

Printing Machinery Maintenance

'M' Scheme Syllabus



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PREFACE

This book of Printing Machinery Maintenance covers all the topics in a clear and organized format for the Third year Diploma in Printing Technology students as prescribed by the Directorate of Technical Education, Chennai, Tamilnadu. It is confidently believed that this book furnishes the students the necessary study material. The topics covered were neatly illustrated for better understanding of the students.

The book is prepared step-by-step lessons in large, eye pleasing calligraphy make it suitable for both direct one-to-one tutoring and regular classroom use. The highlight of this book is its simple English with clear and easy explanation of each topic.

All the topics are explained with supporting diagram for diploma level students to understand effectively.

This book majorly deals with Maintenance Management, Power Transmission, Mechanical and Electrical Elements, Lubrication and Reconditioning and Maintenance of Mechanisms etc.

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PRINTING MACHINERY MAINTENANCE

DETAILED SYLLABUS

Contents: Theory

Unit	Name of the Topic	Hours
I	<p>Maintenance Management</p> <p>1.1 - Maintenance – Definition, Objectives, Types of Equipment Maintenance – Planned maintenance and unplanned maintenance.</p> <p>1.2 - Types of Planned maintenance - Preventive Maintenance, Predictive Maintenance and Scheduled maintenance - Merits and demerits.</p> <p>Unplanned maintenance - Breakdown Maintenance or Emergency maintenance - Merits and Demerits. Contract maintenance - Definition - Merits and Demerits.</p> <p>1.3 - Preventive Maintenance Functions - Planning, scheduling, Repair cycles, Dispatching and Controlling.</p> <p>1.4 - Safety Precautions and House Keeping – safety precautions to be followed in press area and Five steps of housekeeping (5S method).</p>	13 Hrs
II	<p>Power Transmission</p> <p>2.1 - Chain Drives - Introduction, Types of Chains – Roller Chain, Silent Chain, Ewart Chain and Bead Chain, Merits and Demerits of Chain Drives.</p> <p>2.2 - Belt Drives - Introduction, Types of Belts – Flat belt, Rope belt, Tooth Belt, V belt and Timing Belt, Merits and Demerits of Belt drives.</p> <p>2.3 - Gear Drives - Introduction, Types of Gears – Spur gear, Helical gear, Bevel gear, Worm gears and Herringbone gear, Merits and Demerits of gear drives.</p> <p>2.4 - Maintenance and Lubrication of Drive Systems - Chain Drive, Belt Drive and Gear Drive.</p> <p>2.5 - Direct drive technology – Introduction, Advantages and Application in the printing field.</p>	13 Hrs
III	<p>Mechanical and Electrical Elements</p> <p>3.1 - Bearings, Types of Bearings - Sliding bearings and Antifriction bearings – Ball bearings, Needle bearings and Roller bearing. Merits and Demerits.</p> <p>3.2 - Cams and Follower, Types of Cams and Followers – Disk Cam, Translation Cam, Groove Plate Cam, Cylindrical Cam, Eccentric Cam and Tow Wipe Cam. Advantages of cam and Follower.</p> <p>3.3 - Springs, Types of springs – Helical Spring, Conical spring,</p>	13 Hrs.

Unit	Name of the Topic	Hours
	<p>Volute Spring and Torsion Springs and its application.</p> <p>3.4 - Electrical Elements - Introduction to Contactors and its types, Introduction to Limit Switches and its application, Introduction to over Load Relay Switches and its types, Thermal and Magnetic, Introduction to Sensors and Detectors and its application, Introduction to Electrical Panels.</p>	
IV	<p>Lubrication and Reconditioning</p> <p>4.1 - Lubrication – Introduction, Advantages, Types of Lubricants - Solid, Semisolid and Liquid. Lubrication Schedule, Chart and Paint Marks.</p> <p>4.2 - Equipments and Tools used in Erection and Reconditioning - Cranes, Hoists, Spanner, Wrenches, Screwdriver, Spirit level, Dial Indicator with gauge, Feeler gauge, Micrometer and Vernier Calipers, Application.</p> <p>4.3 - Test Run – Types of test runs - Idle, Performance, Accuracy, Rigidity and Vibration test.</p>	13 Hrs
	<p>Maintenance of Mechanisms</p> <p>5.1 - Electrical Maintenance – Introduction to AC and DC motors, Maintenance Check list for motors, Common problems with Electricity.</p> <p>5.2 - Pneumatic System Maintenance - Introduction to pneumatic system functioning, Compressor types - Reciprocating and Rotary compressor, Application in Printing Field and Check List for pneumatic system maintenance.</p> <p>5.3 - Hydraulic System Maintenance - Introduction to Hydraulic System, Application in Printing field and Check list for Hydraulic System maintenance.</p> <p>5.4 - Mechatronics – Introduction and applications in Printing Field.</p>	13 Hrs

UNIT-1

MAINTENANCE MANAGEMENT

MAINTENANCE

The basic principle of maintenance is to extend the useful life of an asset. A proper Maintenance will improve the production with the existing capacity utilization.

Maintenance is usually viewed, as a repair function but it is composite in nature. A wide range of activities are involved in it. In fact maintenance keeps our entire system to be reliable, productive and efficient. Also there is no definite maintenance procedure for a particular plant/ machine; it varies from one plant/machine to others.

1.1 OBJECTIVES OF MAINTENANCE

1. To minimize the breakage and maximize the plant availability
2. To extend the useful life of assets by minimizing wear & tear and deterioration
3. To ensure the operational readiness of all equipment.
4. To ensure the safety of workers.
5. To establish a satisfactory working condition.

1.2 TYPES OF EQUIPMENT MAINTENANCE

1. Scheduled Maintenance
2. Preventive Maintenance
3. Prediction Maintenance
4. Restoration Maintenance/Break down/Emergency
5. Contract Maintenance

PLANNED MAINTENANCE

1. Scheduled Maintenance:

This type of maintenance is done to avoid break down. A schedule is framed for an instrument or machine. According to that all works like inspection, lubrication, repair done.

2. Predictive Maintenance:

Predictive maintenance is to recognize the cause of any change of physical condition of a system. In this method, using instruments like vibrations

analyzer, axial displacement monitors, optical devices, non-contacting sensor etc follows sensing, measuring and monitoring techniques. The main advantages of this system are to inspect the troubles of internal parts without disassembly.

3. Preventive Maintenance:

Preventive Maintenance is naturally carried out before any interruption of production and major breakdown. This maintenance is carried out in predetermined intervals. Preventive Maintenance will not only prevent the breakdown, but also it will improve the output, Quality of product, and contain of the machine. This preventive Maintenance most successful one and it is adopted in much organization. The best way to perform preventive maintenance consistently is to develop operational checklists.

Advantages of Preventive maintenance:

- ❖ Major repairs can be avoided.
- ❖ Gives less production down time.
- ❖ Product rejection is minimum.
- ❖ Provide better quality control facilities.
- ❖ Lengthen the life of equipment.
- ❖ Provides safety to the workers
- ❖ Minimum inventory control

Unplanned Maintenance

1. Restoration Maintenance: -

Restoration maintenance, also called repair and corrective maintenance, is the most common maintenance performed. Restoration maintenance consists of repairing a broken or damaged piece of equipment to restore necessary operation conditions. Restoration maintenance is basically a fix-it-when-it breaks function, where it leads to equipment downtime, loss of money & manpower.

The Breakdown maintenance does not provide any guarantee of reliability to the smooth production running. It is better to avoid breakdown maintenance and go for planned maintenance

2. Contract Maintenance: -

Normally it is adopted by small companies by the way of AMC (Annual Maintenance Contract) by using outside manpower, tolls and consultancy This maintenance is very expensive & time consuming but it leads to hassle free work/production and you may able to concentrate on your core work.

Advantages of Contract Maintenance:

- ❖ Capital expenditures towards maintenance are reduced.
- ❖ No need to train or retain any workers.
- ❖ Control over the result.

Disadvantages of Contract Maintenance:

- ❖ Possibility of a long delay in specialty arrival.
- ❖ More Expensive than integral maintenance.
- ❖ Problem with union, due to outside person service.
- ❖ Dependency upon the contracting company.

1.3 FUNCTIONS OF PREVENTIVE MAINTENANCE

A maintenance system incorporates all functions like

- Planning,
- Scheduling,
- Dispatching,
- Recording,
- Analysis
- Controlling.

PLANNING

Planning means formulation of work in advance. A successful maintenance depends on maintenance planning only. So “What should be done” and “Where should be done” are the major criteria of successful maintenance.

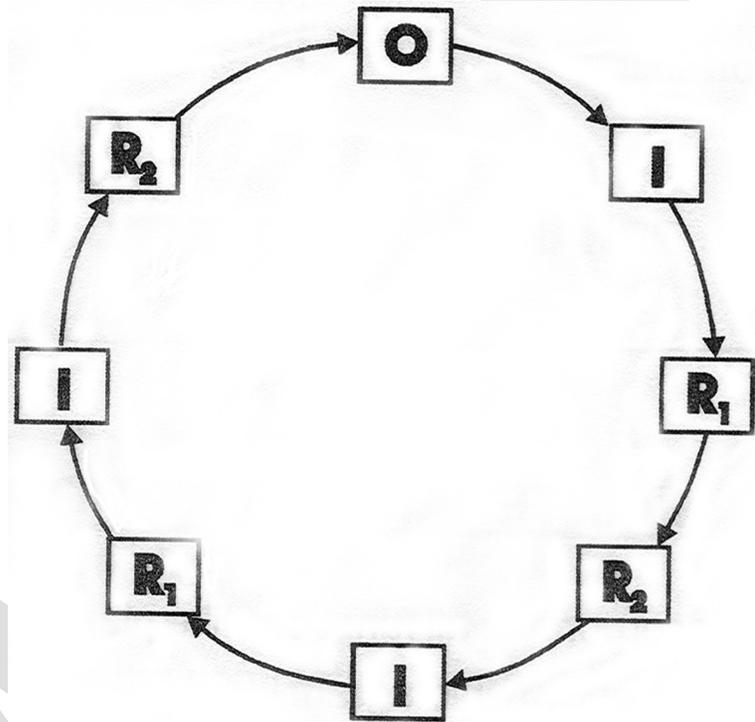
Maintenance planning may be effectively performed, if the past data regarding inspecting etc, are available in the department. The best way is to have a “**History card**” for each machine or instrument. Analysis of the past data can only enable the management build a confident work-planning structure.

In case of a preventive maintenance, the total planning should be reflected in **Master card**. After preparing “Master maintenance schedule”, weekly schedule may also be planned. But while planning, the activities required for an effective maintenance are to identify. For example: cleaning, lubrication etc.

SCHEDULING

Scheduling is the time phase of the sequential activities. A maintenance schedule generally include activities,

- Inspection
- Repair (Major/minor repair)
- Overhauling



All the above activities are performed repetitively and the activities between two overhauling are termed as “**repair cycle**” and it is shown in diagram.

In this diagram, the activity is started in a clockwise direction. It is seen that at first an inspection is scheduled, then a minor and a major is planned. Once again inspection is done and a minor repair is performed. After the third inspection a major repairing takes place and then next overhauling comes. That means completing one repair cycle. So from the above repair cycle we can state three-Inspections, two-minor & major repair are performed in between the two consecutive overhauling.

Now it is evident that the time period for a repair cycle is dependent on the time intervals between the two activities. If the time interval is six month, and then the repair

cycle is for four years. The planning of time intervals may be considered by the past data of the machine, manufacturing instructions and complexities of the instruments etc

DISPATCHING

Once scheduling is completed, the next phase is dispatching, that is to issue order to start work. So maintenance authority issues “work order”.

ANALYSING

To evaluate the maintenance work done so far, a feed system is followed. In that system a “**Work report**” communicates, “What has been done” against our planned work schedule of “What to do” Analyzing of such report will enable the management to control and review the “Maintenance planning”.

CONTROLLING

To enjoy the full planning, an effective control system should be maintained. Whenever the plan deviates or does not occur as per schedule, a corrective measure is to be followed. For this, monitoring of the total project is carried out which provides information, if any change of action is to be made in course of work.

The maintenance work-order and work report may be checked and compared in course of work, whether the work has already been done, or work need is waiting for any spare or is facing any type of administrative or technical difficulties, are always to be monitored. The both way information line should exist with the superior personnel. If the work has been done satisfactorily, then it is recorded in equipment history card.

