



## **BELTCON 4**

An Introduction as to the Choice & Application of  
Conveyor Drives & Ancilliary Equipment

G N J Nel

**7 & 8 September 1987**  
**Sandton Holiday Inn**  
**Sandton**

**The S.A. Institute of Materials Handling**  
**The S.A. Institution of Mechanical Engineers**

TITLE OF PAPER

An introduction to the choice and application of conveyor drives and ancillary equipment.

AUTHOR'S NAME AND DESIGNATION

GNJ Nel B Eng (Mech), MSAIME

Chief Planning and Development Engineer

Hlobane Colliery

Iscor Limited

1

**SUMMARY**

A modern belt conveyor system is made up of numerous components, arranged logically and systematically in order to provide a reliable and effective means of handling material in bulk. It must be appreciated that this is a vast subject, and therefore the author has considered only the main components of the conveyor drive system, viz starting gear, motors, reducers, drive pulleys, brakes and backstops.

If a conveyor belt system is to be designed, installed, commissioned and operated economically, effectively and safely, the choice of components available on the market is of prime importance. A sound philosophy to adopt is one in which experience is combined with and strengthened by a strong engineering approach.

This paper will review the applications of :

- ° Squirrel-cage motors employing direct-on-line starters combined with fluid couplings.
- ° Slip-ring motors
- ° Solid-state reduced voltage starting
- ° Reducers
- ° Design of drive pulleys and the requirements of backstops and brakes

2

**INTRODUCTION**

The increasing demand for raw material emphasizes the need for a faster and more efficient way of material transportation. Several methods for transporting such materials are currently in use depending on the type of material, distance to be covered and the surrounding environment. In the mining industry, heavy dump trucks and belt conveyors are the principal means of local raw materials transportation and each of these has certain advantages and disadvantages in specific applications.

The increasing demand for raw material and the continuous inflation spiral necessitate the development of more efficient conveyors with more sophisticated technological applications.

This paper will deal with belt conveyor applications and more specifically with the conveyor drive.

The conveyor drive must be selected carefully in order to provide the required optimum operating characteristics with maximum reliability and at minimum cost. Simplicity of overall design is always an advantage and care must be exercised to ensure that unnecessarily complicated systems are not supplied.

Considerations such as equipment availability, cost of maintenance and standardization details play a significant role in the conveyor drive selection process. The potential capabilities of the personnel having to maintain the equipment will have an important influence on the final choice.

3

### CONVEYOR DRIVE

The ideal location for the belt drive is the place which minimizes belt tensions both during acceleration and running periods. Thus, the ideal position for the drive of both inclined and horizontal conveyors is at the head end and for a belt running downhill at the tail end of the installation. The drive must provide torque to accelerate the belt plus the load to full speed without imposing unacceptable stresses on any part of the drive.

Power can be transmitted to the conveyor either by means of a single or a multiple pulley drive, depending on the torque requirements of the conveyor.

The single pulley drive has the following advantages :

- It is technically simple
- Only the clean side of the belt is in contact with the drive pulley.

- There is less bending of belt under high tension than with other drives.
- There are no problems related to load sharing, as with multiple drives.

The principal advantage in the multiple pulley drive is that the total arc of contact is increased, thus reducing belt tension. Multiple pulley drives should, however, be used in cases where :

- The single pulley drive and control system become more expensive than a multiple pulley drive
- The contact arc of a single pulley drive becomes too small to transmit the torque to the belt without slip

For the purpose of this presentation, the conveyor drive will be considered as consisting of the following components :

- Motors and starting gear
- Drive pulleys
- Backstops
- Brakes
- Reducers

See figure 1 for a typical single pulley drive layout.

### 3.1 Motors and starters

The two types of motors generally used to power belt conveyors are squirrel-cage motors and slip-ring motors.

#### 3.1.1 Squirrel-cage motors

Squirrel-cage motors are excellent, efficient prime movers for conveyor applications. Unfortunately the torque-speed characteristics are not ideal for conveyor starting and accelerating.

With respect to starting current and starting torque, the NEMA B and NEMA C design motors are recommended for driving conveyors as they offer the most suitable characteristics for this purpose (See fig 2).

The design B motors have a normal starting torque and a relative low starting current, while the design C motors have a high starting torque with a relative low starting current.

To control the starting torque of these motors they can be either started direct-on-line using fluid drive couplings, or at a reduced voltage, or by means of frequency control.

### 3.1.2 Slip-ring motors

The slip-ring motor is, due to its starting characteristics, very popular in the mining industry and with the slip-rings shorted out, it has the same characteristics as a squirrel-cage motor. The slip-ring motor provides access to the rotor windings by terminating them on slip-rings. Control of the starting torque is permitted by adding external resistance to the rotor windings of the motor which are connected to slip-rings.

The methods presently in use to start slip-ring motors, even under loads such as fully loaded conveyors, are :

- resistor starters
- liquid starters
- induction starters

Thanks to modern technology, starters with smooth and stepless starting torque characteristics are readily available on the market. Their excellent starting features have greatly contributed to the fact that step resistor controller starters are now used less frequently, especially in new installations.

Although liquid starters were very popular in the past due to the smooth starting torques offered, their inability to cope with frequent starting may well be the reason why they are used less frequently.

Induction starters are popular for starting slip-ring motors. These starters are simple and consist basically of an inducer, a short circuiting contactor and a timer. The diagram in fig 8 illustrates a typical layout.

The inductor is made up of three elements, one for each of the rotor windings. An alternating current flowing through the windings induces frequency-dependent eddy currents in the iron core. When the main supply is first switched to the starter, the frequency of the current induced in the rotor windings is that of the mains and thus a considerable eddy current loss is set up in the inductor cores. This is equivalent to a high resistance being introduced into each of the rotor winding circuits. As the rotor starts to turn, the frequency decreases and the inductor losses become proportionally less. Thus, the effective impedance of the additional rotor circuit is reduced, resulting in a smooth start up to the point where the slip-rings are shorted out. Fig 9 illustrates the torque/speed curves of a slip-ring motor equipped with a resistor starter and an inductor starter respectively.

Inductor starters have the following advantages :

- easy to install and operate
- low maintenance
- no moving parts of liquids
- no complex switching
- a smooth starting torque

### 3.1.3 Starters

#### 3.1.3.1 Solid state starters

Modern technology has developed new electronic starting systems which has certain applications. Amongst those which are most frequently used is the reduced voltage solid-state starter. The frequency control starter is also available, but has a high cost disadvantage.

#### 3.1.3.2 Solid-state reduced voltage starters

Solid-state reduced voltage starters are popular, mainly because of their reliability, competitive initial capital outlay, low mainte-

nance cost and starting current requirements. They provide a smooth stepless acceleration for squirrel-cage motors, thus reducing surges in the electrical system and preventing mechanical shock. In addition, these starters have the advantage that the voltage and thus the torque can be controlled effectively during the starting cycle (See fig 7).

The solid-state reduced voltage starter also lends itself to linking into Program Logic Control (PLC) systems and provides many additional features such as auxiliary contacts for sequence starting of motors, closing of bypass contactors, remote control and indication. In addition to these features these starters offer the usual motor protection devices such as phase failure and phase reversal as well as instantaneous overload protection.

#### 3.1.3.3 Frequency control

The speed of the squirrel-cage motor is directly proportional to the frequency of the power supply; by altering the frequency of the supply to the motor, the speed of the motor can therefore either be reduced or increased.

Frequency control starters offer variable speed starting and torque, but they are not often used on belt conveyors. These starters will therefore not be discussed further in this paper.

#### 3.2 Fluid drive couplings

The fluid drive coupling is a mechanical device which enables the motor to be coupled to the load by means of a fluid. The rigidity of the coupling is controlled by the amount of fluid introduced between the driving and driven segments.

The use of a fluid drive coupling between motor and load limits the acceleration forces. It permits the motor to be started without load, leaving the coupling device to transmit and control the torque to the load shaft.

The fluid drive couplings most commonly in use for belt conveyor applications are the traction and scoop types.

The traction-type coupling consists primarily of a sealed unit which contains a certain amount of fluid as indicated in figure 5. Controlled relative movement between the driven and driving shafts is obtained due to the locking action of the fluid forced from the drive shaft onto the driven shaft. This locking action is subject to initial slip, so that a prolonged delay between start and full speed is obtained.

Traction-type couplings have the following advantages:

- The starting torque transmitted by the coupling is determined by the initial oil fill as well as coupling characteristics.  
(See figure 4)
- The motor is allowed to start without any load and once it speeds up the coupling starts to transmit power to the conveyor. Mechanical shock is therefore reduced.  
(See figure 3)
- Since the motor is started without load a high inrush current is prevented, thus reducing strong surges in the electrical system.
- They provide overload protection of the motor.
- They are of simple and robust construction, thus making them reliable and ensuring minimum maintenance.

In a scoop-type coupling the oil is kept in a reservoir which rotates with the coupling when the motor is running. The regulation of fluid in the working circuit between the drive and driven shafts is affected by means of an adjustable scoop tube which slides in the stationary housing as shown in figure 6. When the motor is started the scoop tube is retracted from the fluid which forms a rotating ring in the reservoir casing due to centrifugal force. When the motor is running at speed, the scoop tube is immersed into the rotating ring of oil at a predetermined depth. The oil is scooped up by the scoop tube and transferred to the impeller compartment. Power transmission is obtained by the locking action of the fluid forced from the impeller onto the driven shaft. The amount of slip is regulated by the depth to which the scoop is immersed into the fluid.

Scoop-type couplings have the following advantages:

- stepless variable output speed
- control of torque during acceleration
- engaging and disengaging of a drive with a continuously running motor
- they allow for a wide degree of load sharing between multi drive heads or between multiple motors and a single drive head.

The immersion depth of the scoop can be controlled by hand, gravity, thruster control or by means of an electronic control circuit. It is important that the acceleration time is determined fairly accurately. A too short acceleration time will cause unacceptably high starting torques while a too long acceleration period will generate excessive heat resulting in possible damage to the coupling.

Scoop couplings are used on larger conveyors where it is important to control the acceleration of the conveyor accurately to prevent abnormal stresses on the system. These couplings are expensive compared to traction couplings. Scoop couplings are normally provided with oil coolers using forced ventilation or water cooling.

Fluid couplings are provided with lead plugs which will blow out when abnormal slip occurs due to low oil level or overload. Care should be taken that only lead plugs specified for a coupling are used. When a lead plug which does not conform to design specifications is used, the possibility of overheating becomes greater. Excessive heat creates carbon deposits on the impellers and other internal parts resulting in an ineffective coupling. Furthermore, excessive heat is detrimental to seal life and results in premature failure. The starting gear most commonly used with fluid couplings is the direct-on-line starter.

### 3.3 Drive pulleys (Figures 10a, b and c)

The belt speed depends on the speed of the drive motor, the reduction ratio and the diameter of the pulley. There are several types

of pulley designs on the market employing different methods of locking the drum to the shaft.

The pulley drum can be locked to the shaft by means of friction locking elements, or a key. The friction locking assembly is popular because the shaft and drum can be easily dismantled with no damage to any of the components. However, it has the disadvantage that the pulley drum may work loose during operation in the case of overloading.

Admissible deflection of the shaft is influenced by the admissible flexion of the locking device. Thus, friction locking assemblies with more acute selflocking cones will stand higher loads, since under rotating flexion the screws are much less under stress than in friction locking devices with more obtuse angle self-releasing cones.

The shaft can be left thicker inside the drum - which will reduce flexion in the whole of the drum assembly, even with long distances between bearings. (See figure 10c)

The crowning of drive pulleys to assist belt training is frequently used in the mining industry. Two methods of crowning are most commonly used, namely, machining of the shell to a predetermined convex shape and welding a steel strip to the centre circumference of the shell but this practice is inadvisable. Pulleys are crowned to achieve better alignment. However, this alignment procedure is not recommended for steelcord belting application and is to the detriment of belt life, because of a concentration of unacceptable high belt stresses in the region of the crown. Proper alignment can be achieved by utilizing the adjustment provided on the troughing and return idlers without jeopardizing belt life.

