves

- (a) Proper Tension (b) Excessive Tension (c) Insufficient Tension

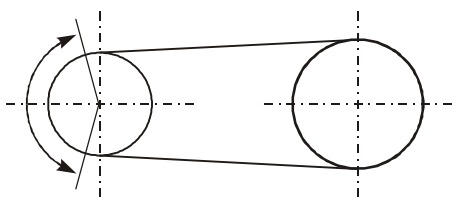
7.5 Checking for Proper Belt Tension

- Recheck the belt tension once a month.

**TABLE 3 - APPLICATION OF V-SHEAVES AND V-BELTS**

Motor Size kW	V BELT (mm)	Dia of Smallest Applicable V-Sheave (mm)	Correction Factor E
0.75 1.5	TYPE A 	100	0.83 1.7
2.2 3.7 5.5 7.5 11	TYPE B 	150	1.0 1.7 2.5 3.4 5.5
15 22 30 37	TYPE C 	230	2.7 4.0 5.5 6.8

**TABLE 4 - CORRECTION FACTOR F FOR ARC OF CONTACT**

Measurement of Arc of Contact	Arc of Contact (deg)	Correction Factor F
 <p>Arc of contact depends on ratio between diameters of and center to center distance between sheaves</p>	120	0.82
	125	0.84
	130	0.85
	135	0.88
	140	0.89
	145	0.91
	150	0.92
	155	0.94
	160	0.94
	165	0.97
	170	0.98
	175	0.99

**TABLE 5 - SERVICE FACTOR K FOR V-BELT DRIVE**

S.No	Operating Conditions	Service Factor
1.	Machine requiring repetition of start and stop	0.20
2.	Machine operated for 16 to 24 hours a day	0.30
3.	Dusty atmosphere	0.25
4.	High temperature upto 60°C (140°F)	0.20
5.	High temperature upto 90°C (190°F)	0.40
6.	Where liquid other than oil may stick	0.20
7.	Horizontal drive	0.20

Where two or more conditions given in table 5 are involved, sum up their service factors and multiply the aggregate by the following value to obtain K:

- When involving two conditions : 0.85
- When involving three conditions : 0.70
- When involving four conditions : 0.60
- When involving five or more conditions : 0.50

Example :  $K = (1) + (3) \times 0.85$   
 $= (0.2 + 0.25) \times 0.85$   
 $= 0.382$

Let us suppose a case where a 3.7 kW EC Drive is to be V-belt connected to a driven machine, The required number of V-belts will be obtained as follows:

- Sheave diameter = 150 from table 2
- E = 1.7 from Table 2
- F = 0.92 from Table 3, assuming arc of contact as 150° C
- K = 0.382, same as example given above.

Consequently,

The number of belts  $N = E \times \frac{1 + K}{F} = 1.7 \times \frac{1.382}{0.92} = 2.55$

By counting 0.55 as 1, we have 3 for the answer.

## 10. MAINTENANCE

### 10.1 REMOVAL OF DUST

Keep the Powermag EC Drive clean. Where it is extensively dusty, it is desirable to protect the unit from entrance of dust. Dust may cause the inductor and drum or the drum and frame to be jammed, making it necessary to disassemble the unit for cleaning. Since dust finds its way into the unit more easily when it is at rest than running provide the Powermag EC Drive with a cover when it is to be shut down for a long period.

### 10.2 BEARING TEMPERATURE

The normal temperature rise of the bearing at an ambient temperature of 40°C (104°F) should be less than 50°C (122°F) when measured at the surface of bracket cover. If the bearing temperature rise exceeds the said limit, it may be assumed that either grease is deteriorated or undue stress is applied to the bearing.

In the case of belt drive, poor belting is often attributable to a high temperature of the bearing.

### 10.3 BEARING LUBRICATION

Powermag EC Drive uses either regreasable or shielded ball bearing. Shielded ball bearings are used in 0.4 kW to 7.5 kW EC Drives. One shielded ball bearing and one regreasable ball bearing are used in 11 kW unit. Regreasable ball bearings are used for units above 11kW.

#### Regreasable Bearing

Lubricate with Lithium grease once every 2000 operating hours. Replenish grease by use of a lever type grease pump while the motor is running, Fig. 8.

#### Shielded Ball Bearing

This bearing is of non-regreasable construction. The periods of replacement of this bearing are shown below. To replace this bearing, EC Drive must be disassembled.

Induction motor – Every Two years

Eddy Current Coupling when speed ratio is :

Up to 3:1 – Every 12000 – 16000 operating hours

More than 3:1 – Every 8000 – 12000 operating hours.

For a new bearing, use lithium grease as lubricant.

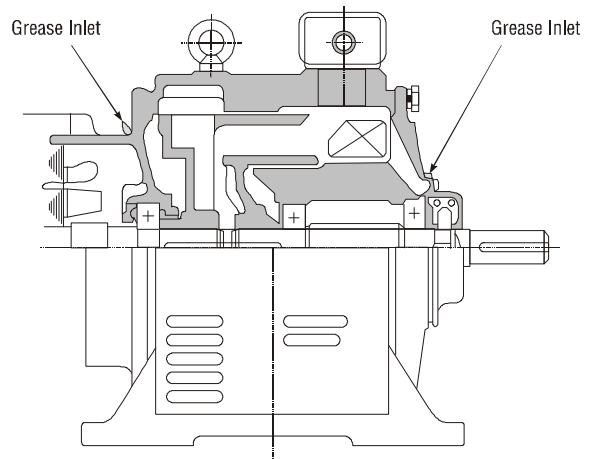


Fig.8 Grease Lubrication of Regreasable Type Bearing-11 kW

### 10.4 BELT TENSION

The belt may slip when it gets stretched and tension decreases. In the case, slide the motor and give proper tension to the belt.