1.4 SAFETY PRECAUTIONS

1. Exercise extreme care and precaution when working on any printing press.
2. Observe and practice all safety rules, regulations, and advice given in the press manual.
3. Read all verbal and written instructions before performing maintenance or operating the press.
4. Wear protective gear for eyes, ears, head, and feet where necessary to protect against injury.
5. Stand clear of the press immediately when the run signal is given.
6. Make sure the press is completely stopped before touching any of its operating parts.
7. Check all safety devices on the press every day to ensure that they are reliable and working.

8. Never switch off safety devices or remove or otherwise bypass guards.
9. Before working on the press, check to make sure it has been put on "safe"
10. Check that stairs, footrests, running bolts, gangways, plat forms, and other equipment surfaces are clean and free of grease. Do not place tools and supplies on these surfaces.
11. Grasp handrails securely when ascending the platforms, standing on the platforms, and before leaving the platforms.
12. Only clean the ink foundations while the press is stopped to avoid injury and press damage.
13. Do not work on moving rollers with rags, tools etc., because of the risk of accident and damage.
14. Reinstall guards immediately after removing the press washup devices.
15. Use the "reverse" button on the press only for plate removal-not for cleaning or gumming cylinders, etc.
16. Do not operate equipment unless authorized.
17. Check that all guards and shields are in place before operating the press.
18. Never release a safe button that someone else has set.
19. Do not start a press that has stopped without an apparent reason.
20. Wear a gearing protection device when working in areas with noise levels.
21. Check that all guards, covers and swiveling footrests are securely fastened before performing maintenance or operating the press.
22. Check for persons, tools, or equipment between and around the press before starting it.
23. Remove all used plates, tools, and equipment from the press area and alert your co-workers before starting the press.
24. Wear a hearing protection device when working in areas with high noise levels.
25. Do not permit people with jewelry, loose clothing, or long hair in the pressroom.
26. Do not lean or rest hands on the press.
27. Do not carry tools in pockets to avoid the possibility of dropping them into the press or other hazardous locations.

28. When making press adjustments, use only recommended tools that are kept in good working condition.
29. Keep clear of nips, slitters, and moving parts when performing maintenance or operating the press.
30. To perform any cleaning process, use rags folded into a pad with no loose edges dangling.
31. Keep all service manuals, instruction manuals, parts lists, and lubrication manuals in the pressroom.
32. Never make repairs and adjustments or perform maintenance and cleaning jobs when the machine is running.

HOUSEKEEPING

Introduction

In industry 'Housekeeping' is not just a push-broom effort. Housekeeping means much more than that. It means not only cleanliness. **It is an orderly arrangement of operations, tools equipment, storage facilities and supplies.** It is a practical method of increasing production, reducing accident and improving morale and public relations.

Typical Accidents due to poor House keeping

- i. Men tripping over loose objects on floors, stairs, and platforms
- ii. Men getting hit by article falling from overhead
- iii. Men slipping on greasy wet or dirty floors.
- iv. Men running against or projecting, poorly piled or poorly placed materials
- v. Men getting trapped under materials falling from piles improperly built
- vi. Men stepping on or tearing hands or other parts of the body on Projecting nails/hooks

Typical Items of Unsafe Housekeeping

1. Excessive materials, waste, or debris in the work area.
2. Congested aisles
3. Overloaded waste containers
4. Disorderly kept locker and washrooms
5. Dirty walls, ceiling & windows

6. Lint and dust on bearing or machines
7. Tools left on machines
8. Poor lighting
9. Acids in open containers
10. Electric wires, cables and hoses across aisles
11. Spillage of oil, grease, storage areas etc not properly marked.

Aids to good housekeeping:

1. Proper layout of work area
2. The marking of aisles and storage areas
3. Cabinets and holders for tools and portable equipment
4. Storage and arrangements for materials
5. Efficient sequence of operations to avoid bottlenecks
6. Efficient transportation of the raw material, the finished product and the refuse
7. Efficient cleaning methods such as use of vacuum cleaners
8. Careful training of employees.

THE 5S's: THE FIVE STEPS OF HOUSEKEEPING**GOOD HOUSEKEEPING**

The five steps of housekeeping, with their Japanese & English names, are as follows:

1. **Seiri/Sort:** Distinguish between necessary and unnecessary items and discard the unnecessary items.
2. **Seiton/Straighten:** Put essential things in order so that they can be easily accessed.
3. **Seiso/ Scrub:** Clean everything-tools and workplaces – removing stains, spots, and debris (Keep machines and working environments clean)
4. **Seiketsu/ Systematize:** Extend the concept of cleanliness to oneself and continuously practice the above three steps.
5. **Shitsuke/ Standardize:** Standardize the previous four steps to make the process one that never ends and can be improved upon.

Build self-discipline and make a habit of engaging in 5s by establishing standards.

5S + SAFETY



SORT

ONLY KEEP NECESSARY ITEMS IN THE WORK PLACE - WHEN IN DOUBT
SORT IT OUT



STRAIGHTEN

ARRANGE ITEMS TO PROMOTE EFFICIENT WORKFLOW



SHINE

CLEAN THE MACHINES AND WORK AREA SO IT IS CLEAN AND TIDY



STANDARDISE

CREATE STANDARDS FOR A CONSISTENTLY ORGANISED WORKPLACE



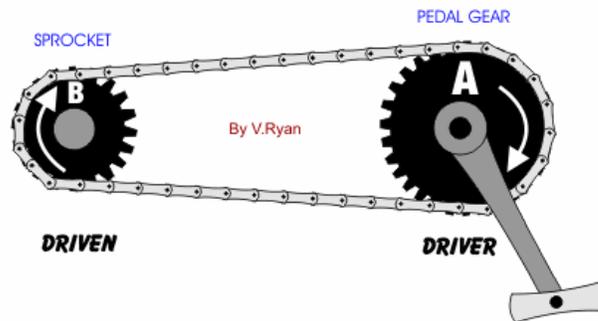
SUSTAIN

MAINTAIN AND REVIEW STANDARDS TO RETAIN AN EFFICIENT WORKPLACE

UNIT –II

POWER TRANSMISSION

2.1 CHAIN DRIVE



A positive transmission of power by the help of chain is very much common, especially for light and medium drives. Chain drives consist of endless chain links over sprockets. Sprockets are usually fitted on driving and driven shaft.

In printing industry chain is used for power transmission, speed conversion, and elevating and conveying system. Some examples are given below,

A belt or a rope drive does not give a constant velocity ratio due to slip, which may occur due to overloads. In order to avoid slipping and to have a constant velocity ratio, steel chains are used.

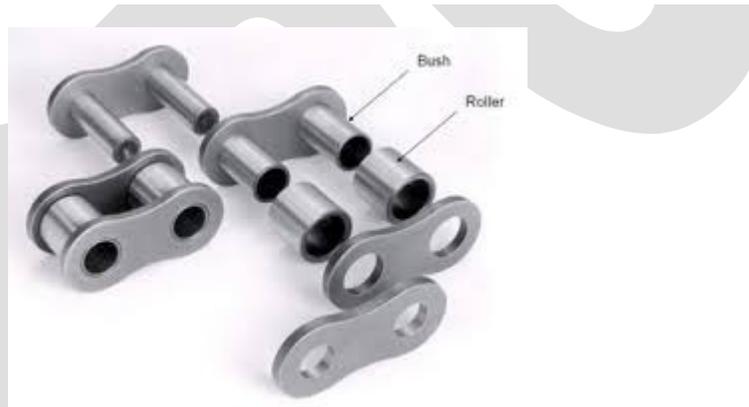
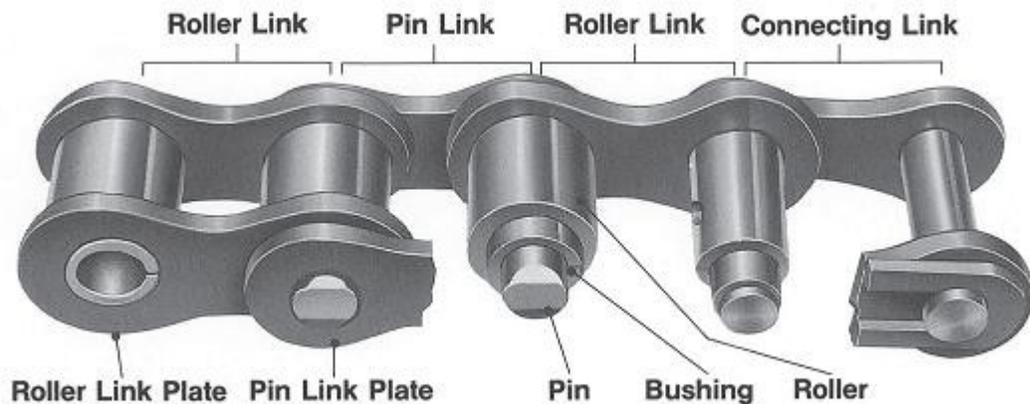
Example:-

- Pile feed board.
- Water pan roller.

TYPES OF CHAINS

1. Roller chain
2. Silent chain
3. Ewart chain
4. Bead Chain

Roller chain



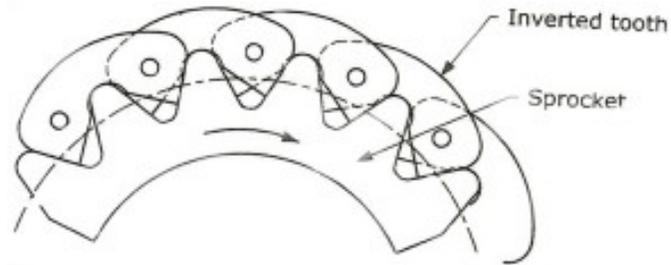
A roller chain, the most common type of chain, is made up of side plates with alternating roller/bushing and pin-link assemblies. It is used for accurate and high-speed chain drives. The chains are made up of a number of rigid links, which are hinged together by pin joints in order to provide the necessary flexibility for wrapping round the driving and driven wheels.

This type of chain is adaptable to widely varying needs, from small-stand drives for light applications to large multiple-strand chains for heavy-duty industrial applications. The following are the key components of a roller chain mechanism:

- Roller chain, which consists of a finished steel roller, alternate assemblies roller, and pin links.
- Link, which is heat-treated strip stock steel that has been perforated and blanked.
- Pin, which is hardened alloy steel that has been ground to specific tolerances.

- Bushings, which is a case-hardened core that prevents metal from rubbing metal
- Rollers made of heat-treated, high-carbon steel.

Silent chain drive



The silent chain, also known as an inverted-tooth chain, consists of a series of inverted-tooth links held together by joint pins to which washers have been riveted. The silent chain, while not exactly silent, is much quieter in operation than transmission chains.

Unlike a roller chain, the silent chain has a tooth engagement with gradual sliding action. This chain “rolls” on its sprockets rather than riding on them. The straight sides of the sprocket teeth mesh with the straight-sided working jaws of the chain links to move the chain along. The chain is constructed of precision-formed leaf links that are perforated and blanked from strip steel. Several different types of guide rails can be used to prevent lateral movement of silent chains.

Ewart Chain Drive

The Ewart chain is principally used for conveying and elevating equipment, although it sometimes used to transmit lightweight loads at speeds under 400ft./min. Ewart chains are generally constructed to malleable iron, though are made from steel.



Bead Chain Drive



A Bead chain consists of beads that swivel and turn in metal link or pins. Because the beads are relatively delicate, the bead chain is used for light service. Sometimes special situations such as misaligned sprockets, skewed shafts or nonparallel planes call for the use of this type of chain.

Advantages of Chain Drive:

1. Positive contact between the chain and the drive sprocket eliminates the possibility of slips.
2. Chain drives are compact and occupy less space.
3. Has a wide range of driving power.

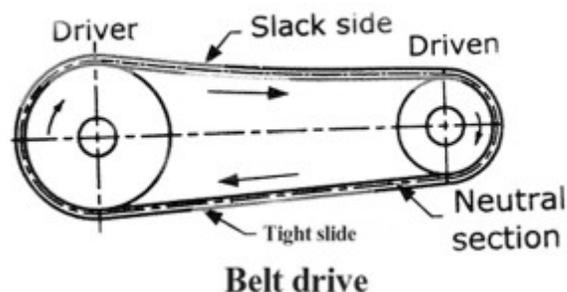
4. Useful for low speed and high torque transmissions.
5. It can absorb shocks.
6. It can be operated under adverse temperature and atmospheric conditions.
7. It gives high transmission efficiency.
8. Chain drives withstand heat, dirt and weather exposure when properly lubricated.
9. It can be used where there is considerably large distance between the driving and driven shafts.

Disadvantages of Chain Drive:

1. The Production cost of chain is relatively high.
2. For better efficiency, lubrication of its parts is necessary.
3. It is heavier as compared to the belt.
4. There is gradual stretching which leads to velocity fluctuations.