The purpose of pulley lagging is to increase the coefficient of friction between the belt and the pulley, to reduce wear on the pulley face and to effect a self-cleaning action on the surface of the pulley. The normal methods of attaching lagging to the pulley are glueing and metal slides. Vulcanizing is not frequently employed on the mines. Glueing lagging to the face of the pulley has the advantage

that it can be done with the pulley in position provided that the surrounding environment where the job has to be performed is kept reasonably free from dust and water.

Slide lagging can be fitted easily in position within a relatively short time. However, the ease and speed of replacement are reduced in the event of the rubber lagging being worn beyond acceptable levels. It is good practice to replace the slide lagging rubbers timeously to avoid unnecessary long delays during replacement.

Grooved or diamond lagging is commonly used in the industry (see figure 11). The grooves in the lagging permit greater deflection of its surface, thus improving the ability of the pulley to clean itself. An added advantage in the use of grooved or diamond lagging is that in wet applications, an improved friction coefficient equivalent to that of a dry belt with a smooth lagging can be achieved.

#### 3.4 Backstops

Normally every inclined belt conveyor which has the tendency to run in the reverse direction when the power to the drive is shut off requires a backstop device.

The importance of a reliable type of backstop for a specific application, though not always the cheapest, cannot be overemphasized, since it is an important safety device which can prevent damage to equipment and injuries to personnel.

When purchasing a backstop the following important points should be taken into consideration:

- Is it subjected to abnormal wear?
- Will it be adversely affected by water or dirt?
- Does it need regular adjustment?
- What is the amount of backlash?

Backstops can be either installed on the high-speed or the low-speed shaft of the drive.

A low-speed backstop refers to a unit which is running at the drive pulley speed. It is mounted on an extended head pulley or drive pulley shaft opposite the drive. If space presents a problem, the backstop can be mounted on the extended low speed shaft of the reducer. The disadvantage of this location is that should a failure in the low-speed coupling occur, the conveyor will run back.

Where two backstops are installed on the same shaft, problems with load sharing can occur. It is therefore recommended that an extra factor of safety be built in prior to the choice of holdbacks. This additional safety feature will ensure that no failure occurs should one backstop be required to carry more than half of the maximum anticipated load.

When connected to the pulley shaft, the low-speed backstop has the advantage that should a failure occur in the low-speed coupling the conveyor will not run back. This backstop has to withstand the full torque of the conveyor and is therefore larger in size and more expensive than the high speed backstop.

The high-speed backstop is installed on the reducer input shaft or on an extended midshaft. The advantage is that the physical dimensions of this type of unit are smaller than those of the low-speed unit, since it only has to withstand the torque of the conveyor at a reduced ratio.

The disadvantage is that should a failure occur in the low-speed coupling, the conveyor will run back.

### 3.5 Brakes

The braking action of a belt conveyor may be defined as the process of producing a retardation torque to the drive. This retardation torque is a function of frictional forces inherent to the moving parts and the force obtained from the application of a braking system. These brakes can be either mechanical or electrical. The functions of a braking installation on a conveyor can be described as:

- Deceleration
- Stopping
- Holding (to a lesser degree)

The friction-type magnetic, solenoid or thruster-actuated drum or disc brakes are normally installed for deceleration and stopping of the conveyor after the power to the drive has been shut off. These types of brakes also assist the backstop marginally in preventing the conveyor from running in a reverse direction.

Rapid deceleration of a belt conveyor will result in mechanical shock in the system, thus causing damage to the conveyor and ancillary equipment. To illustrate this, consider a conveyor layout as in figure 12. When the power to the drive is shut off, the brakes are activated and reverse torque is applied to the conveyor. The inertia of the load tends to pick up the gravity tensioner and releases the tension in the belt between the head and the drive pulley, thereby diminishing the required  $T_1/T_2$  ratio. Depending on the magnitude of the deceleration forces applied, a condition could be achieved where the friction between load and belt is exceeded, thus resulting in a pile-up of the load at the discharge point. The raised gravity take-up expends enough energy during its downward motion to cause the troughing side of the belt to move in the reverse direction. Because of the speed at which the action described above takes place, a considerable amount of shock is absorbed by the belt and ancillary equipment, which could cause damage and will reduce the life span of the components.

On conveyor belt installations where sufficient retardation is achieved because of normal friction between belt and other moving parts, the installation of a braking system is, of course, not required. In practice, a number of conveyor installations do fall within this scope and are therefore not equipped with a braking system.

With regard to a conveyor which will not come to a stop of its own accord within an acceptable time, a braking system is considered necessary because:

- the uncontrolled discharge of conveyed material onto the next belt could damage chutes and other equipment, thus resulting in loss of production
- transfer bunker sizes are not adequate.

Before deciding whether brakes will be used or not, the advantages and disadvantages should be considered carefully because the end result could save or waste money.

### 3.6

#### Reducers

The purpose of the reducer is to reduce the speed of the drive motor to the required speed of the drive pulley. By reducing the speed of the motor the torque is increased in the same ratio.

Three types of reducers are commonly used in the industry:

- worm reducers
- right-angled drive reducers (see figures 13 and 15)
- parallel shaft reducers (see figures 14 and 16).

The drive unit, consisting of the motor, fluid coupling and reducer, can be mounted in two ways:

- on a foundation next to the structure of the conveyor with the output shaft of the reducer coupled to the pulley shaft by means of a suitable coupling
- as a shaft-mounted drive where the drive is supported on the pulley shaft. The drive unit output shaft can be either hollow, driving through a friction locking element or a solid shaft attached to the pulley shaft by means of a suitable coupling.

Worm reducers are relatively simple and cheap, but due to their lower efficiency compared to other types of reducers they are basically used on conveyor drives requiring power less than approximately 50 kilowatt. The lower efficiency is primarily caused by the sliding

action between the worm and bronze worm-wheel and resultant back thrust involved. This results in high wear of the worm-wheel teeth, thus making the worm reducer more maintenance-intensive than other types of reducers.

The right-angled drive reducers and parallel shaft reducers are used on larger drives because of their relatively high efficiency and reliability. With accurately machined gears a rolling action takes place between teeth flanks resulting in minimized wear of the teeth.

Right-angled reducers have the advantage of occupying less space than parallel shaft reducers since they can be mounted parallel to the belt structure. This renders them particularly suited for underground installation where space is often a limiting factor. An added advantage is that this type of reducer can be mounted directly onto the shaft of the drive pulley. This feature reduces the size of the foundation required for the drive. (See figure 13)

Parallel shaft reducers, however, are cheaper than right-angled reducers mainly due to the fact that the machining of the bevel-helical gear sets is a costly operation.

The following points should be considered with respect to reducer maintenance programmes:

- It is recommended that regular oil samples be taken and analysed at predetermined intervals as reducers in the mining industry normally work in dirty and sometimes wet surroundings.
- A magnetic sump plug to catch metal in the oil is recommended.
- To prevent dirt entering the oil by way of the dip stick during regular oil level inspections, the use of a sight glass which indicates the oil level is recommended.
- Dirt in the oil causes wear in the bearings of the reducer. When wear in the bearings surpasses specified limits, it causes excessive wear of gear teeth resulting in improper gear meshing with subsequent point loading and excessive stress concentrations.

- Leaking reducers must be repaired immediately because lack of oil will result in severe damage.
- Only oil recommended for the particular type of reducer should be used.

#### 4 CONCLUSION

The question whether a drive using squirrel-cage or wound rotor induction motors should be selected and which type of starter should be used can only be answered when all pertinent facts concerning the application are known. It is reasonable to conclude that more than one combination could suffice. At this point economic evaluations and sound judgement play an important role in determining the final choice.

In the choice of equipment for a conveyor drive, experience combined with a scientific approach gives optimum results.

In evaluating the best combination for a drive, the following should be taken into consideration:

- Site location
- Power supplies available
- Skills of maintenance personnel
- In a new facility a review of existing drives may dictate which selection parameters are to be employed in order to reduce the types and quantity of spares to be held on site.

5

ACKNOWLEDGEMENT

The authors wish to thank the Management of Iscor for permission to publish this paper. Mr BC Alberts, Divisional General Manager (Mining), and other members of Iscor's staff and private firms are especially thanked for their assistance in the compilation of the paper.

(6347F)