### 10.5 EC DRIVE ELECTRONIC SPEED CONTROLLER

Check to see that connections are tight. For maintenance and inspection, see the instructions "POWERMAG EC Controller"

## 11. DISASSEMBLY AND INSPECTION

To prevent unforeseen accidents during operation, it is extremely effective to make it a rule to disassemble EC Drive about once every two years for inspection and cleaning.

### 11.1 DISASSEMBLY

In disassembly, care should be given to the following :

1. Do not disassemble in a dusty or humid place or where water drips.
2. Place screws and other small parts in a box lest they should be lost during disassembly.
3. Disassembled parts should be placed on clean wooden board, paper or cloth (not directly on the floor).
4. See that bearings are not injured. Avoid hammering the outer race of bearing or applying undue force to it.

Powermag EC Drive 0.37 KW to 11 KW to disassemble, proceed as follows:

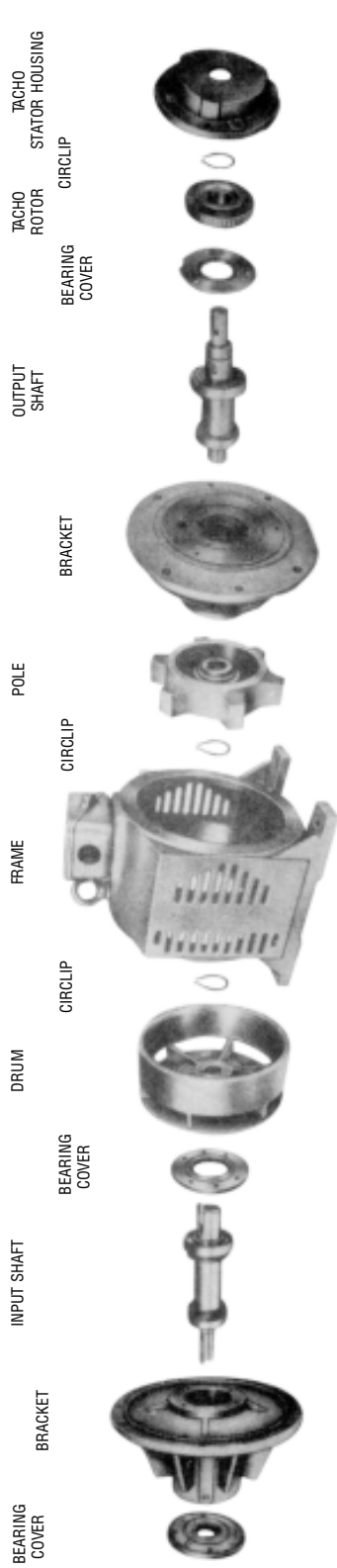
1. Disconnect Powermag EC Drive from the driven machine.
2. Remove from the terminal box, the leads excitation and leads for tachogenerator.
3. Dismantle the drive motor from the coupling frame. In this case give consideration to the weight of the motor and the drum mounted on the motor shaft.
4. Remove circlip and pull the drum from the drive motor with a suitable puller.
5. Loosen the bracket cover fastening bolts. Remove the bracket fastening bolts and remove the bracket together with the output shaft and inductor from the frame. Since the lead wires for excitation coil and tachogenerator are removed together with the bracket, care must be exercised not to break the lead wires.
6. Remove the circlip and pull the inductor from the output shaft with the puller used for the drum.
7. Remove the bracket cover fastening bolt and remove the bracket cover from the bracket taking care not to damage the output shaft.
8. Remove the circlip and remove the tachogenerator from the output shaft.
9. Remove the bearing cover from bracket.
10. Giving blows with a mallet to the end of the output

shaft at the inductor side, pull the output shaft with two bearings attached from the bracket.

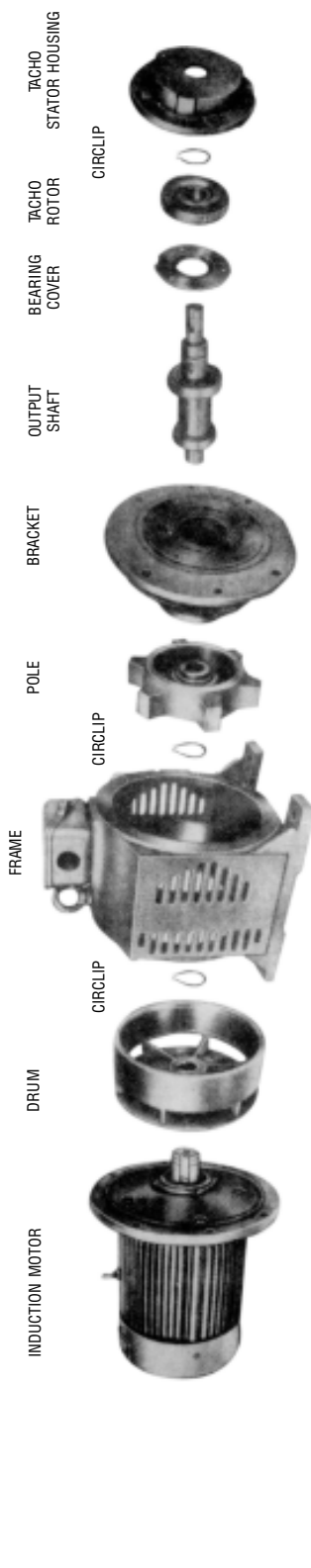
11. Remove the bearings from the output shaft with a bearing puller.