2.2 BELT DRIVES

The belt and rope drive system is widely used in power transmission system. The belts are used to transmit power from one shaft to another by means of pulleys which rotate at the same speed or at different speed. The belts are made from leather, cotton, rubber and synthetic materials. The belt is running over two pulleys as shown in. The pulley on the rotating shaft is called driver and the pulley on the shaft to be rotated called as driven or follower. Varying the diameters of the two pulleys can vary the speed



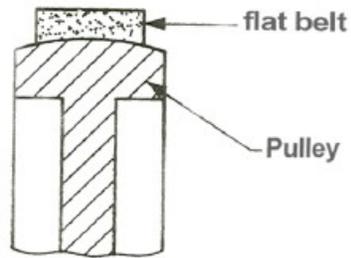
of the driven shaft.

Type of belt :

1. Flat belt drive

2. V-belt drive
3. Circular belt or Rope drive
4. Ribbed belt drive
5. Toothed or timing Belt drive

Flat belt drive



A belt may be of rectangular cross section known as flat belt. It is mostly used in the factories and workshops where a moderate amount of power is to be transmitted. In the case of flat drive, the rim of the pulleys is slightly crowned which helps to keep the belt centrally on the pulley rim. Generally the distance between the pulleys should not be more than 10 meters apart.

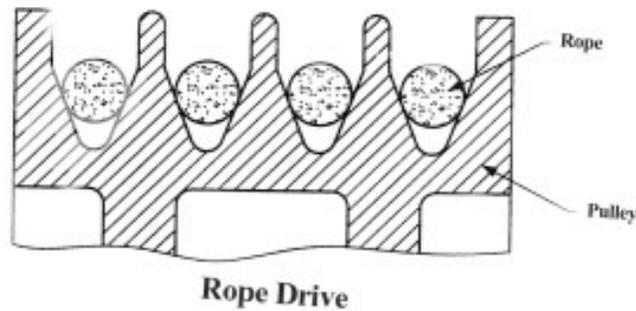
Advantages of Flat belts:

1. It is simple and cheap.
2. It runs smoothly.
3. It is suitable for any arrangement of shafts.
4. It transmits power over considerable distance between driver and driven shafts.

Disadvantages of Flat belts:

1. The life is very short.
2. It requires comparatively large size.
3. Slip of belt will occur frequently.

Rope Belt Drive



The belt with circular cross section is known as rope or circular belt. It is widely used where greater amount of power is to be transmitted and the distance between the pulleys is more than 8 meters apart.

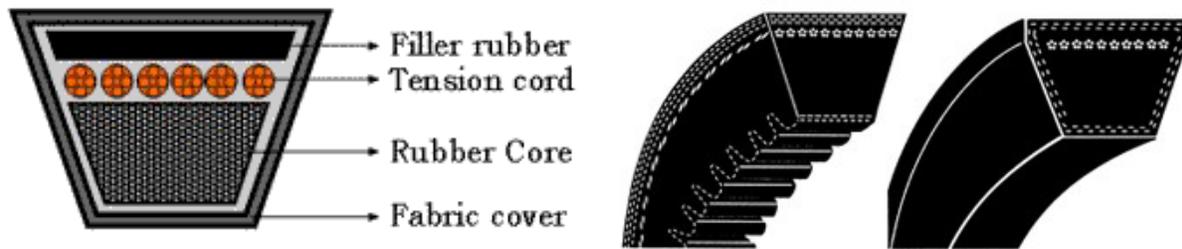
One of the main advantages of rope drive is that any number of separate drives may be taken from the one driving pulley. The rope drives are mainly employed in mining and textile industries. The commonly used rope drives are 1. Fiber ropes and 2. Wire ropes.

Advantages of Rope drives:

1. These are lighter weight.
2. They give high mechanical efficiency.
3. The cost is low.
4. They are more durable and more reliable as compared with others.
5. Frictional grip is more.
6. They can withstand shock loads.
7. It is more useful to transmit large amount of power over long distance from one pulley to another.

V-belt drive:

V-belts are particularly suitable for short drives (i. e) the pulleys are nearer to each other. A belt with trapezoidal cross section is known as V- belt. They are made endless and it used in factories and workshops where greater amount of power is to be transmitted. Owing to the wedge action between the belt and the sides of groove in the pulley, the V- belt is less likely to slip. The V-belts are made of rubber impregnated fabric with angle V between 30 to 40 degrees.



Advantages of V- belts:

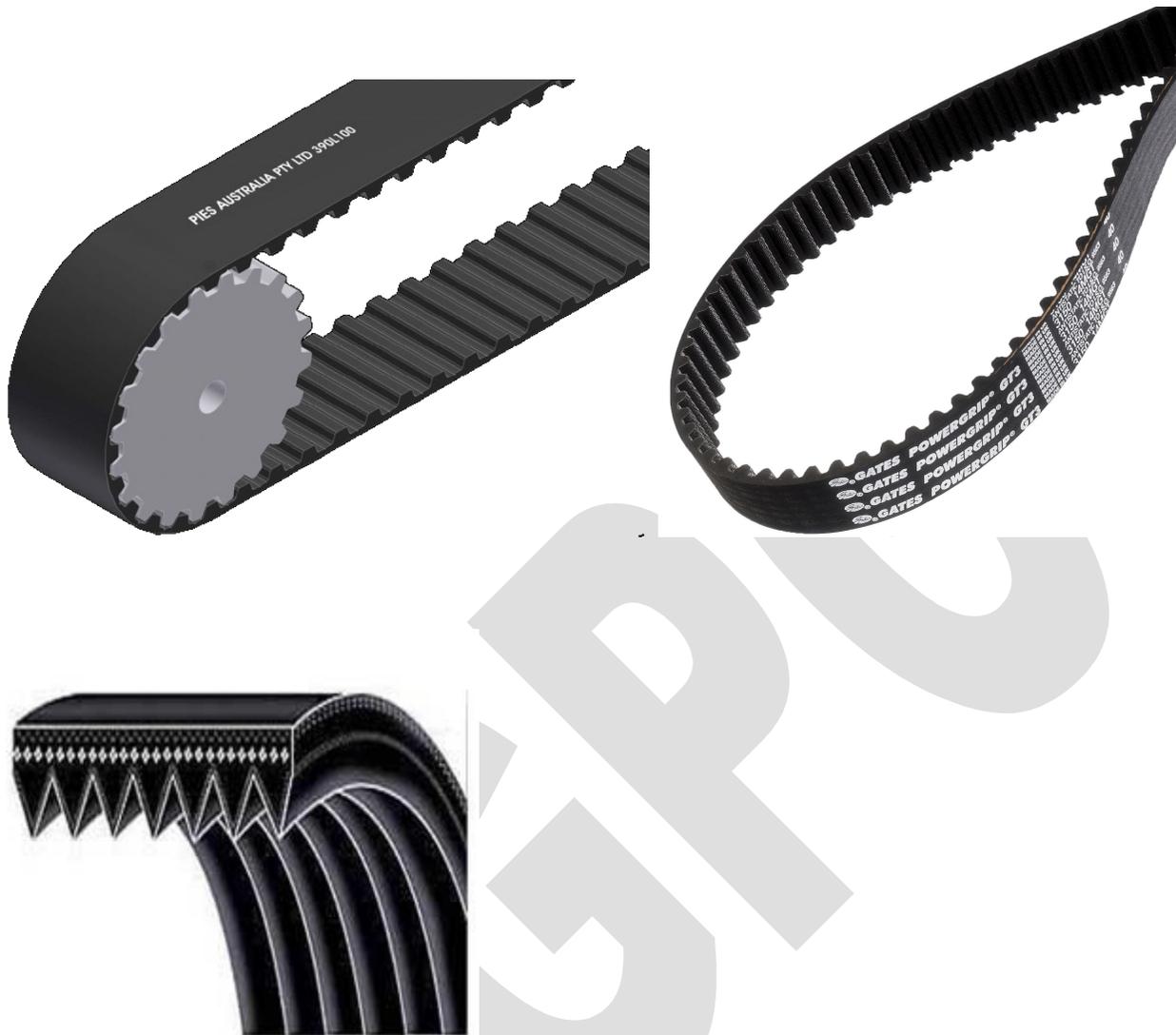
1. It is compact, so installation is possible in limited space.
2. Less vibration and noise.
3. Easy replacement and maintenance.
4. They are suitable for transmission of power for short center distance.
5. They transmit more power.
6. Slip between the belt and pulley groove is negligible.
7. Since the V- belts are made endless and there is no joint trouble. Hence the drive is smooth.

Disadvantages of V- belts:

1. It is costlier.
2. The V- belt are not as durable as flat belts.
3. The construction of pulleys for V-belts is more complicated than flat belt pulleys.
4. V-belt drive cannot be used for long distances due to weight per unit length is more.

Toothed or timing Belt drive

A toothed belt; timing belt; cogged belt; ; or synchronous belt is a flexible belt with teeth molded onto its inner surface. It is designed to run over matching toothed pulleys or sprockets. Toothed belts are used where high-power transmission is desired.



2.3 GEAR DRIVES

A gear is a mechanism that transmits mechanical rotary power from one shaft to another at shorter distance, smoothly and positively.

Gear drives are used to transmit power from one shaft to another shaft where constant velocity ratio is essential.

Purpose of Gears

The gear drives are used to transmit motion from the driving shaft to the driven shaft to

- Change the velocity ratio
- Change the direction of rotation
- Get a Positive Drive

TYPES OF GEARS

- a. Spur gear
- b. Helical gear
- c. Bevel gear
- d. Worm gear
- e. Herringbone gear
- f. Rack & Pinion gear
- f. Rack & Pinion gear

Advantages of Gear Drives:

- It transmits exact velocity ratio
- It has high efficiency
- It transmits high power
- It has reliable service and compact layout

Disadvantages of Gear Drives

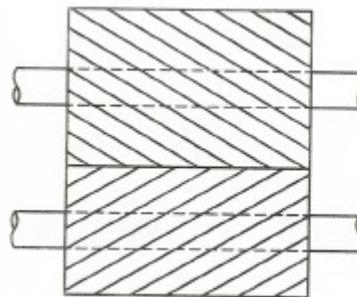
- It is costlier than others, as it requires special machine tools.
- It requires suitable and proper lubrication system, and hence maintenance cost is high.

Spur Gear



It has teeth parallel to the shaft, and used to transmit power to only parallel shafts. Use of spur gears will eliminate the end thrust and axial displacement at moderate speeds.

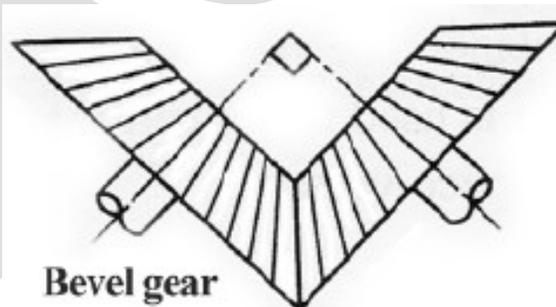
Helical Gear



Helical gear

Helical gear has teeth that form a helical angle around the center. Helical gears are most accurate and stronger than spur gears. This type of gear eliminates the shock and jarring under heavy loads. As these gears provide thrust, it is recommended to use thrust bearings.

Bevel Gear

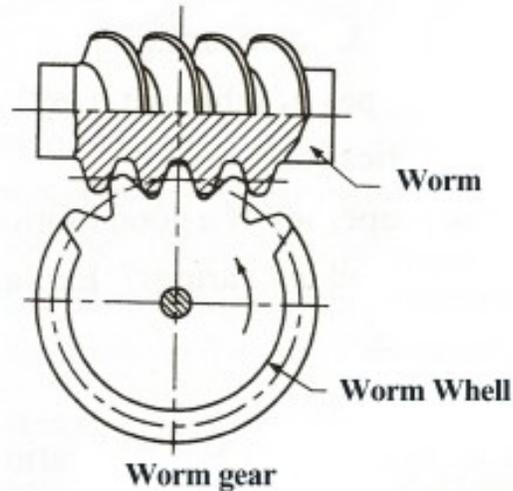


Bevel gear

It has teeth cut on an angular face for transmitting power between shafts that are at an angle to each other.

Bevel gears are not as precise as spur gears. They are only suitable for shafts at right angles.

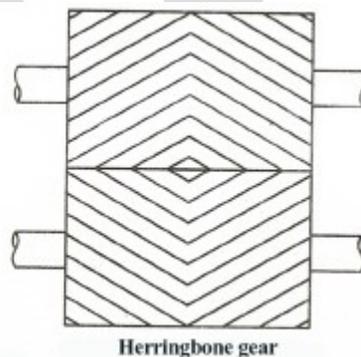
Worm Gear



Worm gears combine worm wheel and gear. They are used to connect the shafts in parallel planes. Worm gears are used for high precision and high quality work. Worm gears produce less noise and vibration also they handle high loads.