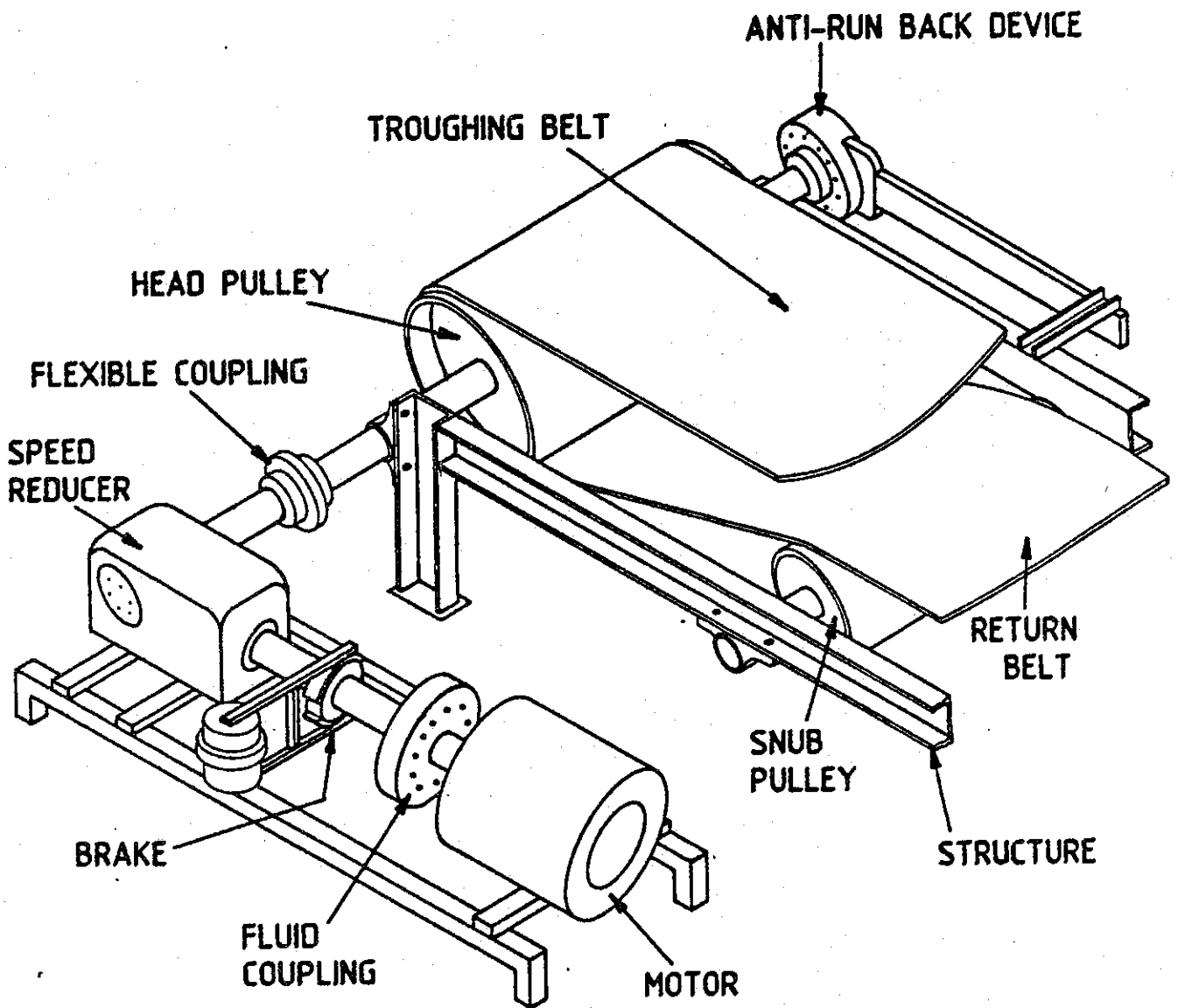


FIGURE 1

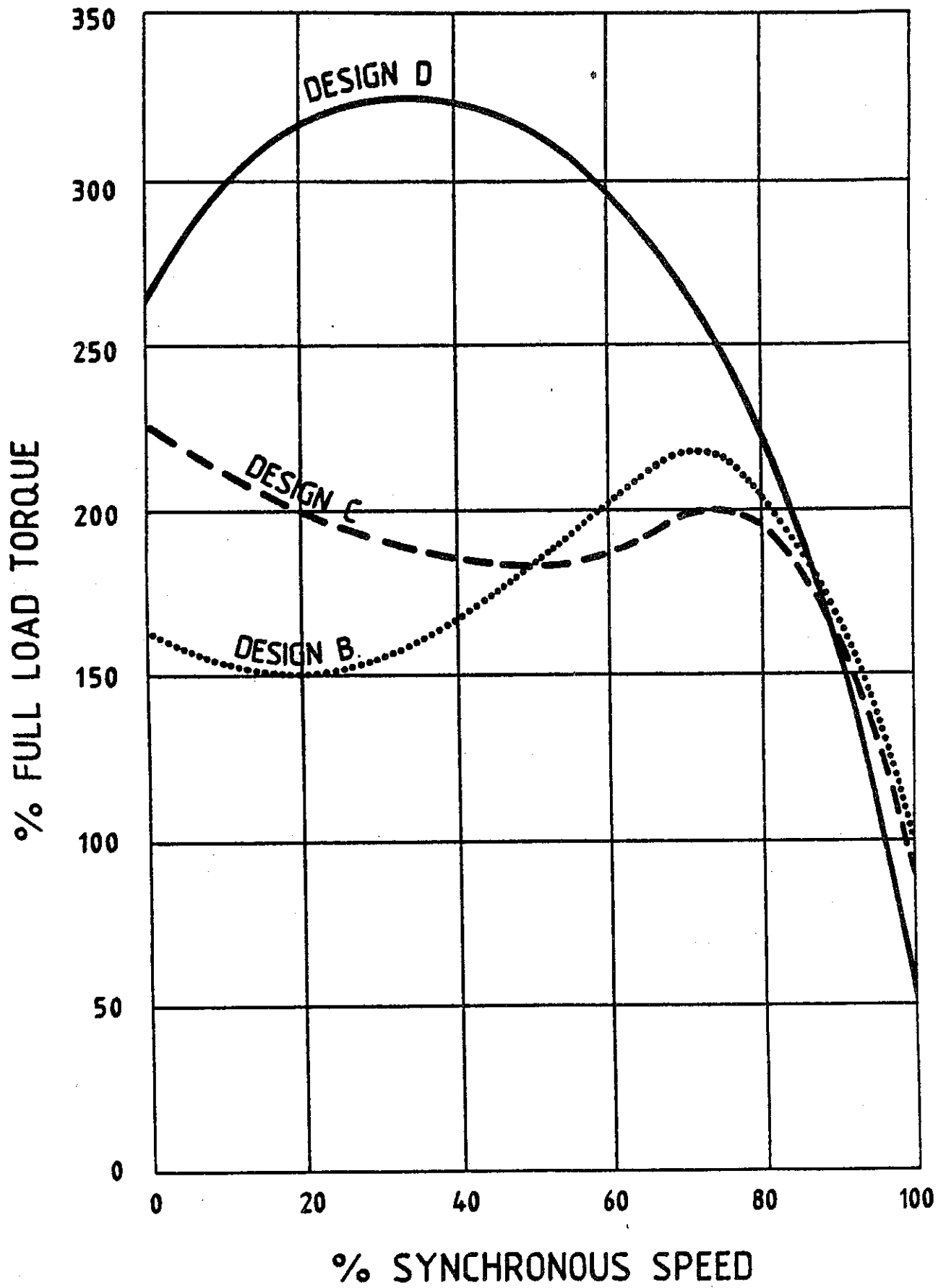


FIGURE 2

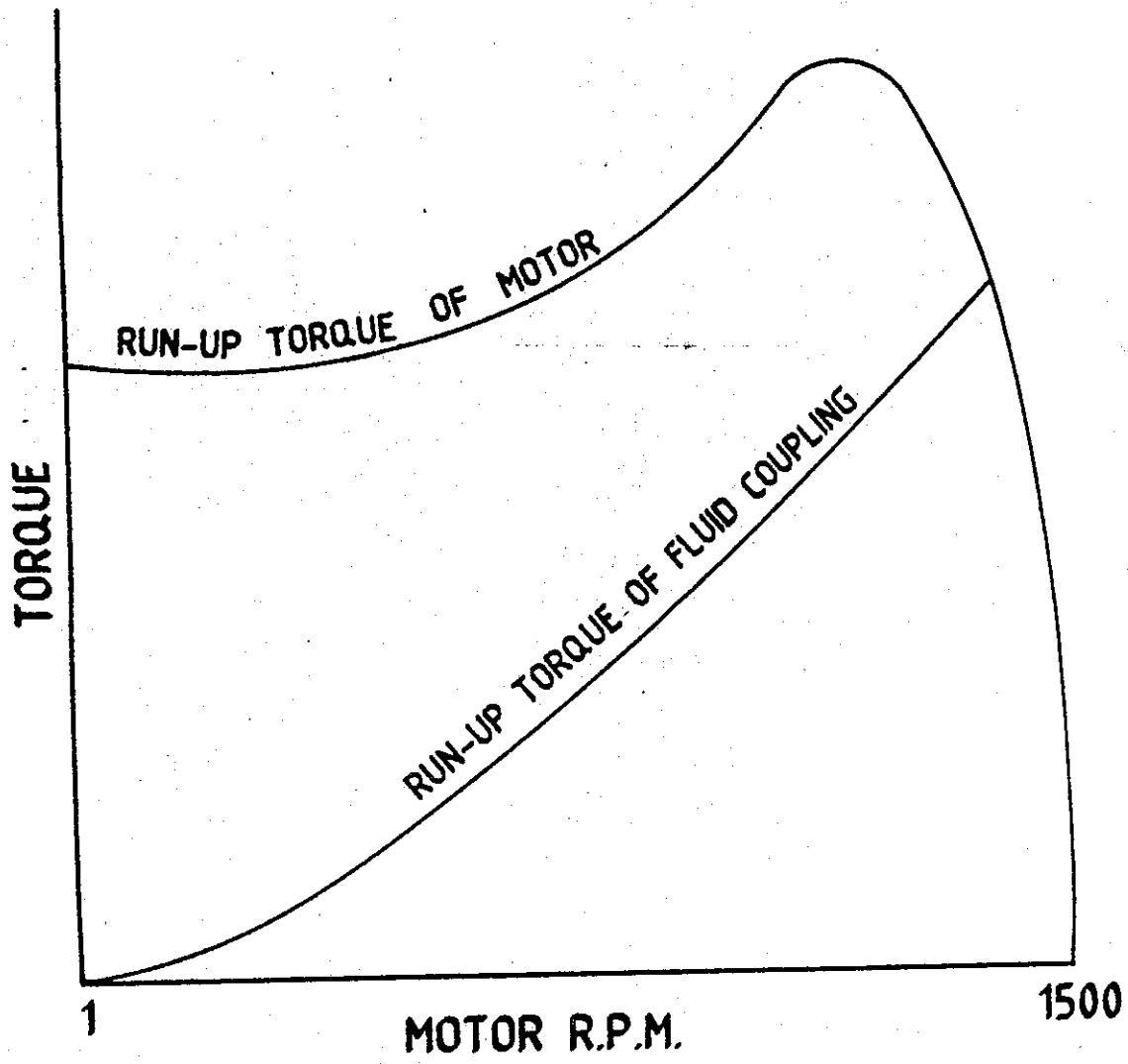


FIGURE 3

INFLUENCE OF THE FILLING PERCENTAGE  
ON THE CHARACTERISTIC  
OF A FLUID COUPLING