POWERMAG EC Drive 15KW to 37KW Disassembly.

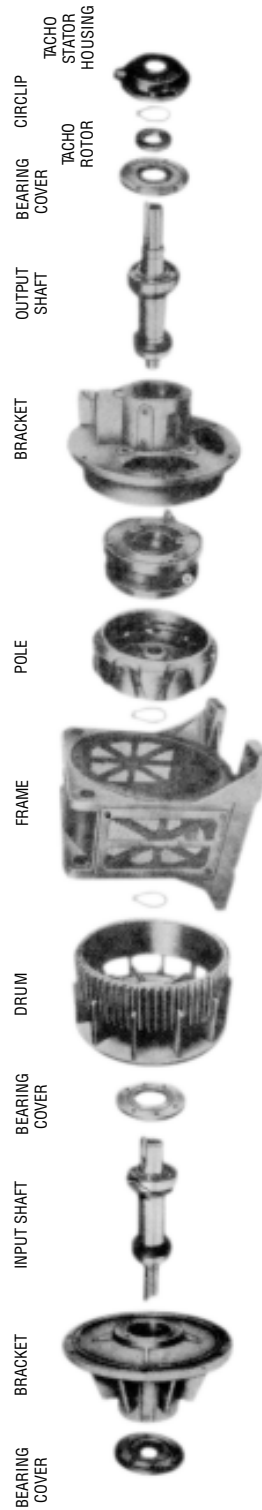
1. Disconnect Powermag EC Drive from the driven machine.
2. Remove from the terminal box, the leads for excitation and leads for tachogenerator.
3. Dismantle the drive motor from the coupling frame. In this case give consideration to the weight of the motor and the drum mounted on the motor shaft.
4. Remove the circlip and pull the drum from the drive motor with a suitable puller.
5. Loosen the bracket cover fastening bolts. Remove the bracket together with the yoke, output shaft and inductor from the frame. Since the lead wires for excitation coil and tachogenerator are removed together with the bracket, care must be exercise not to break the lead wires.
6. Remove the circlip and pull the inductor from the output shaft.
7. Remove the bracket cover fastening bolt and remove the bracket cover from the bracket taking care not to damage the leads for tachogenerator.
8. Remove the circlip and remove the tachogenerator from the output shaft.
9. Remove the bearing cover from the bracket.
10. Giving blows with a mallet to the end of the output shaft at the inductor side, pull the output shaft with two bearings and grease valves attached from the bracket.
11. Remove the yoke from the bracket.
12. Remove the bearings and grease valves from the output shaft with a bearing puller.