Herringbone Gear

They are called as double-helical gear. There are opposite angle helixes on the two sides of gears. Sometime two opposite-angle helical gears are fastened together. These gears are used to transmit heavy loads with a minimum of noise and thrust.



MAINTENANCE OF CHAIN DRIVE

- Scheduled lubrication should be employed to restrict wear.
- It is advisable to adjust the alignment in regular intervals.
- Whenever you replace the chain by new one, you must change the sprocket also.

- d. Worn out sprocket sometime may be used in a reverse manner.

MAINTENANCE OF BELT DRIVE

- a. Belt drive is covered at the top to protect the belt from ant dust, metal particles to enter.
- b. Excess load on belt should be avoided; otherwise it will stretch the belt.
- c. Slippage if any in the drive, should be checked periodically to ensure the transmission of the rated load.
- d. Belts of different bands should not be mixed. When replacing belts, total set of belts is to be replaced. New and used belts should not run together.
- e. Belts wear results by the contact of pulley walls groove. So groove must be checked periodically.

MAINTENANCE OF GEAR DRIVE

- 1. Always use recommended lubricants and filter to avoid normal wearing.
- 2. To avoid abrasive wear, gear teeth should be scrapped and cleaned, and care to be taken to use dust-free lubrication.
- 3. Ridging appears on gear teeth as diagonal lines due to heavy load and inadequate lubrication use.
- 4. Pitting (surface-fatigue) occur at initial stage should be avoided by gradual running. Sometime, grinding and polishing of tooth surface is done.
- 5. Gears running in one direction may be reversed 180 degree to take the help of a non-worn surface for better operation.
- 6. When a wear appears on both sides of the tooth surface, it may be seen that a smaller meshing gear will wear more. New one may replace this.

Direct Drive Technology

The direct drive motor is brushless and gearless so it eliminates friction from its power transmission since the feedback element is coupled directly to the load. The motor contains precision bearings, magnetic components and integral feedback in a compact motor package. The motor is an outer rotor type, providing direct motion of the outside housing of the motor and thus the load. The cross roller bearings that support the rotor have high stiffness, to allow the motor to be connected directly to the load. In most cases, it is not necessary to use additional bearings or connecting shafts.

DDT is dependent upon maintaining extreme accurate synchronization of each cylinder rotation. Traditionally, this has been accomplished by gearing. As press speed and printing quality requirements have increased, the inevitable inaccuracies in the gearing system have become a limiting factor on press print quality and speed.

Recent advancements make it possible to synchronize them to a much higher level of precision without mechanical transmissions by using **closed loop control technology** and driving them directly with independent, Direct Drive Rotary (DDR) servo motors. The elimination of the mechanical transmission enables elimination of the gear backlash, thus providing for higher speeds and accuracies for improved print quality.

A feedback device such as a high resolution sine encoder provides the servo motors with far more accurate position and velocity information that the controller compares to its programmed motion profile and based on this signal sends velocity command signals to the amplifier that drives the servo motor. A motion profile defines the operation of each servo motor in terms of time position and velocity. In practice, all cylinders are synchronized in both speed and phase.

Conventional



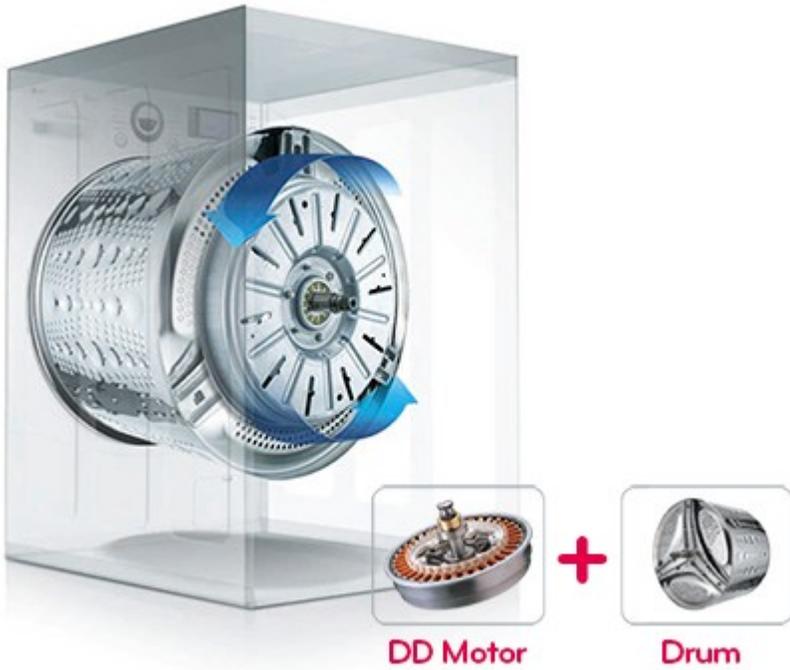
- Rotation axis and central axis are not consistent
- Creates noise and abrasion
- Less stable balancing system

LG Inverter Direct Drive



- Motor directly attached to drum
- Less noise and vibration
- No loss of energy due to power directly transmitted onto drum

DD MOTOR
10 Year Warranty
VDE
Life Time Insulated
VDE
Certification



Advantages:

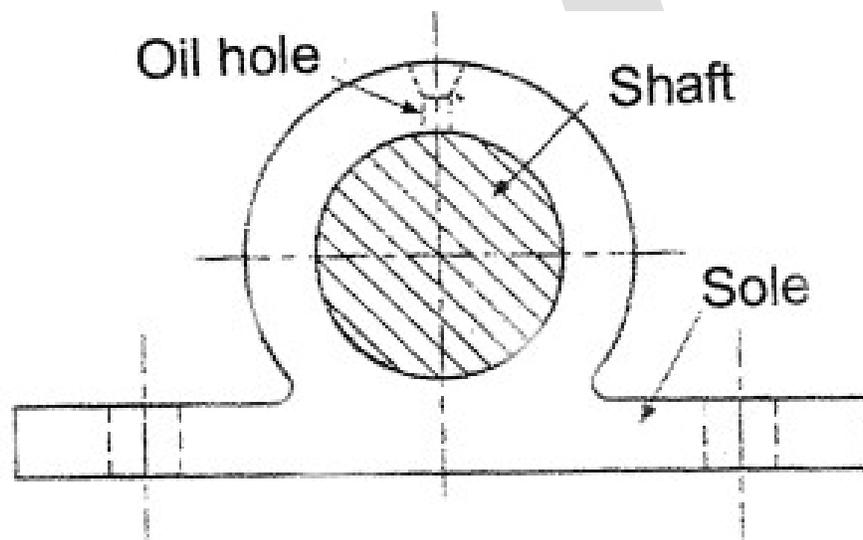
- **Increased efficiency:** The power is not wasted in friction (from the , chain, etc., and especially, gearboxes.)
- **Reduced noise:** Being a simpler device, a direct-drive mechanism has fewer parts which could vibrate, and the overall noise emission of the system is usually lower.
- **Longer lifetime:** Having fewer moving parts also means having fewer parts prone to failure. Failures in other systems are usually produced by aging of the component (such as a stretched belt), or stress.
- **High torque at low rpm.**
- **Faster and precise positioning.** High torque and low inertia allows faster positioning times on permanent magnet synchronous servo drives. Feedback sensor directly on rotary part allows precise angular position sensing.
- **Drive stiffness.** Mechanical backlash, hysteresis and elasticity is removed avoiding use of gearbox or ball screw mechanisms.

Disadvantages:

- The main disadvantage of the system is that it needs a special motor.
- The slow motor also needs to be physically larger than its faster counterpart.
- Also, direct-drive mechanisms need a more precise control mechanism.

UNIT-III**MACHINE ELEMENTS (MECHANICAL & ELECTRICAL)****3.1 BEARING**

Bearings are one of the most important machine elements. Bearings have contact with rigid frame and movable parts.

**TYPES OF BEARINGS**

1. Sliding bearings
2. Antifriction bearings

SLIDING BEARINGS

Sliding bearings may be used to support the rotating, reciprocation or oscillating shafts. This type of bearings is also called as plain bearing. Sliding bearings may be classified in to three types.

- a. Journal bearing
- b. Thrust bearing
- c. Guide bearing

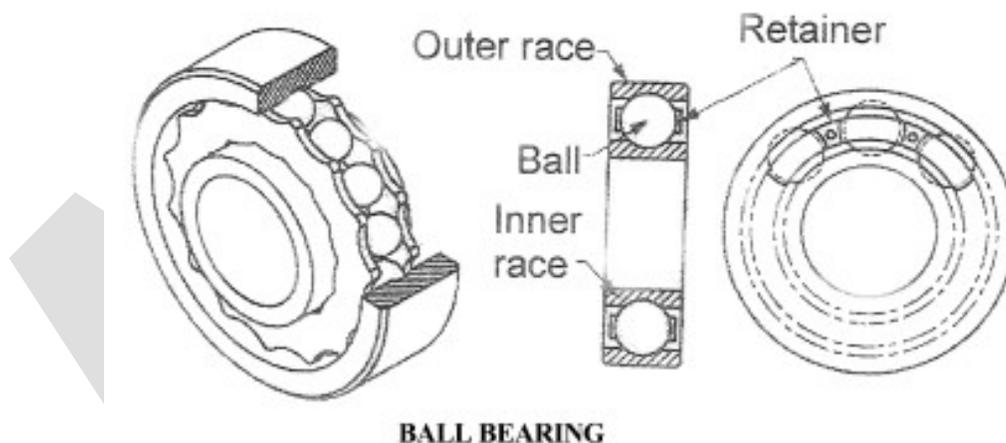
Journal bearing is a most common type used in printing machinery (Ink oscillator roller, Ink feed roller, web offset reel shafts etc.) This bearing is a bush made of copper, brass or bronzes. This bearing is available in solid, split, etc. This type of bearing allows the shaft rotate and slide unlike antifriction bearing. Cost of this bearing and replacement is very easy one. This bearing requires thin film of oil to separate the shaft from wear and friction.

ANTIFRICTION BEARING

Antifriction bearings are classified in to three types. They are,

- a. Ball bearings
- b. Roller bearing
- c. Needle bearings

BALL BEARINGS



Ball bearing in which a shaft or journal turns in contact with hardened steel balls usually. These balls are placed between and outer race. This bearing is suitable for high-speed operation and requires less maintenance. However load carrying capacity is somewhat low. It produces too high noise. The common types of ball bearings are,

1. Deep groove ball bearing
2. Self-aligning ball bearing
3. Angular contact ball bearing
4. Duplex ball bearing

3. Thrust ball bearing

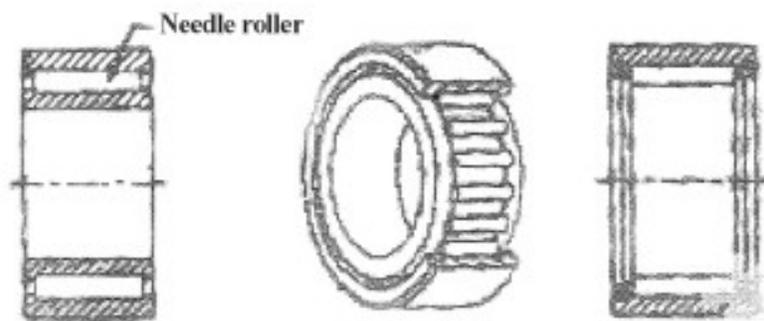
ROLLER BEARING

Roller bearing is also one of the rolling contact bearing. These are similar to the ball bearings where the balls are replaced by hardened short cylindrical rollers in order to carry greater radial loads than the ball bearings.

All rollers are of equal size with their length equals to diameter. They are made of chromium (or) chrome nickel steel with a ground polished surface. Roller bearings are relatively rigid against radial motion and hence they carry heavier loads. This type of bearing will carry only the radial loads or loads perpendicular to the axis of shaft. Cage or retainers are used to keep the roller at a uniform distance apart.

NEEDLE BEARINGS

Needle bearing is a cage less bearing. This type of bearings has no cages. But the needle is long and thin. So this of bearings is small in diameter and carries high loads with more accuracy. Needle bearings also have a larger coefficient of friction than roller bearings. The main advantage of needle bearing over ball bearing is less space it occupies.



3.2 CAMS AND FOLLOWER

CAM

To move the machine parts in precise way cams are used in printing machines.