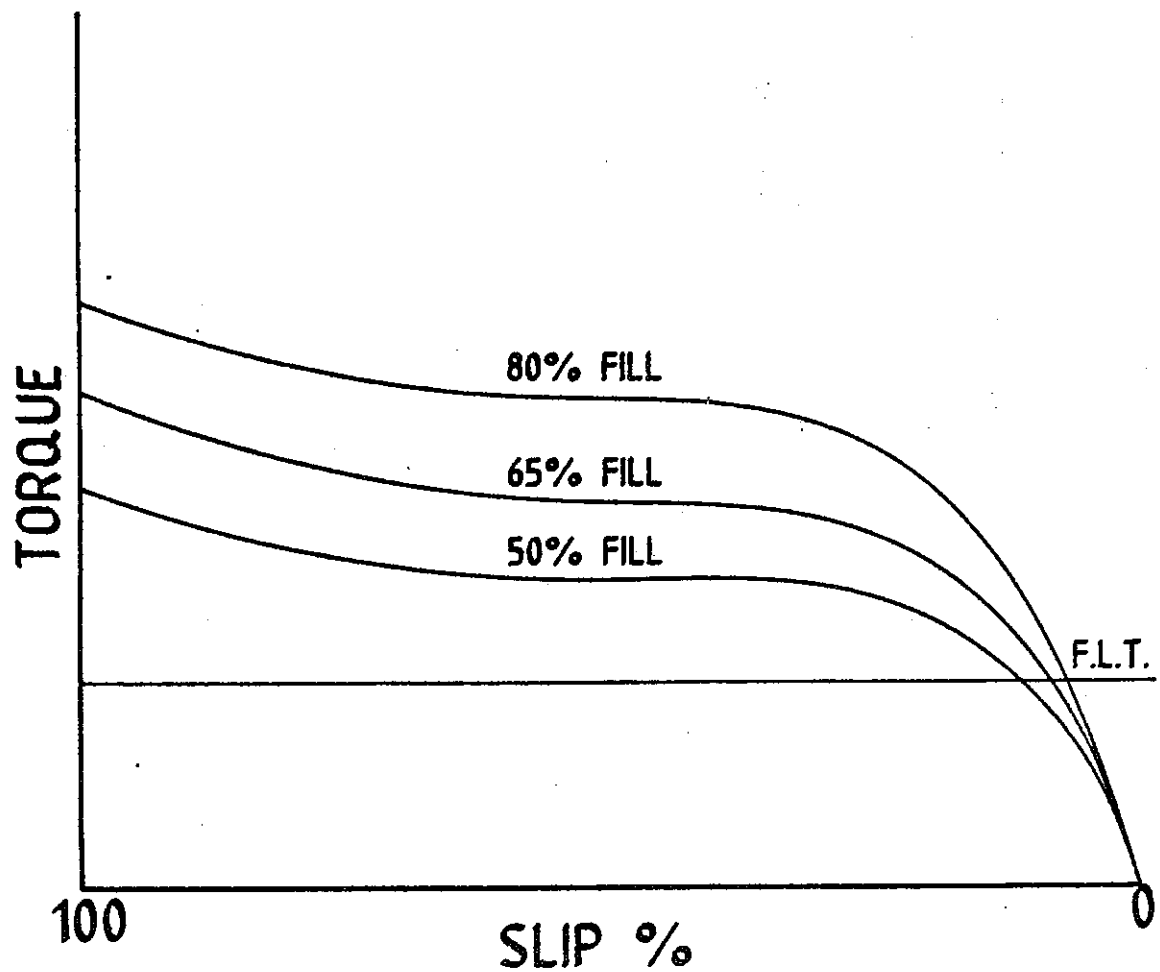


FIGURE 4

# TRACTION COUPLING

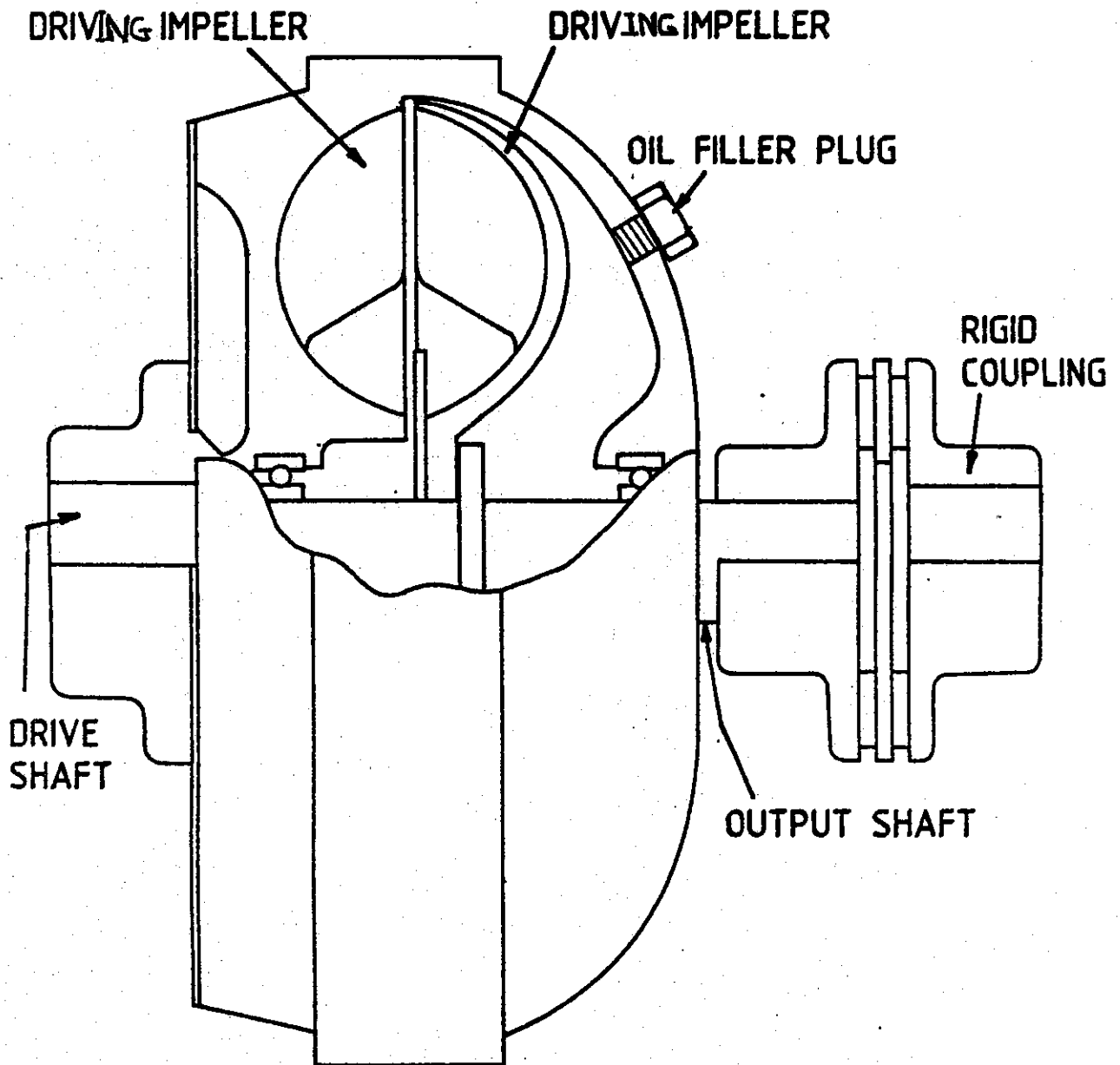


FIGURE 5

# SCOOP COUPLING

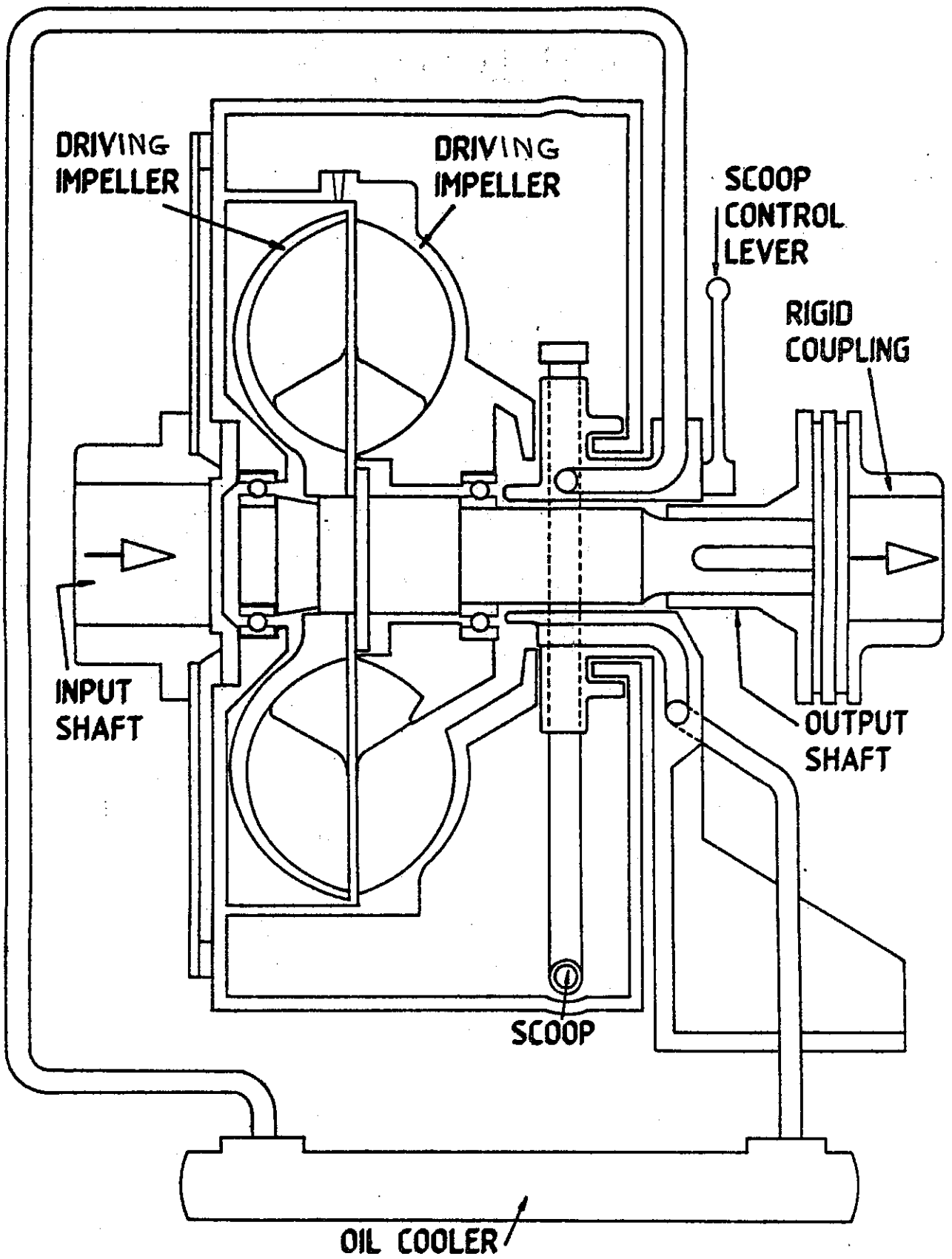
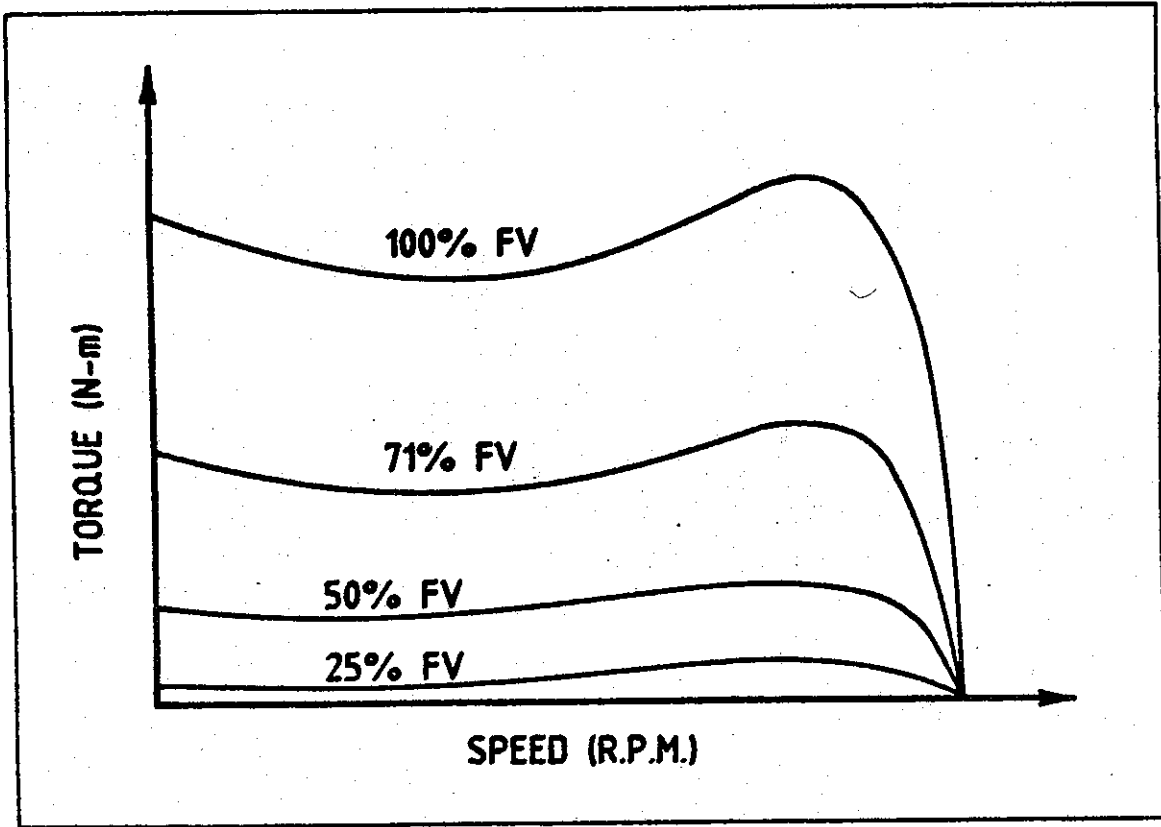