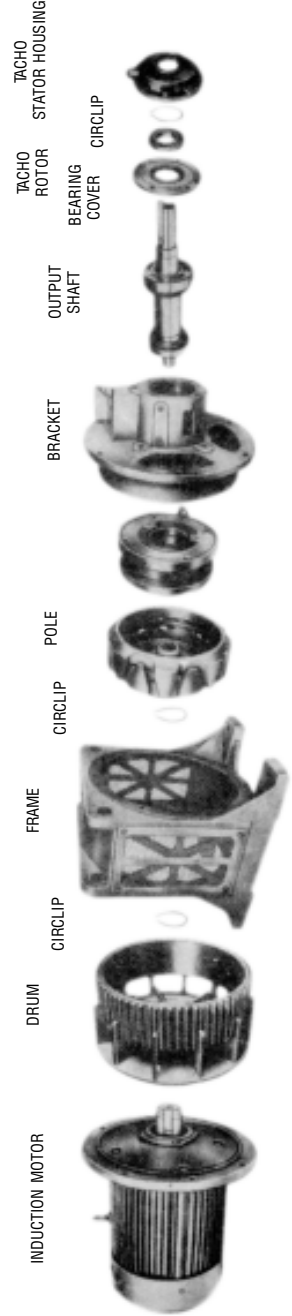
(MODULAR) DESIGN-I  
0.37 to 11 kW



(INTEGRAL) DESIGN-I  
0.37 to 11 kW



(MODULAR) DESIGN-II  
15 to 90 kW



(INTEGRAL) DESIGN-II  
15 to 90 kW

Fig.9 - Exploded views of Powermag EC Drive 0.4 to 11 kW and 15 to 90 kW

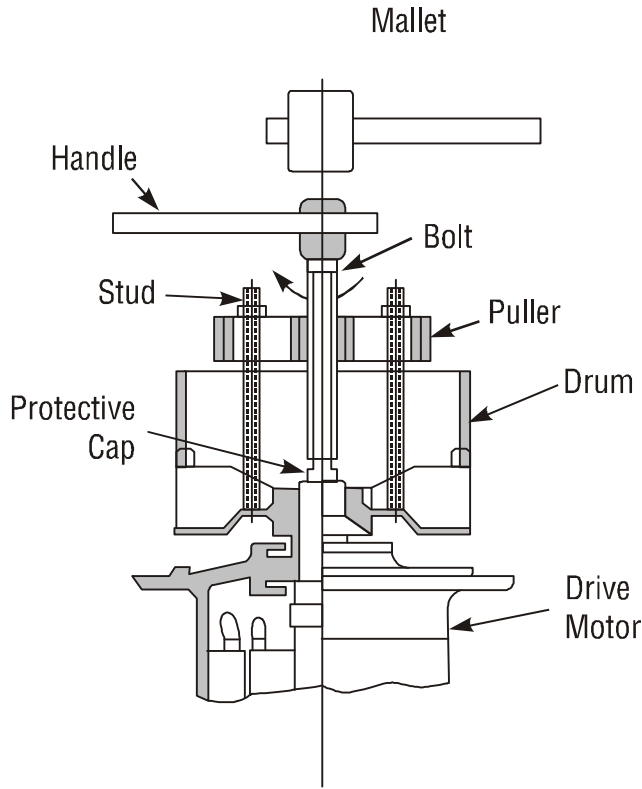


Fig.11 - Removal of Drum

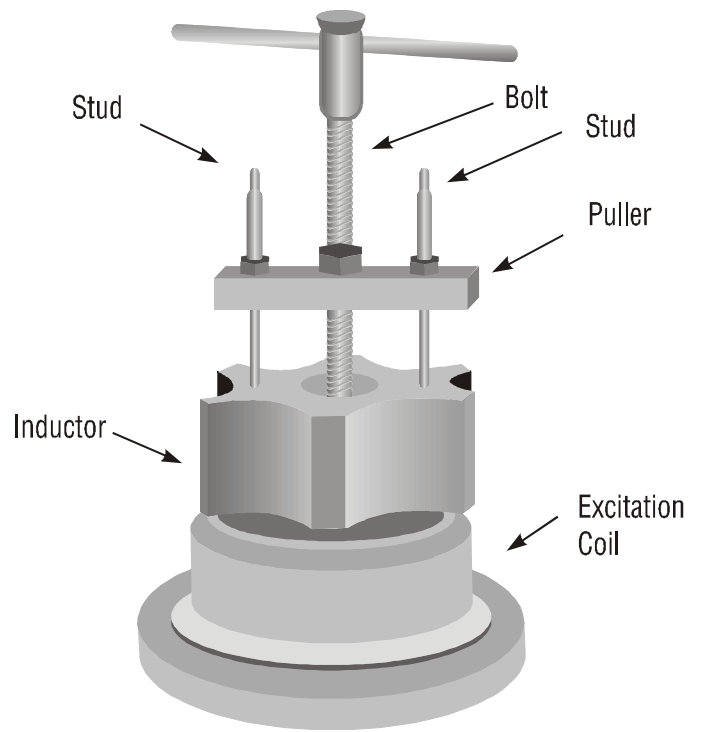


Fig.12 - Removal of Inductor

**11.2 CLEANING OF COMPONENTS AFTER DISASSEMBLY**

After Powermag EC Drive is disassembled, remove dust with compressed air and wash away grease with petrol or thinner.

**11.2.1 TOOLS USED FOR DISASSEMBLY**

The following tools should be prepared before disassembling.

**Gear Puller** - To remove bearings from shaft.

**Eye bolt** - To set the frame of EC Drive upright on the block, screw two eyebolts in bracket mounting tapped holes at the drive-end of frame and lift the frame.



Gear Puller



Eyebolts

**11.3 REASSEMBLY**

To reassemble the parts, reverse the disassembly operations. When reassembling, care should be exercised as follows.

**11.3.1 DRUM AND INDUCTOR**

To fit the drum to the drive motor shaft and mount the inductor on the output shaft, use a hammer and transit blows through a wooden block. Before fitting the drum, fix the motor shaft so that it does not move axially.

Drum and inductor may be easily fitted by heating them to about 50°C (122°F) and shrinking them on to the shaft. The drum and inductor, however, may be deformed if overheated.

**11.3.2 TIGHTENING**

Every bolt should be secured tightly through washer. Where three or four bolts are used to hold one part (such as bracket, bracket cover) they should be tightened gradually and evenly, seeing that no one bolt it is tightened more than the others.