Cam is a machine part that either rotates, move back and forth or remain stationary to produce a prescribed motion by contacting a follower. The follower can be a round turning bearing, a non-moving flat-faced surface, or a knife edged.

Cam-follower systems are particularly useful when the uniform the uniform revolving or reciprocation motion of one part of a machine is to be converted to any kind of non-uniform alternating, elliptical or rectilinear movement.

TYPES OF CAM MACHANISM

Following are the types of cams

- a. Disk cam
- b. Translation cam
- c. Groove plate cam
- d. Cylindrical cam
- e. Eccentric cam
- f. Tow & Wiper cam

DISK CAM

The most common type of cam is the disk cam, which is a flat rotating plate with a curved contour that usually rotates with a constant velocity to impart a desired, constrained motion through the movement of a follower device riding on the cam.

TRANSLATION CAM

A translation cam produces a vertical motion in the follower when the cam is moved horizontally. In some translation cams the follower travels over the surface of a stationary cam.

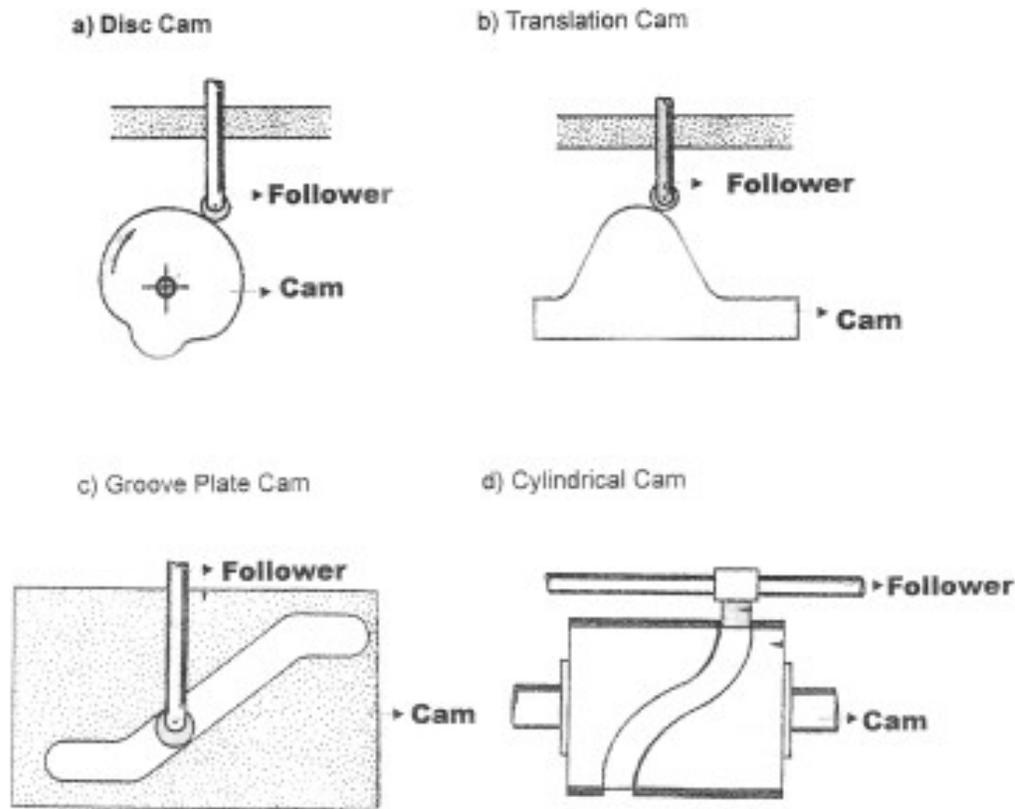
GROOVE PLATE CAM

A groove plate cam has the follower restrained within a groove cut in the cam plate. It is use primarily for high-speed applications. With this design, springs are not required to keep the follower in contact with the cam face, as the groove guides the follower along the accurately.

CYLINDRICAL CAM

A cylindrical cam is a cylinder into which a contour has been grooved. The follower is guided through a contour, which usually pushes or pulls the arm in a vertical

or horizontal motion to perform the work. A cylindrical cam is a very sturdy, accurate design.

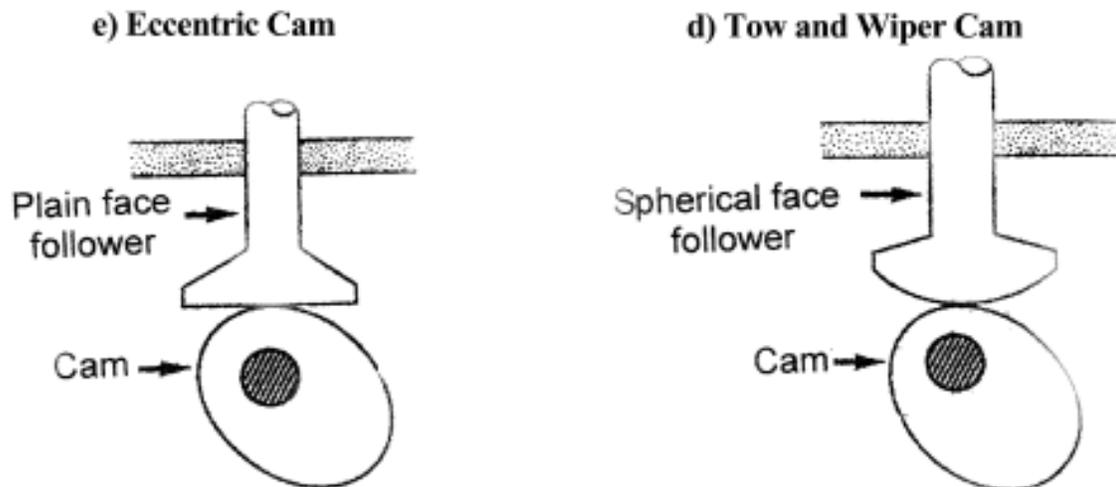


ECCENTRIC CAM

An eccentric cam is a circular cam in which the rotating shaft is off-center.

TOW AND WIPE CAM

A tow and wipe cam is a cam that rotates and imparts movement that lifts or lowers the follower, depending on the direction of rotation.

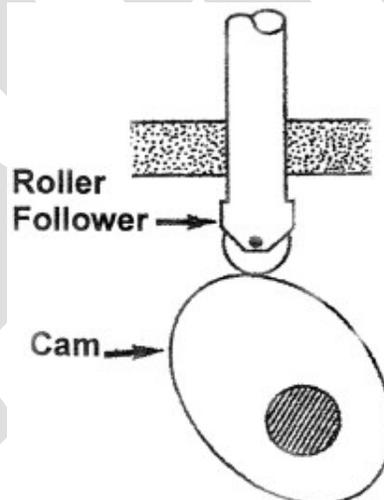


FOLLOWER

Follower is a device that follows the contoured cam surface, producing a prescribed motion of output. There are different types of followers,

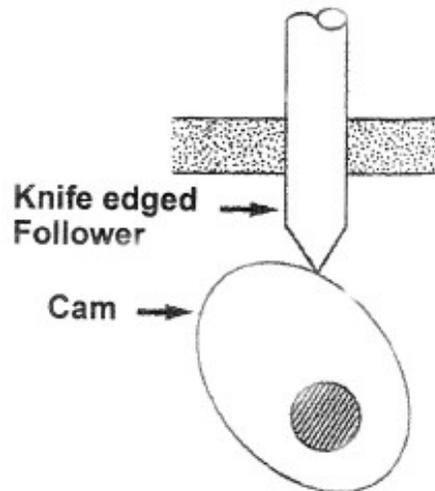
- Roller follower
- Knife Edged follower
- Flat edge

ROLLER FOLLOWER



A roller follower, the most common type, is a roller mechanism that rides on the cam face to impart linear motion. Its advantage is the reduction of sliding friction as the follower travels over the cam face. The disadvantages of the roller follower are that weak points are created at the pin axis and that steep cam contours may jam the translation roller follower.

KNIFE EDGED FOLLOWER



A knife edged follower is a pointed device that rides on the face to impart linear motion. Because the sharp edge of the follower causes excessive wears on the cam face, its practical use is limited to precision, light-load mechanisms.

FLAT-FACED FOLLOWERS

A flat faced, or “mushroom” follower. The type used in automotive engines, is a flat faced spherical surface mechanism that rides on the cam face to impart linear motion. There are types of flat-faced follower (a) plain face (b) spherical face. In printing machine cams are used to precise the sheet transfer, ink doctor roller timing, feeder mechanisms and oscillating roller mechanism etc.

Characteristics of cams and followers

- a. It has limited speed
- b. It is very expensive system
- c. It is a précised component
- d. It gives longer operation life
- e. It carries high load
- f. It requires minimum maintenance
- g. It requires frequent lubrication
- h. Follower contaminated with dirt or water should be replaced
- i. It gives dependable operation only

3.3 SPRINGS

A spring is defined, as an elastic body, whose function is to distort when loaded and to recover its original shape when the load is removed.

TYPES OF SPRINGS

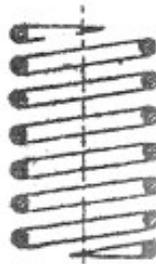
1. Helical Spring
2. Conical & Volute Spring
3. Torsion Springs

Helical Springs

Helical Springs



compression helical spring



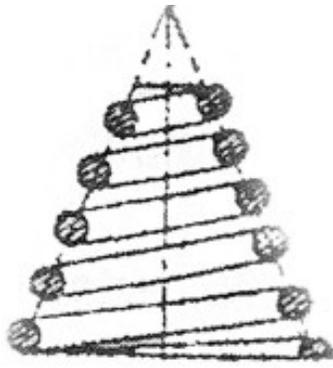
Tension helical spring

The helical springs are made up of a wire coil in the form of helix and are primarily intended for compressive or tensile loads. The cross-section of the wire from which the spring is made may be circular, square or rectangular.

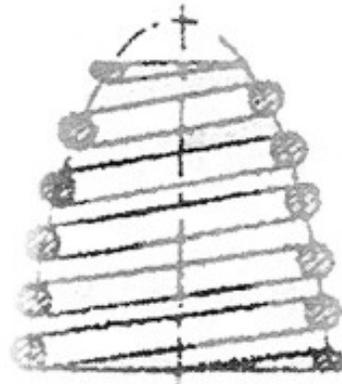
Conical and volute Springs

These springs may be of helical or spiral type. The helical type may be used only in applications where the load tends to wind up the spring are used in various electrical mechanism. The spiral type is also used where the load tends to the number of coils and when made of flat strip are used in watches and clocks.

The laminated or leaf spring (also known as flat springs or carriages spring) consists of a flat plates (known as leaves) of varying held together by means of clamps and bolts. These are mostly used in automobiles.



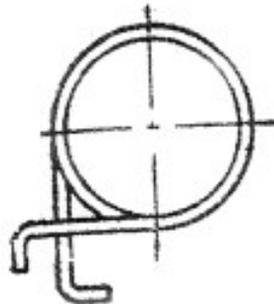
Conical spring



Volute spring

Torsion Springs

Torsion Spring



Helical Torsion Spring



Spiral Torsion Spring

3.4 ELECTRICAL ELEMENTS

CONTACTORS

A contactor is a mechanical switching device, used to switch on and off the power circuit.

There are various is types of contactors available. There are

1. Electromagnetic contactors
2. Pneumatic contactors
3. Electro-pneumatic contactors

4. Latched contactors

Among the above contactors, electromagnetic contactor is widely used. This will have contacts, some normally open (NO) and some normally closed (NC).

When the supply is given to the coil, it is energized. A strong magnetic field is produced and it activates the mechanism so the NO contacts are closed since, NC contacts opened.

We use this above magnetic contactor as a mechanical switching device (magnetic starter) to start a motor.

STOP, START Push buttons are used to switch ON/OFF the magnetic contactor to working.

NOTE

Normally open contacts (NO) are open when the contactor coil is de-energized condition and they close when the coil is energized. Similarly (NC) Normally closed contacts are in closed condition when the coil is de-energized condition and they open when the coil is energized.

Separate push buttons are provided for energizing and de-energizing contactor. For starting, a push-button with NO contact and for stopping another push-button with NC contact is used.

APPLICATION

1. Use of one push-button for both starting and stopping.
2. Use of separate push-button for starting and stopping.
3. Multiple push-button stations. (One start and many stop buttons.)