FIGURE 6



SPEED-TORQUE CURVES AT REDUCED VOLTAGES

FIGURE 7

# INDUCTION STARTER

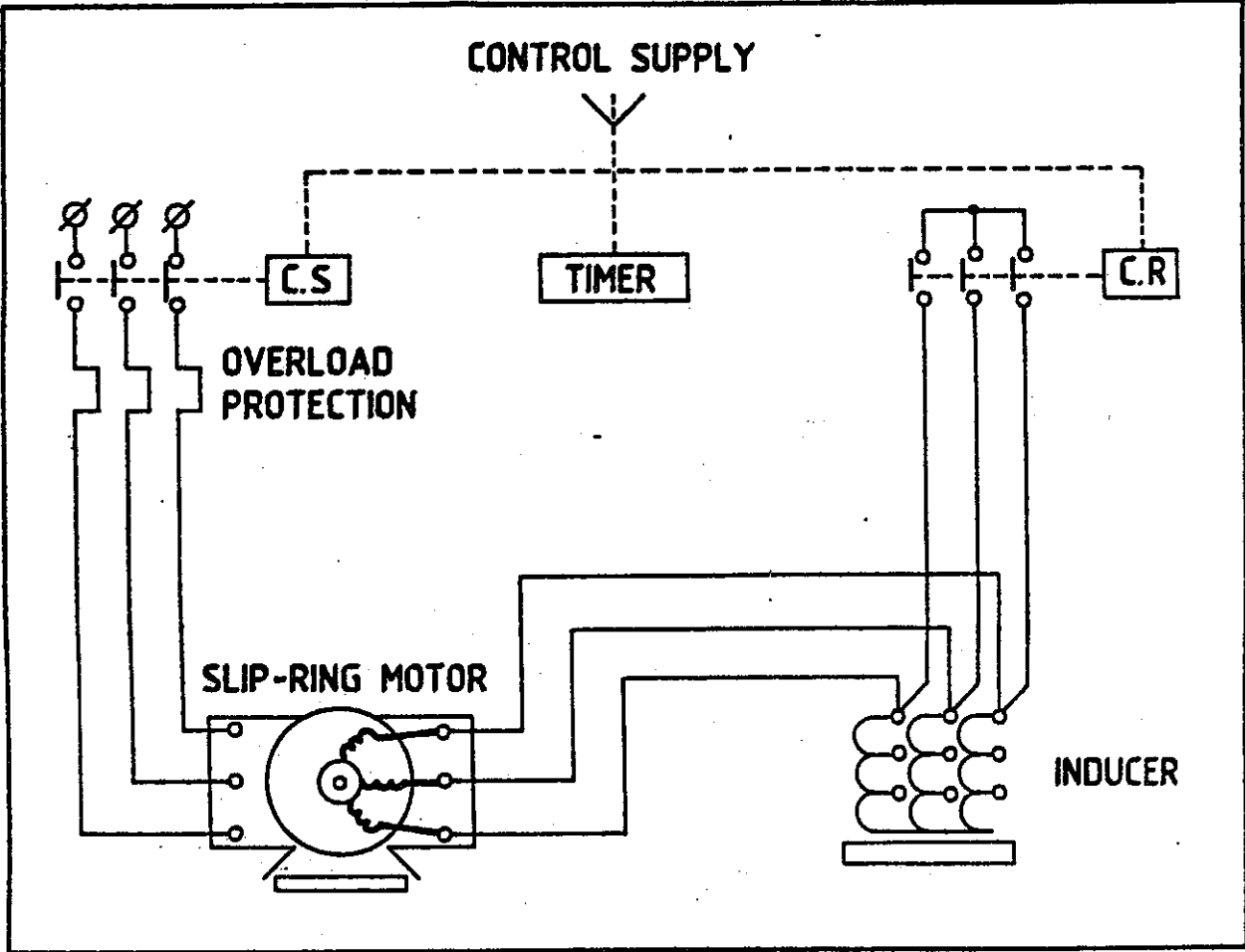
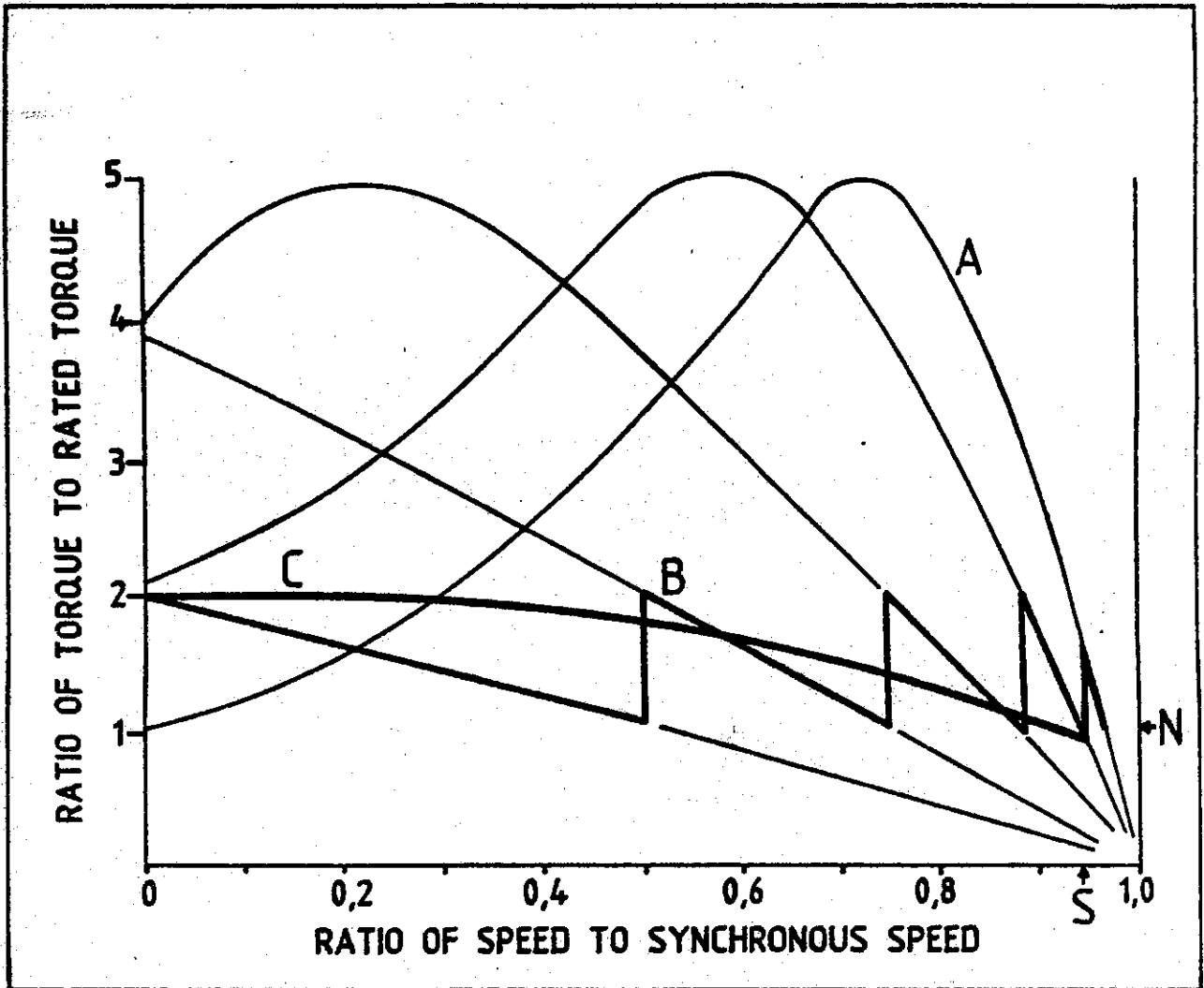


FIGURE 8

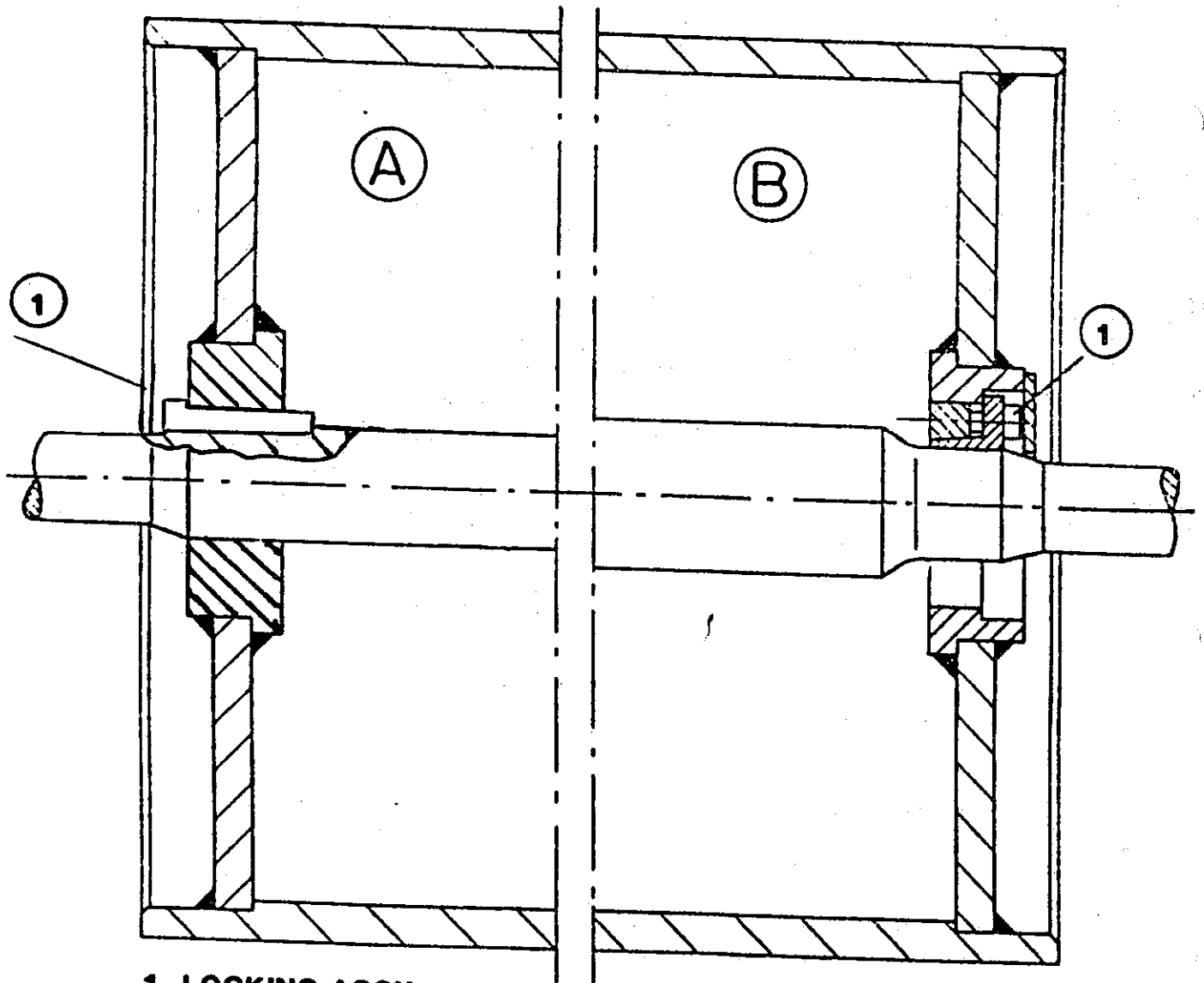


- A - NATURAL MOTOR CURVE
- B - START WITH SWITCHED RESISTANCES
- C - START WITH INDUCTION START
- S - SHORTING OF SLIP-RINGS
- N - NOMINAL RUNNING CONDITION

**FIGURE 9**

# DRIVE PULLEY ASSEMBLY

## LIGHT DUTY APPLICATION



**1 LOCKING ASSY**  
**ALTERNATIVES A AND B**

FIGURE 10(a)