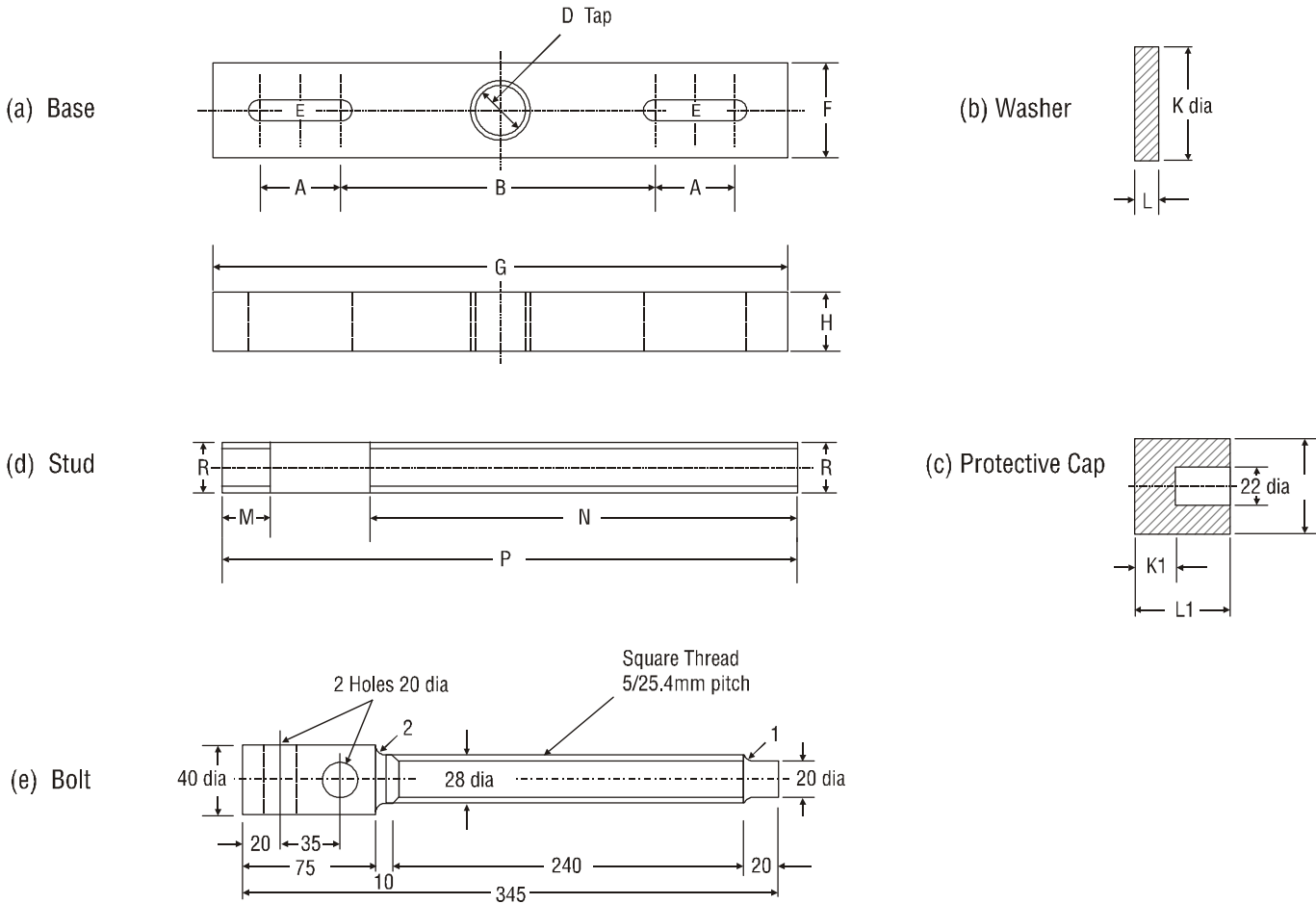


Fig.13 - Dimensions and Quantities Required

kW	(a) Base								(b) Washer			(c) Cap			
	Dimensions (mm)								Qty.	Dimensions (mm)		Qty.	Dimensions (mm)		Qty.
	A	B	D	E	F	G	H	K		L	K1		L1		
0.4 - 0.75	20	45	M 16	7	40	110	22	1	16	7	1	-	-	-	
1.5 - 3.7	40	70	M 16	10	40	170	25	1	19	10	1	-	-	-	
5.5 - 11	50	90	M 28 Square Thread (P=5/25.4)	15	50	220	40	1	-	-	-	9	22	1	
15 - 37	75	100		20	60	300	40	1	-	-	-	9	22	1	

kW	(d) Stud					(e) Bolt			Nut		
	Dimensions (mm)				Qty.	Dimensions (mm)		Qty.	Dimensions (mm)		Qty.
	M	N	P	R							
0.4 - 0.75	8	100	120	M 6	2	M 16 x 120 (Thread length: 100 and over)		1	M 6		2
1.5 - 3.7	10	130	150	M 8	2	M 16 x 170 (Thread length: 150 and over)		1	M 8		2
5.5 - 11	12	240	260	M 12	2	Fig (e)		1	M 12		2
15 - 37	12	240	260	M 16	2	Fig (e)		1	M 16		2

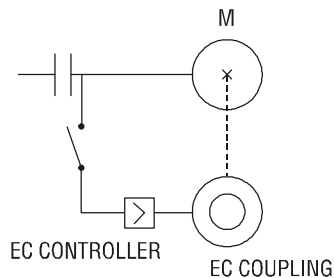


## 12. WIRING

Proper wiring is essential for the correct operation of Powermag EC Drive and wrong lead connection may result in malfunction or motor burnout. Make correct wiring between the EC Drive and the controls such as EC Drive Controller, according to the specified diagrams. Observe the following precautions for wiring.

### CAUTION

- To prevent excitation coils from burnout, energize the EC Drive coupling after starting prime mover (IM). (i.e. Control circuit power supply will be taken from the load side of an electromagnetic switch for the main circuit power supply)



- Where the main circuit power supply is separated from the control circuit source, provide interlock so that EC Drive controller is turned on after the closure of magnetic starter for main circuit.
- If a EC Drive is started by preset, wiring should assure that EC coupling is energized two or three seconds after starting prime mover. This prevents the prime mover and the EC coupling from starting simultaneously.
- Remove all the connections of EC Drive before megger testing. To megger-test, measure the resistance with a 500V megger:
- For induction motor-across common wire connecting motor terminals U, V, W, (Z, X, Y) and motor frame.
- For Tachogenerator – across either terminal F1 or F2 and motor frame.
- For EC Coupling – across either terminal E1 or E2 and motor frame.
- Insulation resistance of induction motor and EC coupling should be above 3 M Ohms and that of Tachogenerator above 1 M Ohms, when measured with a 500 V megger.