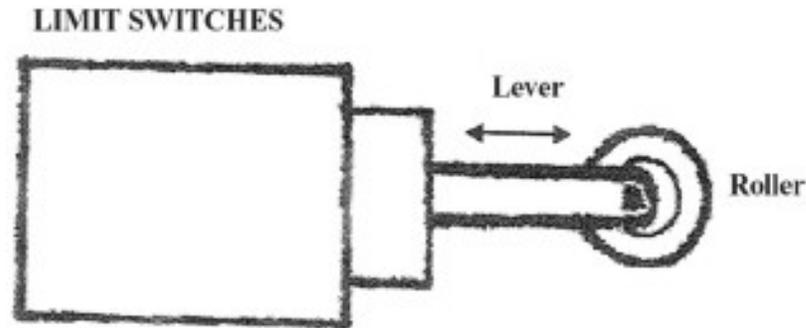
LIMIT SWITCHES

Switches of these types are generally used to limit or indicate the travel of some moving part of the machine. The mechanism is equipped with either NO or NC contacts.

When the moving part touches the liver, which carries a small roller at the end will move to a position where contacts in limit switches are either opened or closed.

Some of the applications in printing industry are safety doors, paper-lifting mechanism, folder jamming, etc.

When the machine operation is more accurate, a micro switch is employed instead of metallic contacts. This micro switch allows operation on very minute movements of external lever of the switch.

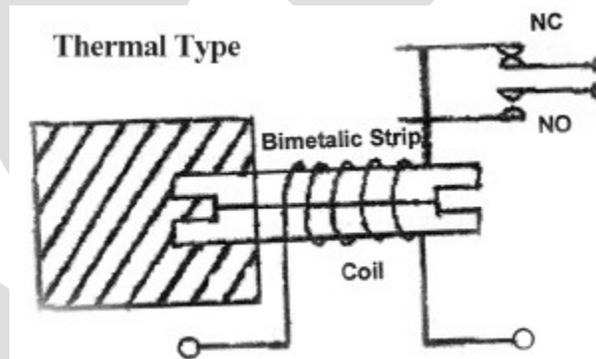


OVERLOAD RELAY SWITCHES

Overload relay switches are normally used to protect the motor from various problems like, low voltage, excessive loads, high temperature, etc. If any of the above factors causes, the relay will trip the circuit and disconnect the motor from main supply. Overload relays are classified are into types,

1. Thermal type
2. Magnetic type

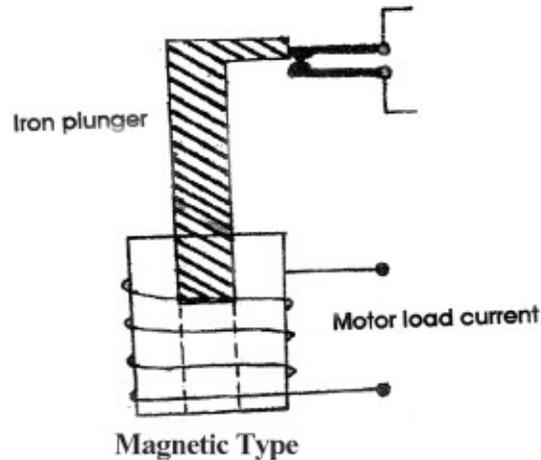
THERMAL TYPE



This is most common type of overload relay. It has two bimetallic strips having different temperature co-efficient, joined together either by rolling or welding. Due to over load current, when heated the strips bend on account of differential expansions of two metals, which open the contacts then the motor is disconnected from the supply.

MAGNETIC TYPE

In this relay the magnetic core and contacts are fixed as shown in fig. This relay has movable magnetic iron core inside a coil, which carries the motor current. When the current through this coil becomes high, a strong magnetic field is produced and pulls the magnetic iron core up or down. So the contactor is opened and the motor is disconnected from the supply.

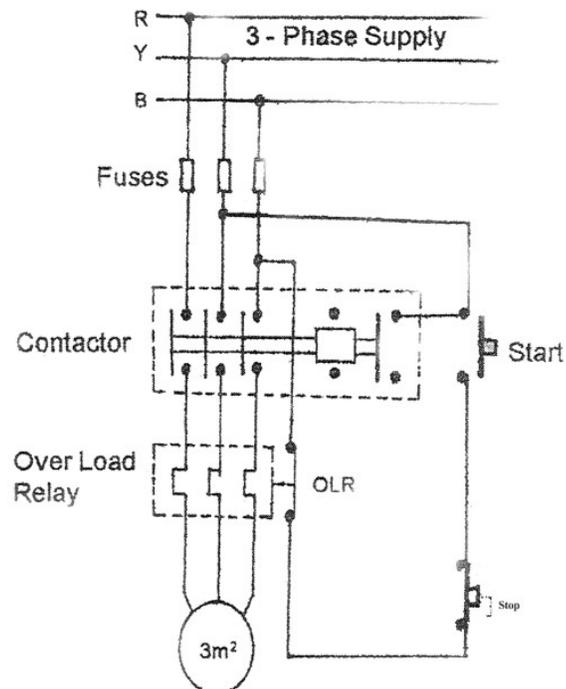


ELECTRICAL PANNELS

It is the supplying and monitoring units used in industries. Size of the panel and its operation facility is depending on the nature of job we handle. Also it varies from one manufacturer to other.

Usually panels are kept away from machine area (especially in a closed glass chamber). In this room there should be proper ventilation or refrigeration.

Electrical Panels



POWER SUPPLY AND DISTRIBUTION

Power supply from supplier is gut here and distributed sufficiently. Primarily the bus bar is placed in top of the panel and function of supply points are noted and fed into

distribution chamber. Proper earth system is provided here. All the supply loads are connected with distribution chamber through the instrument parameters like relays and measuring instruments for proper monitoring and protection.

Sensors/Detectors

A sensor or a detector is a device that responds to a stimulus or form of energy. It then generates a signal that can be measured or interpreted. Humans, animals and even plants have sensors that can detect the world around them. Detectors are used in physical science to respond to energy signals and forces. They are necessary for measurements and experiments. Signals can be manipulated to make their information more usable.

How Sensors Work

A photoelectric sensor has two main components: an [emitter](#) and a [receiver](#).

The emitter contains the light source, which is either an [LED](#) or a [laser](#). The emitter's light source is pulse-[modulated](#) by an oscillator.

The receiver contains an opto- electronic element, such as a [phototransistor](#) or a [photodiode](#), which detects the light from the emitter, and converts the received light intensity to an electrical voltage. That voltage is amplified and demodulated. The receiver is "tuned" to the pulse frequency of its emitter, and ignores all of the other [ambient light](#), which is gathered by its [lens](#).

The receiver is set to produce an output signal, which occurs either above or below a specified intensity of the light received from its emitter. Most sensors allow adjustment of how much light will cause the output of the sensor to change state.

Sensors

Force sensitive resistor - Used to detect physical pressure such as pinching, squeezing, pushing, brushing

[Photocells](#) - Used to detect light/dark, breakbeams, simple object detection

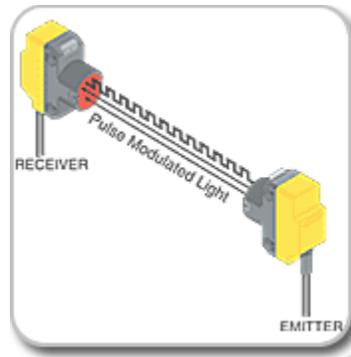
[Temperature](#) - Used to determine environmental temperature

[Tilt sensors](#) - Used to detect motion/vibration and orientation.

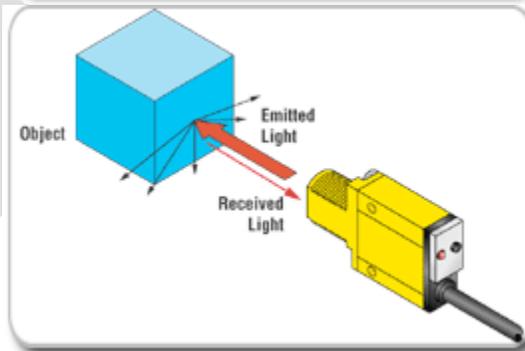
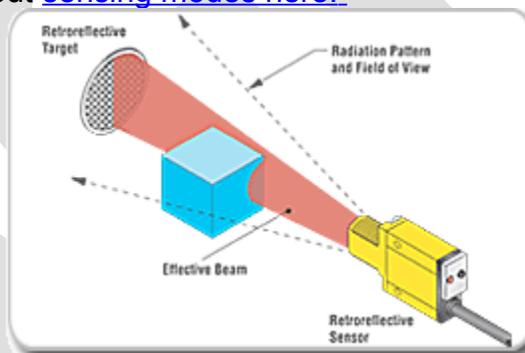
[PIR sensors](#) - Used to detect motion activity such as animals or people

[Thermocouple](#) - Used for temperature measurements, usually those above 150°C

[IR receivers](#) - Used to detect IR signals from remote controls



Some photoelectric sensors are designed to respond to objects which interrupt the beam normally maintained between the [emitter](#) and [receiver](#). These sensors operate in the [opposed](#) and [retro reflective](#) sensing modes. Some photoelectric sensors respond to objects which reflect the light from the [emitter](#) back to the [receiver](#). These sensors operate in one of several [proximity](#) sensing modes. Learn more about [sensing modes here](#).



UNIT-IV

LUBRICATION & RECONDITIONING

4.1 INTRODUCTION

Lubrication is a procedure to separate the surfaces with a thin film of lubricant to minimize friction and to restrict wear & tear. The substance used for this purpose is called "Lubricant".

Purpose/ Advantage of Lubrication

1. It minimizes the friction, wear & tear of the surfaces.
2. It dissipates heat generated as a result of friction and acts as a coolant.
3. It prevents rusting and controls corrosion.
4. It prevents entry of moisture, dust and dirt between the moving parts and thus acting as a seal.
5. It acts as cleaning agent.
6. It acts as electric insulator in transformers, switches, gears, etc.
7. It lengthens the service-life of the components.

TYPES OF LUBRICATION

On the basis of physical state the lubricants can be classified as follows.

1. Solid lubricants
2. Semi solid lubricants
3. Liquid lubricants

SOLID LUBRICANTS

Solid lubricants are used either in the form of dry power or mixed with water or oil so that they can stick firmly to the metal surfaces.

Solid lubricants are used in special conditions. When a liquid or semi-solid lubricant film cannot be maintained.

When the operating temperature and pressure are too high to use liquid lubricants.

Solid lubricants are used at low or high temperature also at very high loads.

Examples of solid lubricants: Soap stone, graphite, talc, chalk, mica Teflon, molybdenum disulphide etc.

SEMI-SOLID LUBRICANTS

Greases and Vaseline are the most important semi-solid lubricants.

1. These lubricants are used for machines at slow speed and high pressure.
2. When bearing and gears to be lubricated at high temperature.
3. When sealing is required against dust, or moisture.
4. When oil-film cannot be maintained due to high load, slow speed, sudden jerks.

Example:

Grease, Vaseline and etc.

LIQUID LUBRICANTS

Since the liquid lubricants provide separation when correctly applied. They have high cooling ability when circulated through bearing area. They also act as sealing agent and prevent corrosion.

Example:

1. Animal and vegetable oils
2. Mineral oils
3. Synthetic oils
4. Blended oils

Lubrication Schedule

Manufactures will generally prescribe the schedule of lubrication, which should be strictly followed as a maintenance measure, will clearly specify the lubricants to be applied and the frequency. Lubricating is a regular being performed by the operators, attenders.

Lubrication chart

Printing plants should use lubrication charts, is the only way to be sure that the proper types of lubricants have been used at the proper intervals.

4.3 EQUIPMENTS & TOOLS USED IN ERECTION & RECONDITIONING

EQUIPMENTS & TOOLS USED IN ERECTION

For installation and maintenance work, we use large variety of measuring tools, gauges and instruments. We discuss a few of them.

CRANES

Cranes and hoists are used to move materials through overhead space. There are several types of cranes and hoists.

Fixed crane

This type of crane is fixed in one position. From this fixed position, the crane will be handling materials. This type of cranes can be seen in ship yards and railway yards to handle heavy and bulky materials.

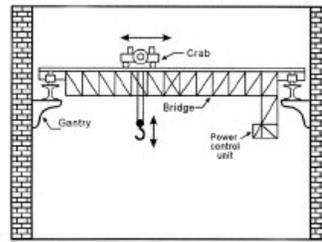
Pillar crane

This may be for heavy and bulky materials in industries. The crane travels along overhead rails and materials can be moved both longitudinally and crosswise along the bays. An operator sitting in the cabin over head operates the crane. The materials will be loaded and unloaded by the person on the ground.