# DRIVE PULLEY ASSEMBLY

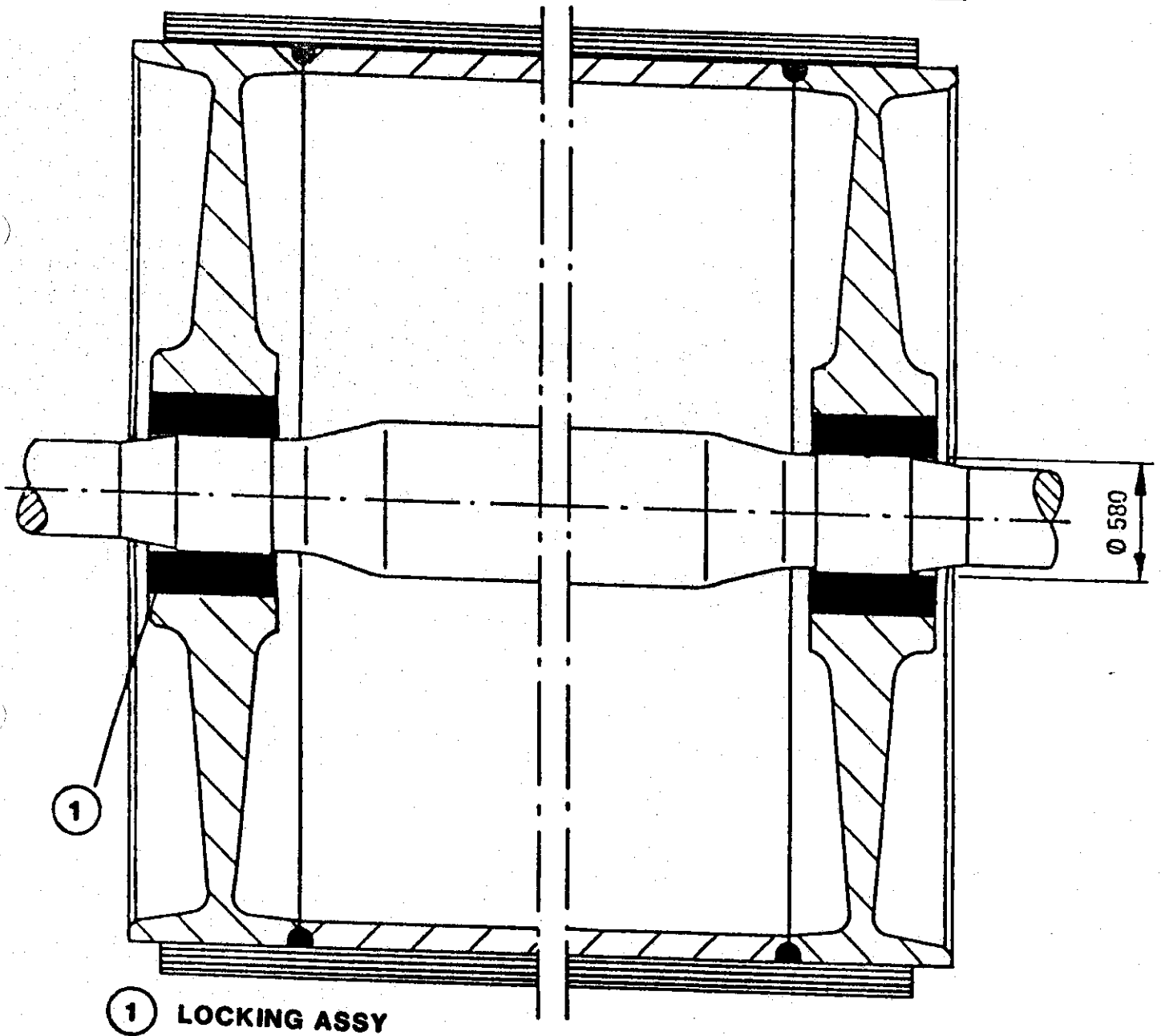
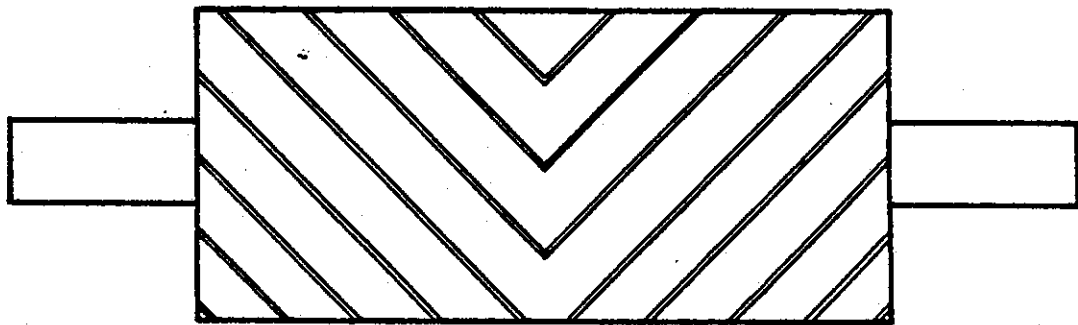


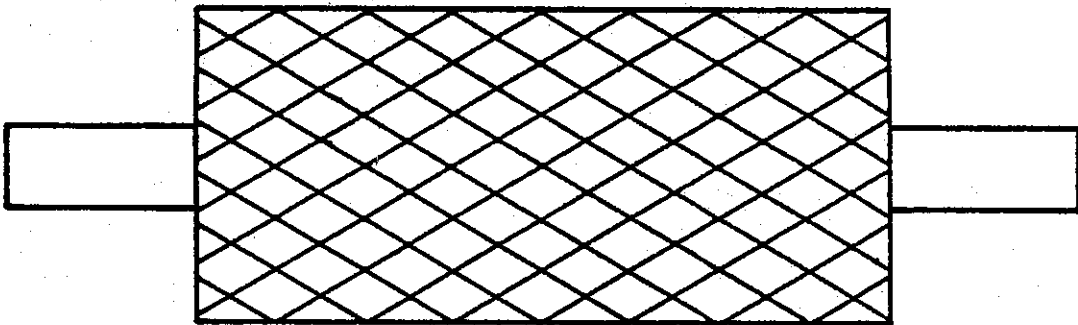
FIGURE 10(b)

HEAVY DUTY APPLICATION

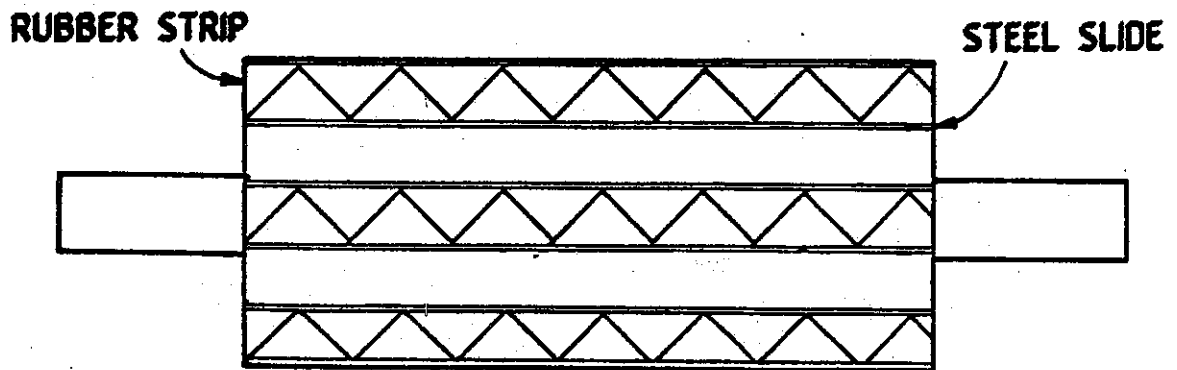




**GROOVED LAGGING**



**DIAMOND LAGGING**



**SLIDE LAGGING**

**FIGURE 11**

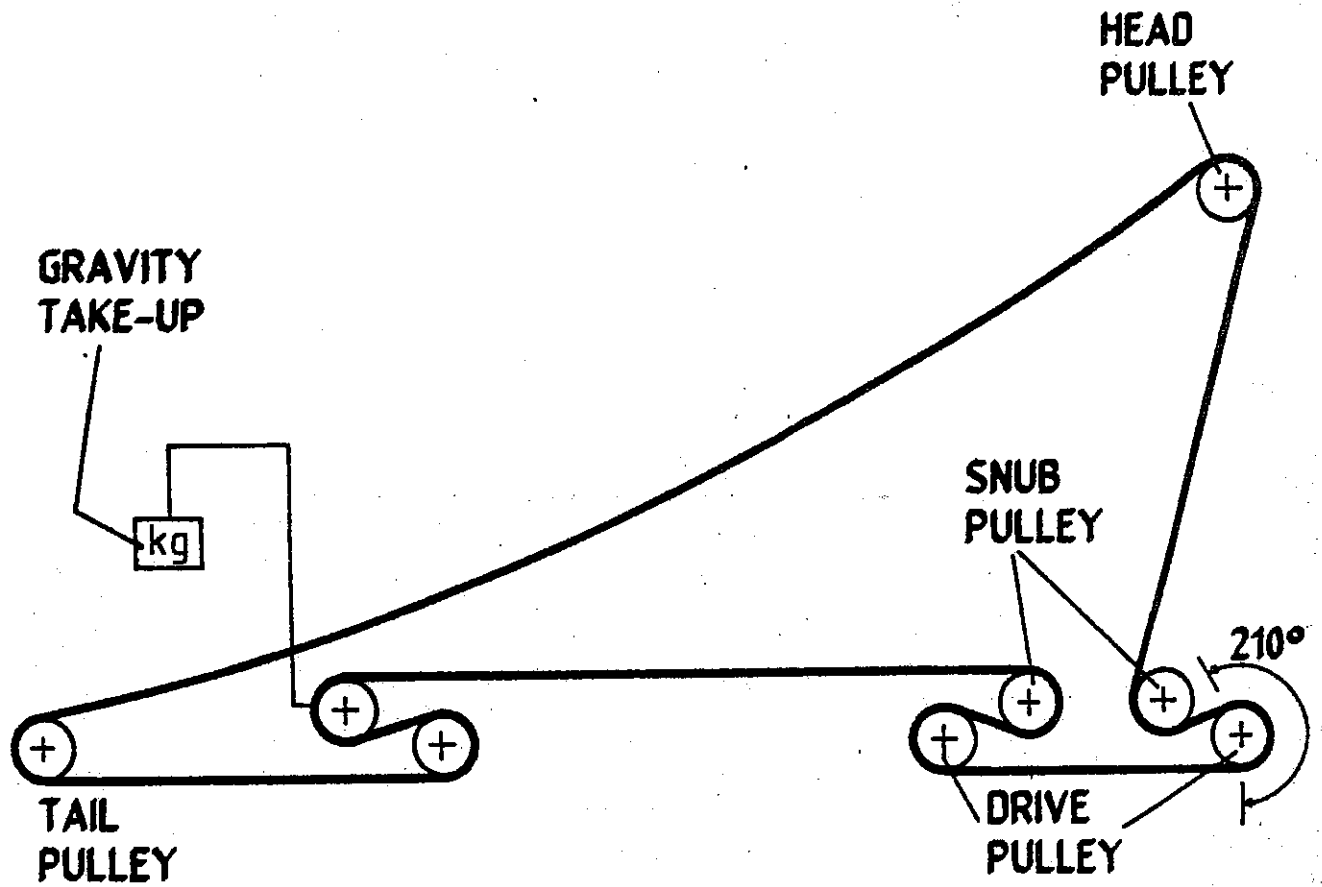
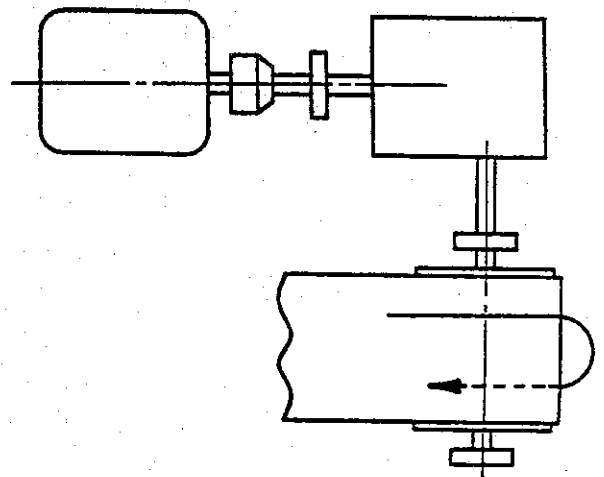
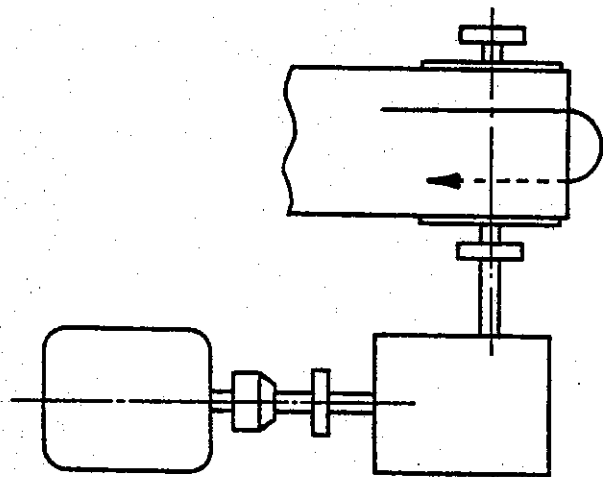
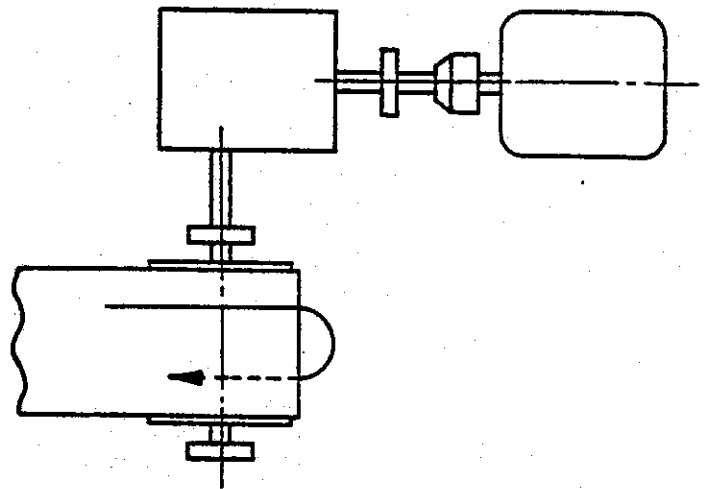
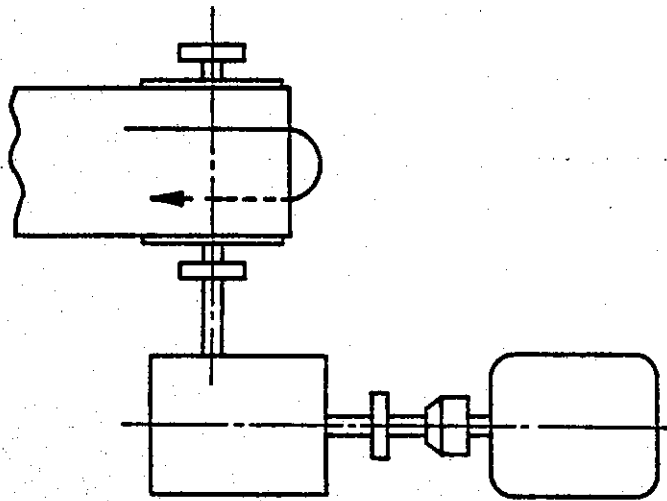