## 12.1 FOR INDUCTION MOTOR

### 12.1.1. WIRE SIZE

Cable size	Sq.MM	Nominal thickness of insulation (mm)	Current rating (A)
16/0.2	0.5	0.7	4
24/0.2	0.75	0.7	7
32/0.2	1.0	0.7	11
48/0.2	1.5	0.7	14
30/0.25	1.5	0.7	14
28/0.3	2.0	0.7	17
50/0.25	2.5	0.8	19
80/0.2	2.5	0.8	19
36/0.3	2.5	0.8	19
56/0.3	4.0	0.8	26
85/0.3	6.0	0.8	31
140/0.3	10	1.0	42
101/0.45	16	1.0	57
157/0.45	25	1.2	71
220/0.45	35	1.2	91
314/0.45	50	1.4	120

### 12.1.2. DIRECTION OF ROTATION

Direction of rotation is counterclockwise viewed from the drive end. To reverse the direction of rotation, interchange any two of the three phase line leads R, Y and B.

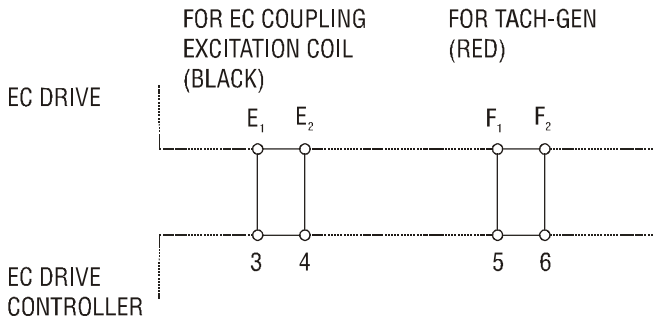
## 12.2 FOR EXCITATION COIL & TACHO GENERATOR

### 12.2.1 WIRE SIZE

Use 2 to 5.5 mm<sup>2</sup> leads for the excitation coil of EC coupling and 0.75 to 2 mm<sup>2</sup> leads for Tachometer generator. The size of terminal fastening screw is M4.

## 12.2.2. CONNECTION METHOD

Connections of EC Drive and its controller are shown in Fig. 7.1 F1 and F2 terminal for Tachogenerator may be connection in reverse. Observe the following precautions for connections to tachometer generator.



Connections of EC Drive and EC Controller

### CAUTION

- Make correct connections to EC coupling excitation coils and for tachometer generator. Incorrect lead connections may result in tachometer generator under voltage or coil burn out.
- When 4-core leads are used as distributing leads, incorrect connections should be avoided by color coding the leads for excitation coil and for tachometer generator.

## 13. OPERATION

### 13.1 INSPECTION BEFORE TEST RUN

Check the following items before starting the machine for the first time, after an extended shutdown or after a teardown for extensive maintenance or repair.

- Disconnect the EC Drive from the driven machine, and turn shaft by hand to assure free rotation.
- Check that motor, starting and control device connections agree with wiring diagrams.
- Check the leads are not short-circuited.
- Check that all screws and bolts are tightened.
- Check to be sure that the connections to tachometer generator are correct.

### 13.2 TEST RUN

Perform a test run according to the INSTRUCTION FOR EC CONTROLLERS. Start the trial operation at high load and gradually increase the load to the full.

### 13.3 OPERATION

Before starting the operation, keep in mind the following characteristics of EC Drive.

- EC Drive output is usually indicated by the output of induction motor.
- Be sure to operate the motor within the allowable speed range described on the nameplate. Failure to do so will make accurate speed control impossible or result in motor trouble.
- Operation with minimum load torque or below cannot provide accurate speed control.
- When load torque varies from 100% to 10%, speed regulation of 2 to 20% maximum speed is obtained from the EC Controller.
- Setting the speed setting potentiometer of EC Controller to LOW causes the motor output shaft to rotate slowly, when the motor is disconnected from load, due to the wind pressure of induction motor and the rotating friction of drum bearing.

14. MAINTENANCE

Routine, regular maintenance is the best assurance of trouble-

free, long-life operation. It prevents costly shutdown and repairs. Table 7 shows Inspection schedule.

Component	Inspection Item	Schedule					Inspection or Maintenance Operation
		Daily	Monthly	Yearly	With motor running	With motor at rest	
External Inspection and Cleaning	EC Drive Proper	Vibration	●			●	Feel by hand. If excessive, measure the vibration with a vibrometer, Max. amplitude: 50μ . Pay attention to variation of vibration
		Noise	●			●	If unusual magnetic noise is heard, or unusual noise is accompanied with mechanical vibration. Detect the malfunction
		Temperature	●			●	One touch with linger for two seconds (70-80°C). If high, measure with a thermometer
		Ventilation	●			●	Check for clogged window or dust accumulation
		Bolts		●		●	If loose, tighten with a wrench
		Cleaning		●		●	Clean the parts without disassembling with compressor air
	Bearing	Noise	●			●	Check for any intermittent and unusual noise. If excessive, inspect bearing surface and ring for wear
		Greasing		●		●	Grease with a grease gun
	Grease Inlet Port	Damage	●			●	Repair
	Output Shaft	Shaft and transmission gear	●			●	If vibration and noise are unusual, detect the malfunction
	Terminal Box	Loose cover fastening screws		●		●	Tighten with a driver
		Deterioration of leads		●		●	Repair leads
	Induction Motor	Insulation resistance			●	●	Be sure that insulation resistance is not below 3 MΩ Use a megger
	EC Coupling	Insulation resistance			●	●	Be sure that insulation resistance is not below 3 MΩ Use a megger
	Tachometer Generator	Insulation resistance			●	●	Be sure that insulation resistance is not below 1 MΩ Use a megger
	Cable	Deterioration damage		●		●	Replace if damaged
Grounding Wire	Slack damage		●		●	Tighten with a wrench	
Internal inspection and cleaning	Magnetic Starter	Load current	●			●	Check with an ammeter if load current is less than the rating
	Controller	Output shaft speed	●			●	Check using a speedometer if output shaft speed is within the rated speed range
	Bearing	Damage			●	●	Replace
	Frame	Dust, damage			●	●	Remove dust. Replace if damaged
	Coil	Varnish deteriorated			●	●	Retreat coil
	Rotor	Damage			●	●	Repair or replace
	Bracket	Bearing fit, damage			●	●	Repair or replace
	Fan	Dust, damage			●	●	Remove dust. Repair if damaged
	Inductor	Crack, damage			●	●	Repair if damaged
	Drum	Crack, damage			●	●	Repair or replace
	Tachometer Generator	Damage			●	●	Replace
Output Shaft	Damage, bent			●	●	Repair or replace	