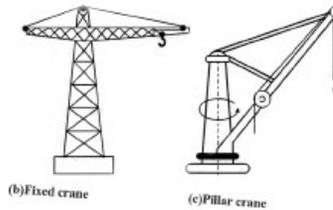
Traveling crane

There are two types of traveling crane. One is mounted on the truck and in the other type it is mounted on rails.

HOIST



(a) Over head crane



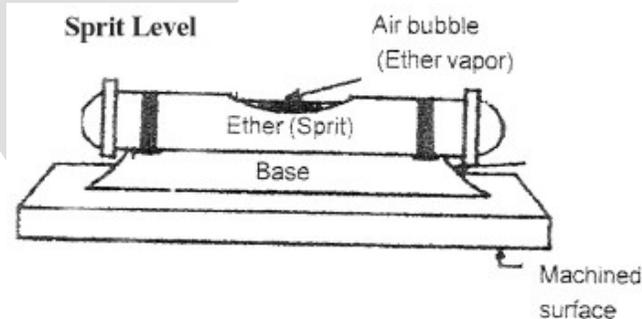
(b) Fixed crane

(c) Pillar crane

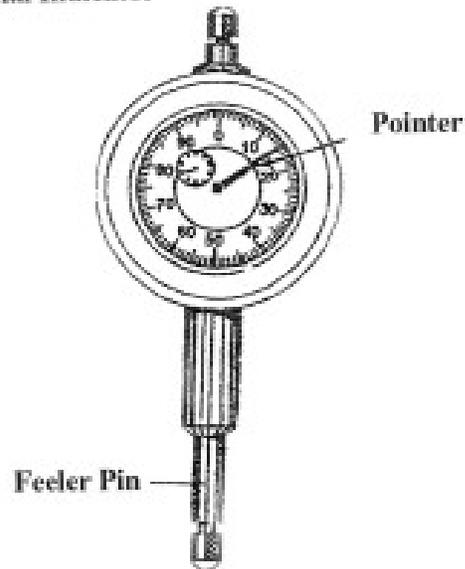
This is used for lifting materials vertically. The hoist is operated between fixed guide rails. There are numerous types of hoists. The simplest type is chain hoist, operated by hand. There are also hoists operated by electric power. The hoist is similar to overhead crane except that a hoist does not carry the operator in it but operated from one or two other points.

SPIRIT LEVEL

It is a common instrument to test or adjust horizontal surfaces. In printing industry machines are leveled by this equipment. Usually spirit level is kept on rollers and cylinders for leveling purpose. It is simply glass tube, having the length of 200-300 mm filled with liquid. An air bubble is present at the top of the tube. This glass tube has flat base at the bottom. When the spirit level moved, the air bubble will move left to right, depending on the amount of tilting of its base. The angle tilting can be calibrated. The work will be leveled, when the air bubble is exactly centered on the center mark. The level may be moved in either horizontal or vertical directions.



DIAL INDICATOR

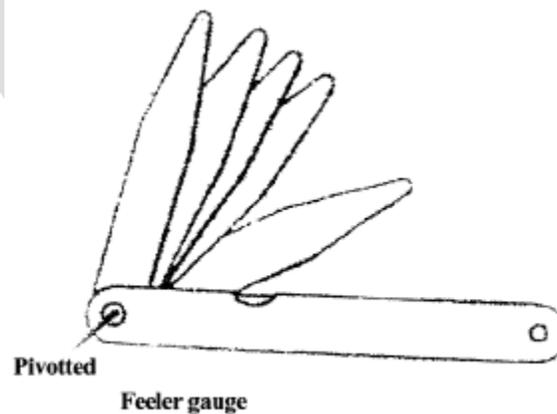
Dial Indicator

It has a feeler pin below the dial. A slightest pressure in its transmitted to the pointer through a gear train drive in such the ratio that exact reading is shown on the dial.

In printing dial gauges are frequently used with “Block gauges” for checking the parallelism of metal rollers and unit parallelism etc. Sometime it is used to measure the difference between the actual dimensions with the designed dimension

One complete revolution of pointer indicates movement of 1mm and as the dial is divided into 100 divisions. It gives a reading with an accuracy of 0.01mm.

FEELER GAUGES



The gap or clearance between the mating surfaces can be checked with feeler gauges. They are simply precision steel blades. The thickness of which are 0.03 to 1 mm pivoted together. The thickness of the gauges is clearly marked on it. In printing this gauges are used to find the clearance between bushes & bore wall, gap between plate and blanket, cylinder and bearing wear etc.

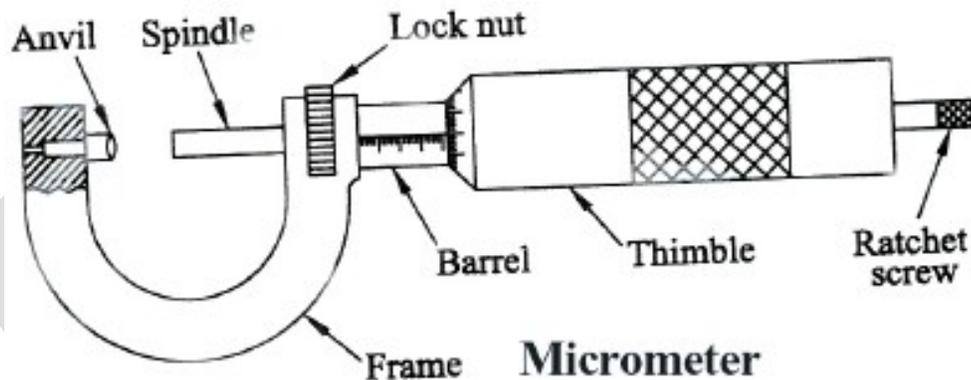
MICROMETER

It is a very much useful instrument for taking external dimensions up to an accuracy of 0.01 mm.

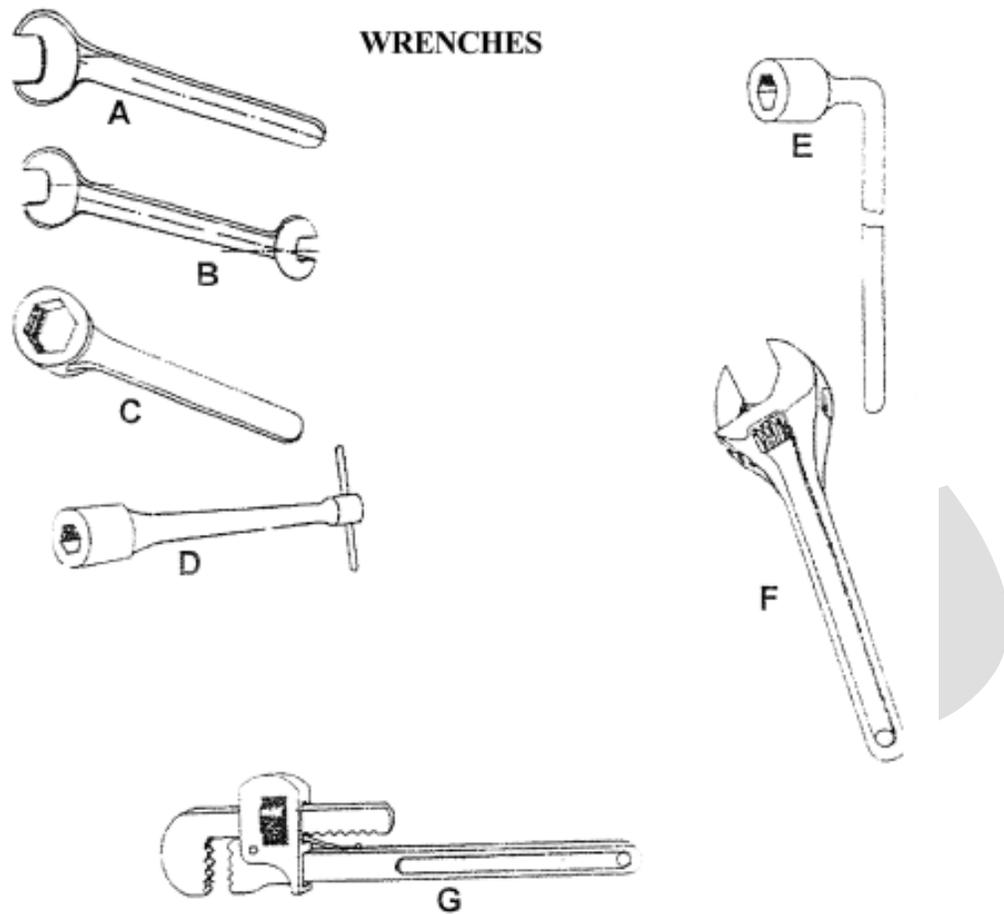
Here the job to be measured is placed between the anvil and spindle as shown in the figure. By rotating the sleeve (threaded) spindle moves towards anvil, and tightens the job. Now ratchet is tightened and the micrometer is taken out of job.

The dimensions now can be read primarily from the linear scale on the barrel which processes (1 mm, 0.5) and then circular readings to be noted. For each turn of the circular scale, the thimble moves fractionally (slowly).

These micrometers are available in different ranges. Micrometer should be kept clean. Error correction to be made properly if any error is there.



WRENCHES

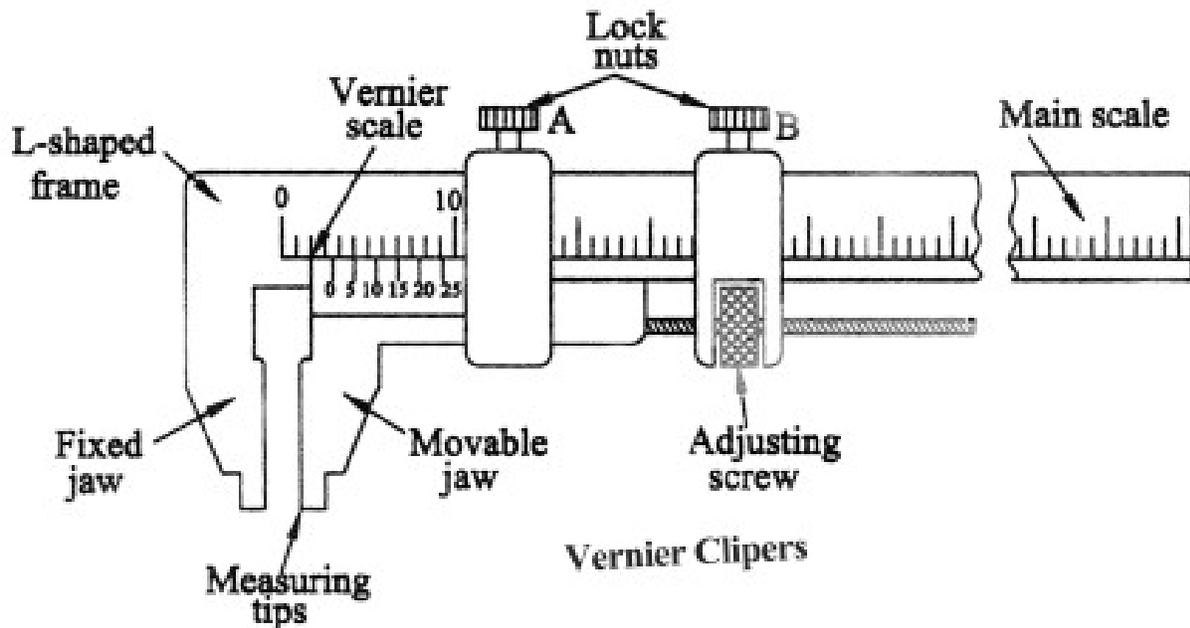


It may be noted that wrong selection of screwdriver, application of undue pressure. This tool is used to tighten or loosen the nuts and bolts. Its may be single or double- ended spanner. It may also be closed end spanner, where one of its end is closed completely to form hexogen or square. This removes possibility of slippage.

T- socket wrench or box spanner may also provide greater leverage. Pipe wrenches are used for connecting or disconnecting conduit pipes.