FIGURE 12



**SINGLE DRIVE ARRANGEMENTS  
RIGHT-ANGLE DRIVES**

**FIGURE 13**

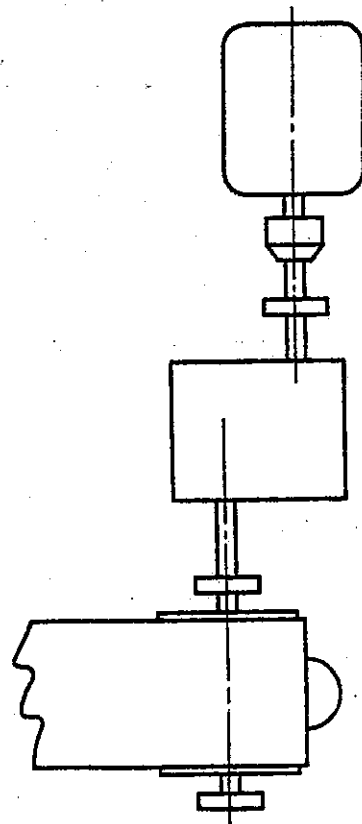
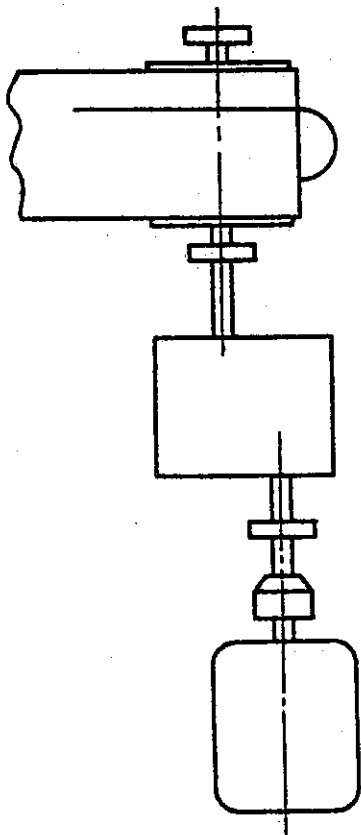
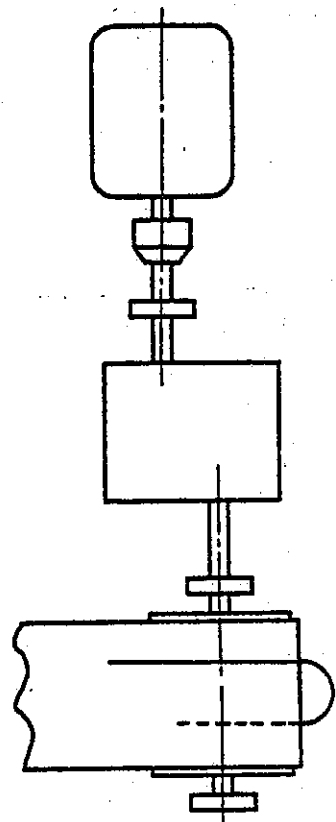
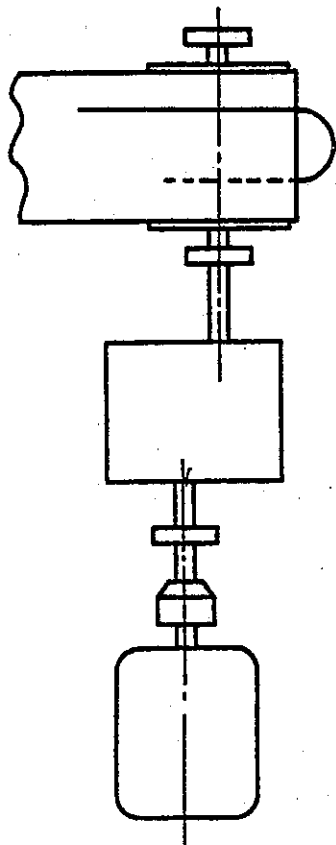
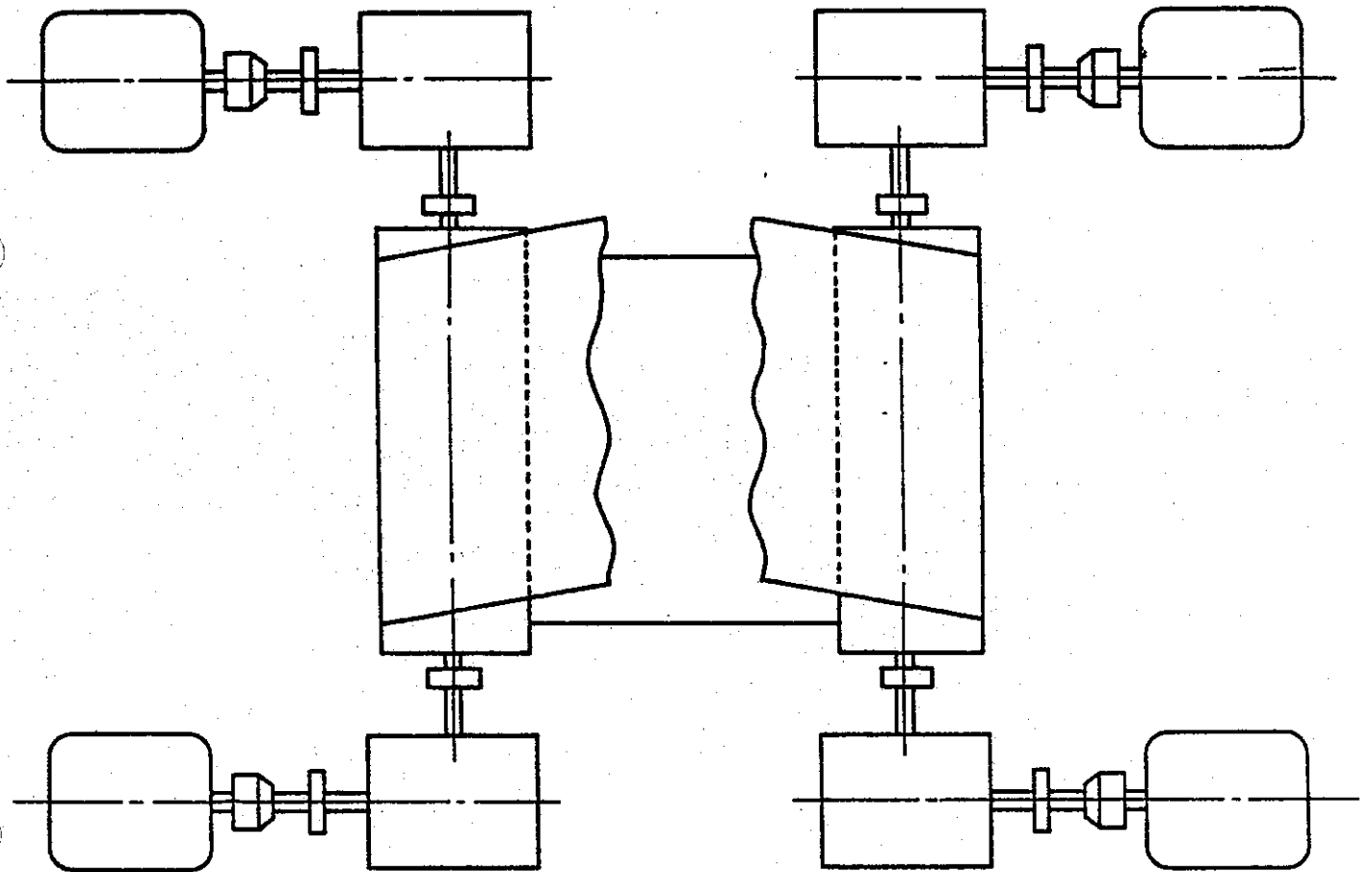


FIGURE 14

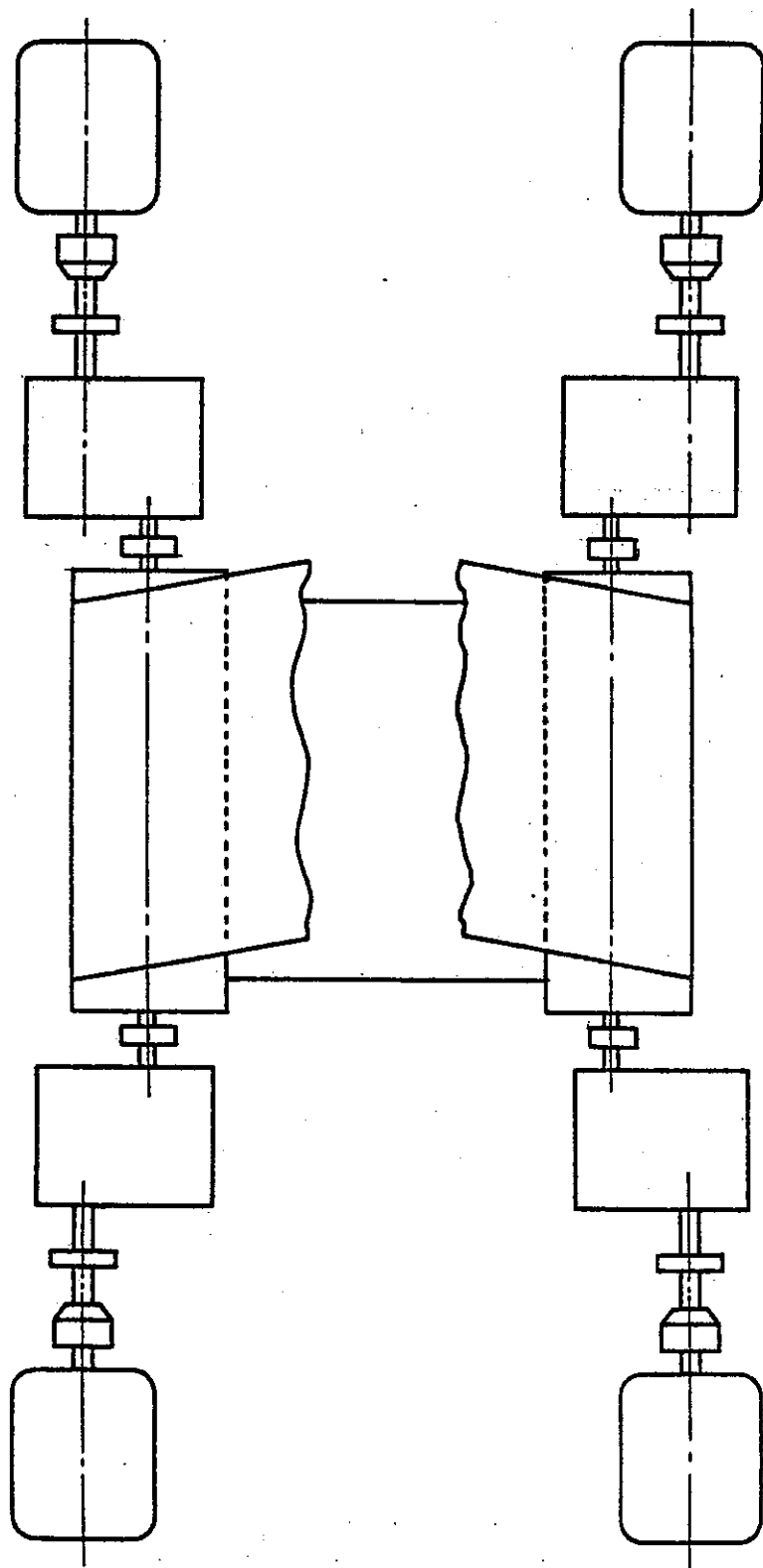
SINGLE DRIVE ARRANGEMENTS.  
PARALLEL SHAFT DRIVES.