Table 7 - Inspection schedule

## 14.1 TACHOMETER GENERATOR

### 14.1.1 CONSTRUCTION

The stator of tachometer generator is built into the bracket cover, and the stator coil resin encapsulated. The rotor is made up of a permanent magnet and fixed to the shaft together with a bushing.

### 14.1.2. DISASSEMBLY PROCEDURE

#### 1. Tachogenerator Rotor

Remove the circlip and remove the tachogenerator rotor by puller, and pull out the rotor from the output shaft.

#### 2. Tachogenerator Stator

Remove tachogenerator stator cover mounting bolts, insert the bolt in the tacho-generator stator removal tap and pullout the stator.

### 14.1.3. VOLTAGE GENERATED

Voltage 35 VAC is generated at 1800 rpm. Measure the voltage applying a tester across the terminals 5 and 6 of EC drive controller. The voltage generated should be approximately 24 VAC at 1200 rpm, 30 VAC at 1500 rpm.

## 14.2. COILS

### 14.2.1 INDUCTION MOTOR COIL

Maximum allowable temperatures of the induction motors are :

120°C (class E insulation)

Temperature of the frame surface may read 75 to 85°C

If the insulation resistance decreases 3 M ohms or below, drying or varnish treatment is recommended

### 14.3.2. EXCITATION COIL

Maximum allowable temperature of the excitation coils are:

155°C (class F insulation)

If the insulation resistance decreases 3 MΩ or below, drying or varnish treatment is recommended.

Measure coil resistance with a tester applied across terminals E1 and E2 of EC coupling after disconnecting from controllers. If the measured value is different by more than 20% from the tabulated value in Table 8, it indicates abnormality. In case of wire breakage or short circuit, the coil should be replaced with a new one.

## 14.4 INSPECTION

A systematic inspection should be made at regular intervals depending on the service and operating conditions. Inspect following items, referring to the inspection schedule in Table 7. For trouble shooting of EC drive refer to Table 13.5.

### 14.4.1 VIBRATION

Excessive vibration causes damage to bearings and coils. The total amplitude at maximum vibration should not exceed 50 μ at 1800 rpm. If it exceeds that value, refer to Table 13.5 to remove the cause.

### 14.4.2 NOISE

Noise of EC drive may be caused chiefly by electro magnetism, ventilation, bearing, transmission gear and metal-to-metal contact. Unusual noise during the daily inspection must be eliminated in accordance with Table 13.5

### 14.4.3 TEMPERATURE

Motors operating under normal conditions become quite warm. Although motor surface feels hot to the touch, the motor may be within guaranteed limits, if OPERATED WITHIN RATED SPEED on the nameplate and ventilation is not restricted.

Temperature of frame may read 75°C to 85°C on the surface. The temperature rise of drum and frame of EC coupling, and the temperature difference between intake and discharge air are approximately proportional to load torque and speed difference between induction motor and EC output. As the shaft speed decreases, the temperature of frame or discharge air becomes higher. However, this is not unusual.

The temperature rise at minimum speed, while dependent on the EC drive output, will be 40°C to 70°C for frame and 20°C to 70°C for exhausted air (both rarely 100°C). See the test report or consult us for the normal temperature of each part.

## 14.5. TROUBLESHOOTING GUIDE

The following chart from Page 20 lists various troubles that may occur during operation of the drive, the probable causes of the troubles, and the remedial action to be taken.

Symptom	Possible Cause	What to do	
Motor runs hot	High ambient temperature	Keep ambient temperature below 40°C at all times Check ventilation conditions and air temperature at inlet Remove obstacles	
	Deposits of dust	Check for dust, ventilation and heat dissipation Disassemble and clean motor	
	Bearing temperature excessively high (See note)	Too high belt tension	Correct belt tension
		Small bearing gap	Replace bearing
		Eccentricity at time of bearing assembling	Remount bearing correctly
		Burnout of bearing	Replace bearing
	Excessive trust from driven machine	Eliminate	
With EC Drive coupled to driven machine, starting induction motor causes rotation of EC drive without excitation	Defective wiring	Correct	
	Load too light	Increase	
	Foreign matter stuck between inductor and drum	See if inductor and output shaft rotate simultaneously, tuning output shaft by hand. Clean	
	Seizure of intermediate bearing	Replace	
Energized EC drive rotates when speed potentiometer is set zero	Adjustment of bias potentiometer improper	Check bias adjusting, referring to instructions for controllers	
	Speed setting pot, is connected at reverse polarity	Check the voltages across 9 (-) and 8 (+) with multimeter The voltage measured should be zero volts when speed setting pot is set to zero, and approx. 15 volts when turned full clockwise Correct wiring diagram	
Energized EC drive does not rotate even if speed setting potentiometer is set to higher speed	Dust stuck between inductor and yoke	Remove dust	
	Bearing of output shaft seized	See if motor output shaft is locked Replace bearing	
	Supply voltage is not proper	Check to see that the voltage across controller terminals 1 and 2 is 200/220 volts Check wiring	
	Protective fuses 1FU and 2 FU are blown	Replace	
	Breakage of excitation coil lead	Check insulation resistance of excitation coil and external excitation circuit with tester by open-circuiting either terminal 3 and 4.	
	Excitation coil damaged		
Output voltage is not proper	Check to see that output voltage of 0-80 volts appears across terminals 3 and 4 as speed setting potentiometer is turned clockwise Replace controller		
EC drive does not come up to rated speed	Layer short circuit of excitation coil	Measure coil resistance with tester applied across terminals Replace coil	
	Bearing seizure	Hand rotate output shaft Replace bearing	
	Foreign matter struck between inductor and yoke	Hand rotate output shaft Disassemble the motor and clean	
	Overload	Reduce to the nameplate rating	
Speed of EC drive unadjustable	No load or little load	See if load is less than 10% of rating Increase load to rating	
	Load driving EC drive	Reduce to the nameplate rating	
	Foreign matter stuck between inductor and drum	See if inductor and output shaft rotate simultaneously, turning output shaft by hand Disassemble and clean	
	Drum bearing seized	Replace	
	Defective wiring in tachogenerator	Correct	
	Thyristor 1SCR or 2SCR is still conducting	If with speed potentiometer set to zero, EC Drive speed does not decrease, check the thyristor Replace the EC Controller	

Symptom	Possible Cause	What to do	
Vibration	Foundation not rigid	Check for adjacent vibration source, settled foundation, crevice and rigidity of mount Rebuild. Reinforce mount	
	Low rigidity of bed	Reinforce bed or rebuild foundation	
	Anchor bolts loosely tightened	Tighten nuts for anchor bolts. Rebuild foundation	
	EC drive loosely mounted	Tighten frame fastening bolts	
	EC drive feet uneven	Add shims under foot pads to mount each foot tight	
	Loose screws of VS motor	Tighten	
	Coupling of V-belt sheave	Eccentricity	Measure run-out tolerance and compare with that of shaft. If over 0.05 mm, correct
		Weight unbalance	Correct
		Damage	Repair or replace
	Pin-type flexible coupling	Worn or damaged coupling pin	Repair or replace
		Poor position accuracy of holes for coupling pin	Check position of tram marks. Correct
	Misalignment	Correct by realignment of drive See ALIGNMENT on page 4	
Worn or damaged bearing	Check for vibration of bearing Detect noise with listening rod Replenish grease, if regreasable type. Replace bearing		
Vibration in driven machine	Disconnect EC drive from driven machine. Correct		
Bearing noise	Insufficient lubricant. Shrill chatter due to metal-to-metal contact Where ambient temp, is below 0°C, noise may occur right after starting	Check with feeler or bearing checker Replenish bearings, if regreasable type, with grease or replace	
	Slip between raceway balls High pitch chatter		
	Flaking a form of pitting resulting from failure Rattling or chattering		
	Cracked ball or ring Rattling or chattering		
	Indentation due to dirt and dust. Grinding		
	Electric pitting caused by the passage of electric current across the surface of raceway Buzz or low pitch buzz	Check with feeler or bearing checker Disassemble motor and inspect bearings Check for axial current and vibration Replenish bearing, if regreasable type, with grease, or replace	
	Outer race rotates Grinding	Check with feeler or bearing checker Check bracket fit	
Noise of EC Drive	Noise due to electromagnetism including high frequency 1000 Hz or above. With power switch OFF, magnetic noise disappears	Motor generates magnetic noise in general No trouble unless noise is extremely high	
	Intermittent noise due to accumulation of foreign matter between inductor and drum	Disassemble EC drive Remove foreign matter Check atmospheric conditions	
	Gear coupling	Insufficient lubricant	Supply oil Check for oil leakage and repair
		Worn gear tooth	Remove coupling and check tooth mesh Replace coupling
	Pin-type coupling	Worn or damaged bushing	Check bushing
		Poor accuracy of bushing	Replace
Motor runs hot	Output shaft speed low	Read tachometer of controller Operate EC drive within rated speed range	
	Overload	Check primary current of induction motor Operate EC Drive below rated current	

Symptom	Possible Cause	What to do
Speed of EC Drive unstable	Periodic load fluctuations	Check driven load Mount flywheel or refer to instructions for controllers
	Poor contact of speed setting potentiometer or other components	Check with a tester connected across speed setting potentiometer terminal 8 and either 7 or 9. Turning slowly the potentiometer clockwise will cause needle of tester to fluctuate in case of poor contact. Repair or replace
	Leads between operator, controller and tachogenerator poorly connected	Check wiring and correct
Sudden stop of EC Drive (Frequent failure of protective fuse 1FU inside the controller)	Excitation coil of EC coupling or output circuit of controller is short circuited	Check with a tester Replace coil
	Thyristor 1SCR or flywheel diode is short circuited.	Check with a tester Replace controller
	Surge absorbing circuit are short circuited	Check diodes with a tester Replace controller
	Selection of controller capacity is not suitable	Select the controller according to motor capacity
	Controller is not grounded	Check with a tester between each terminal and ground

List of Recommended spares

S.No.	Description	Qty.
1.	Clutch coil	1 No.
2.	Tachogenerator	1 No.
3.	Bearings	1 No.

**Note:** Please specify model no. and drive rating along with other nameplate details of EC drive while ordering spares.  
For spares of controls, refer relevant manual.