MULTI-DRIVE ARRANGEMENTS

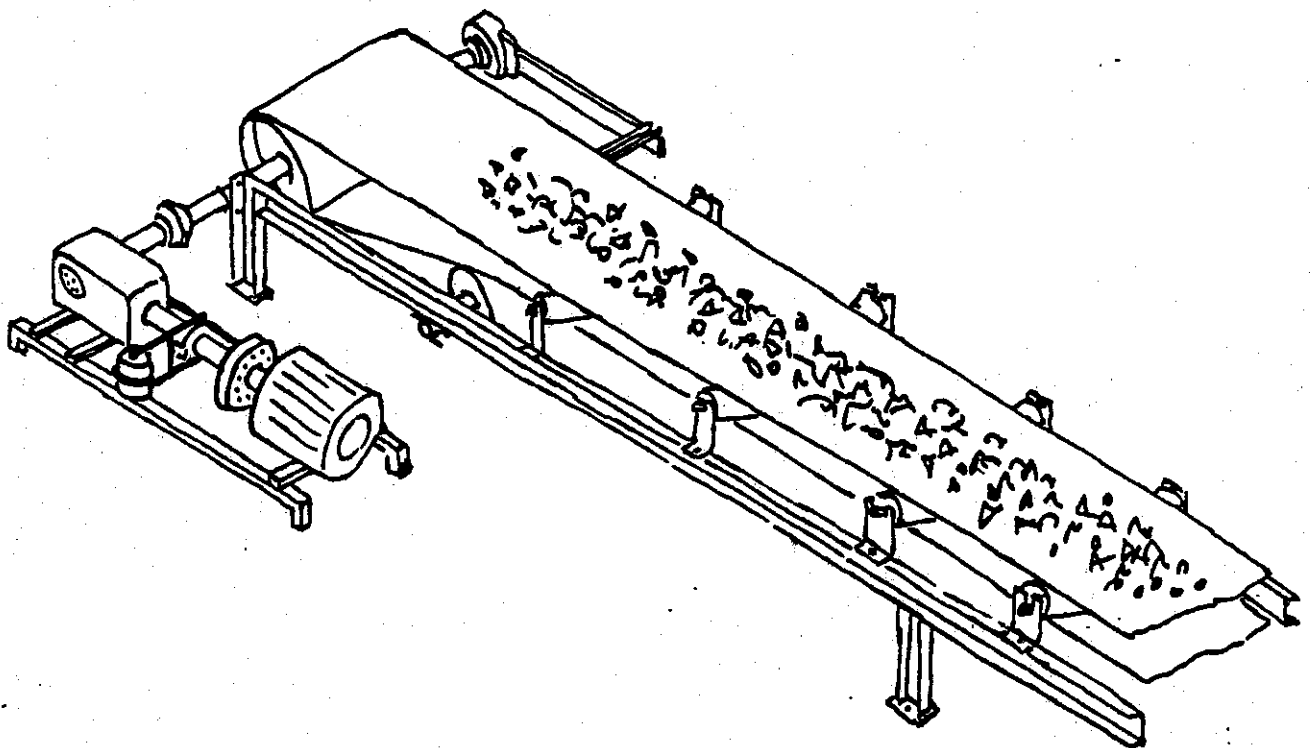
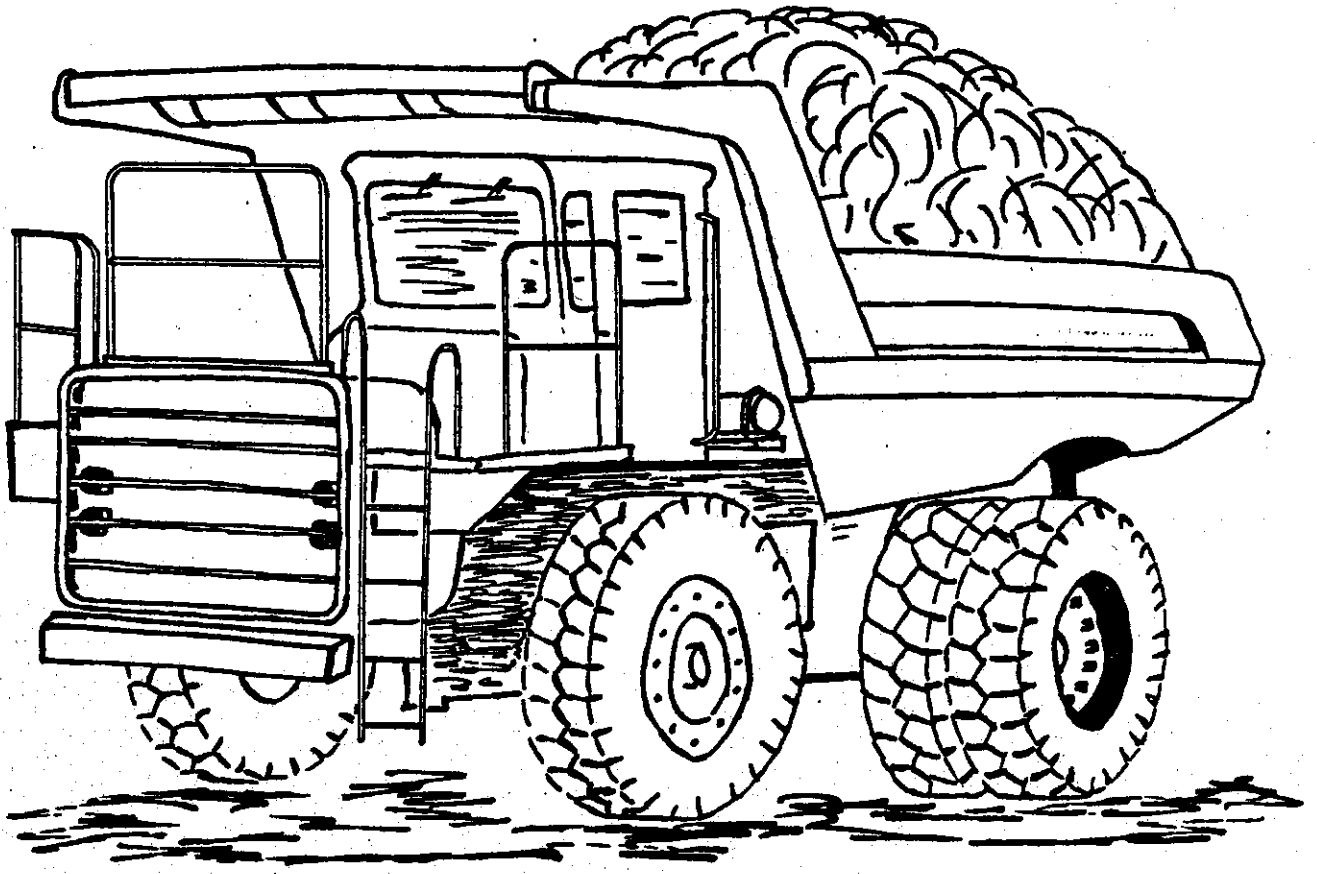
RIGHT-ANGLE DRIVES

FIGURE 15



MULTI-DRIVE ARRANGEMENTS  
PARALLEL SHAFT DRIVES

FIGURE 16



THE DRIVE WILL BE CONSIDERED AS  
CONSISTING OF:

- MOTORS AND STARTING GEAR
- DRIVE PULLEYS
- BACKSTOPS
- BRAKES
- REDUCERS

**STARTING TORQUE OF SQUIRREL-CAGE  
MOTORS CAN BE CONTROLLED BY:**

- **FLUID COUPLINGS**
- **REDUCED VOLTAGE**
- **FREQUENCY CONTROL**

## ADVANTAGES OF TRACTION COUPLING

- **STARTING TORQUE DETERMINED BY INITIAL OIL FILL**
- **MOTOR IS ALLOWED TO START WITHOUT LOAD**
- **HIGH INRUSH OF CURRENT IS PREVENTED**
- **PROVIDES OVERLOAD PROTECTION**
- **SIMPLE AND ROBUST CONSTRUCTION**

## ADVANTAGES OF SCOOP COUPLINGS

- **STEPLESS VARIABLE OUTPUT SPEED**
- **CONTROL OF TORQUE DURING ACCELERATION**
- **ENGAGING AND DISENGAGING OF DRIVE WITH A CONTINUOUS RUNNING MOTOR**
- **ALLOW FOR LOAD SHARING BETWEEN MULTIPLE DRIVE MOTORS**

## ADVANTAGES OF SOLID-STATE REDUCED VOLTAGE STARTERS

- A SMOOTH STARTING TORQUE
- RELIABLE AND LOW MAINTENANCE COST

## ADVANTAGES OF SLIP-RING MOTORS EQUIPPED WITH INDUCER STARTERS

- RELATIVE LOW COST COMPARED TO OTHER TYPES OF STARTERS
- EASY TO INSTALL AND OPERATE
- LITTLE MAINTENANCE
- NO MOVING PARTS OR LIQUIDS
- NO COMPLEX SWITCHING
- A SMOOTH STARTING TORQUE

## ADVANTAGES OF A SINGLE DRIVE

- TECHNICAL SIMPLE
- CLEAN SIDE OF CONVEYOR IN CONTACT WITH PULLEY
- LESS BENDING OF BELT UNDER HIGH TENSION
- NO PROBLEMS WITH LOAD SHARING

**MULTIPLE PULLEY DRIVES SHALL BE USED**  
**WHERE:**

- SINGLE PULLEY DRIVE AND CONTROL SYSTEM BECOME MORE EXPENSIVE THAN A MULTIPLE PULLEY DRIVE
- ARC OF CONTACT AT SINGLE PULLEY DRIVE BECOMES TOO SMALL TO TRANSMIT TORQUE WITHOUT SLIP

## THREE DIFFERENT TYPES OF REDUCERS

- WORM REDUCERS
- RIGHT-ANGLED DRIVE REDUCERS
- PARALLEL SHAFT REDUCERS

## POINTS TO BE CONSIDERED IN THE MAINTENANCE OF REDUCERS

- OIL HAS TO BE ANALYSED REGULARLY
- MAGNETIC SUMP PLUG TO BE INSTALLED
- USE SIGHT GLASS INSTEAD OF DIPSTICK
- DIRT IN OIL CAUSES WEAR IN BEARINGS  
THUS CAUSING MISALIGNMENT OF GEARS
- REPAIR LEAKING REDUCERS IMMEDIATELY
- USE ONLY RECOMMENDED OIL

- IS IT SUBJECTED TO WEAR ?
- WILL IT BE AFFECTED BY WATER ?
- DOES IT NEED REGULAR ADJUSTMENT ?
- WHAT IS THE AMOUNT OF BACKLASH ?
- DOES IT HAVE HIGH STRESS CONCENTRATIONS ?