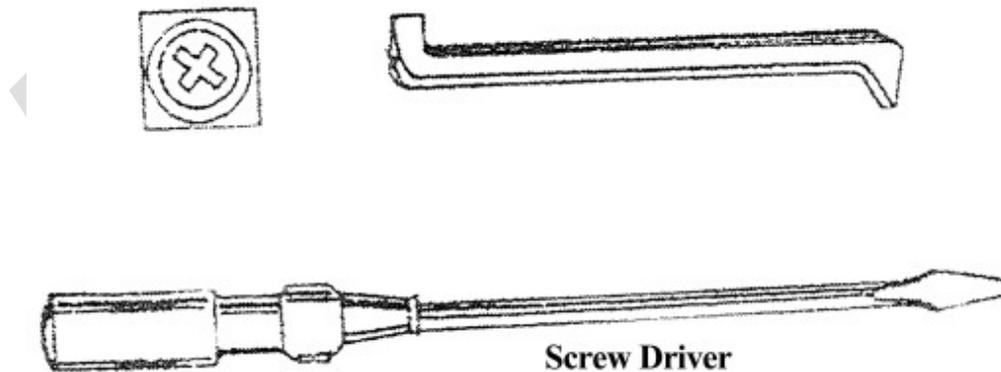
VERNIER CALIPERS

Vernier calipers consist of two steel rules, which slide among each other. One is called main scale and the other is called vernier scale. Main scale is engraved on a L-shaped frame, which contain the fixed jaw and measuring tip. Vernier scale slides on the main scale and it contain the movable jaw and measuring tip. When the two measuring tips contact each other, then reading will be zero. The design of measuring tip is in such as to measure inside and outside features.



SCREW DRIVER

It is a common tool for maintenance and assembly work. Various types of screwdrivers are available today. (Stand screwdrivers; offset screwdriver and cross-slot screws). It may pressure, spoil both the screw head and screwdriver tip.



4.4 TEST RUN

The purpose of a test run is to check the print accuracy and performance of the machine whether it complies with the manufacturer specification. These test give you a general idea of the quality of the machine without taking much time. So these tests are conducted at manufacturing plant, during overhauling and even repair stage.

Following are the “Acceptance test” carried out now a days to know the present quality of the machine.

1. Idle-run tests
2. Performance test under load
3. Accuracy tests
4. Rigidity tests
5. Vibration – resistance tests

IDLE-RUN TESTS

This test is conducted at no load. In this Idle run, operation of all mechanisms in electric, hydraulic and pneumatic equipments and lubricating system are checked. Also machine is operated in maximum speed.

PERFORMANCE TEST UNDER LOAD

In this above test machine will be run with full production capacity at high speed (all units of the machine with ink and paper). During the test, power consumption of the drive motor is also checked. This test will show how the machine is operating and what accuracy its print quality.

ACCURACY TESTS

It is used to check the geometrical accuracy of the machine (Parallelism, alignment etc., for the above accuracy test feeler gauge spirit level, dial indicators, straight edges are used.

This accuracy test also includes the print quality test. For the print quality we use,

- i. GATF – Register test grid,
- ii. GATF – Sheet fed test form,
- iii. GATF – Digital sheet fed test form,
- iv. GATF – Mechanical ghosting test form,
- v. Solid printing test of all colours

The aim of the accuracy test is to compare the actual condition of the machine with standard accuracy.

RIGIDITY TEST

This determines the accuracy under load in steady state operation. If the machine has no rigidity, then the product quality like registration, ink and water balance will be a problem. Applying force and measuring the deflection test it.

VIBRATION – RESISTANCE TEST

When vibration developed in operation, it increases the wear in machine parts, decreases the production rate, causes breakdown, and reduces life of machine. For this test a glass of water is normally used.

AGPC

UNIT –V

MAINTENANCE OF AUXILIARY EQUIPMENT

5.1 ELECTRICAL COMPONENTS MAINTENANCE

The majority of equipment in the printing plant is electrically operated. Only qualified electrical technicians should be allowed to work on the electrical systems, in order to ensure safety and help eliminate electrical component failure.

COMMON PROBLEMS WITH ELECTRICITY

VOLTAGE FLUCTUATION

One of the most frequently overlooked items in most plants is voltage fluctuation, which can cause major problems in many areas of a printing plant. Voltage fluctuation can be overcome by the rather the simple combination of a voltage meter and audio transformer. Computer equipment should also be equipped with uninterruptible power systems (UPS).

PROPER INSTALLATION

A critical factor leading to efficient electrical operation is the correct installation of electrical components, which requires timely consultation with the equipment's manufacturer prior to and during the installation process. Poor installation of an electrical component could result in safety hazards, the component's failure, and negate any manufacturer guarantees and warranties. Correct wiring and grounding of equipment cannot be stressed too much.

POWER REQUIREMENTS

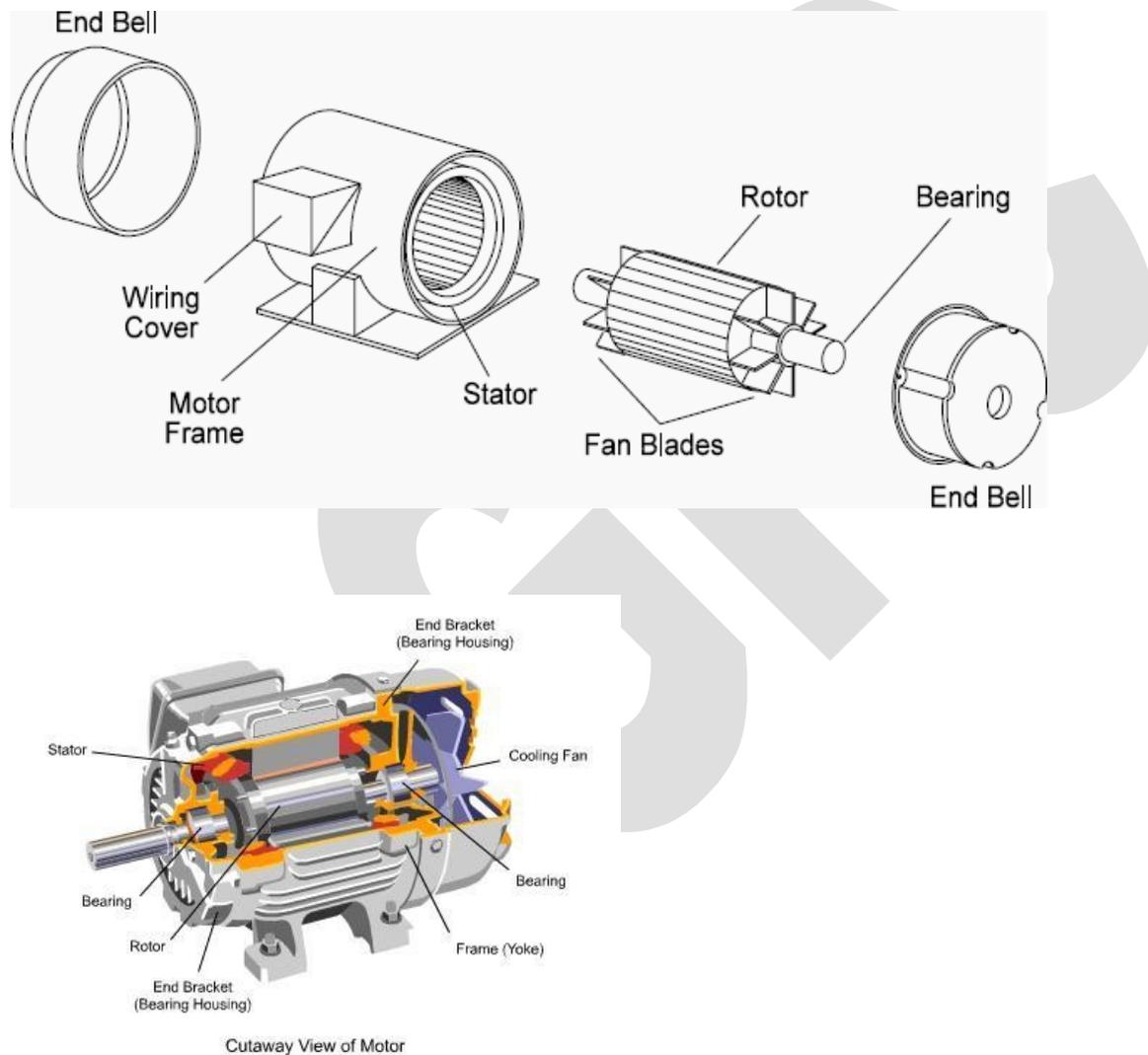
When a printer is looking for a new building, one of the biggest considerations should be the power available in the building or if and when the utility company will bring in the power needed. Never assume that power is available. Always check with your utility representative and make sure you have the right power and, if not, when the utility will be able to schedule the installation. Never sign a lease until this is clearly established in writing.

When buying new equipment, always check with the manufacturer as to its electrical power requirements. Sometime, the purchaser of a new piece of equipment finds that the voltage requirement to operate it is not same as the voltage level presently in the building. This is not an infrequent occurrence. It can cost thousands of dollars to bring the proper power lines to your plant –if the power company can even to it. The printing equipment manufacturer and the equipment purchaser should never assume that there will be no problem with operating voltages. Power requirements should be one of the first items checked before purchasing equipment.

AC & DC motors

An electric motor is a device that converts electrical energy into mechanical energy. An electrical signal is applied to the input of the motor, and the output of the motor produces a defined amount of torque related to the characteristics of the motor.

AC Motor

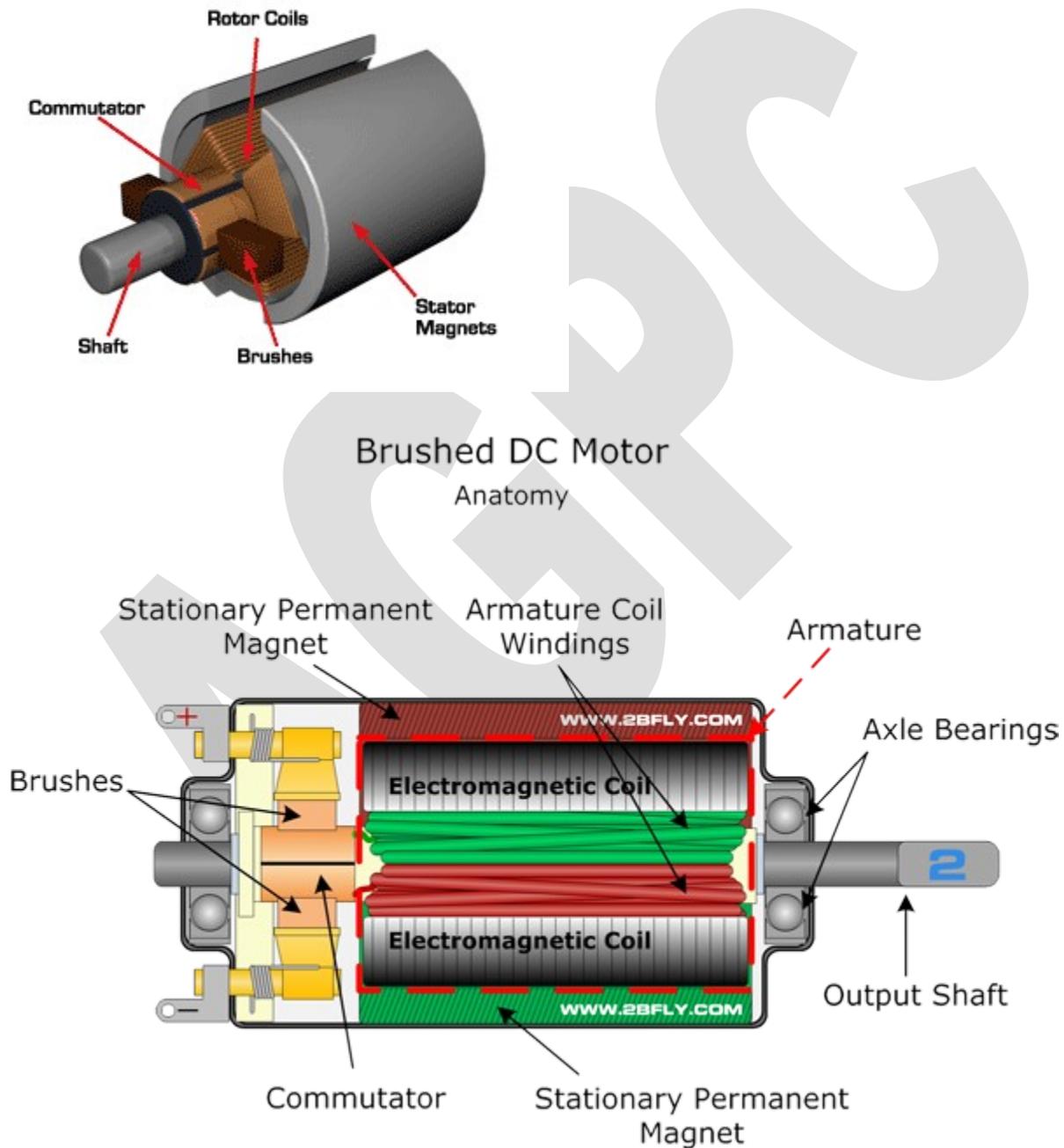


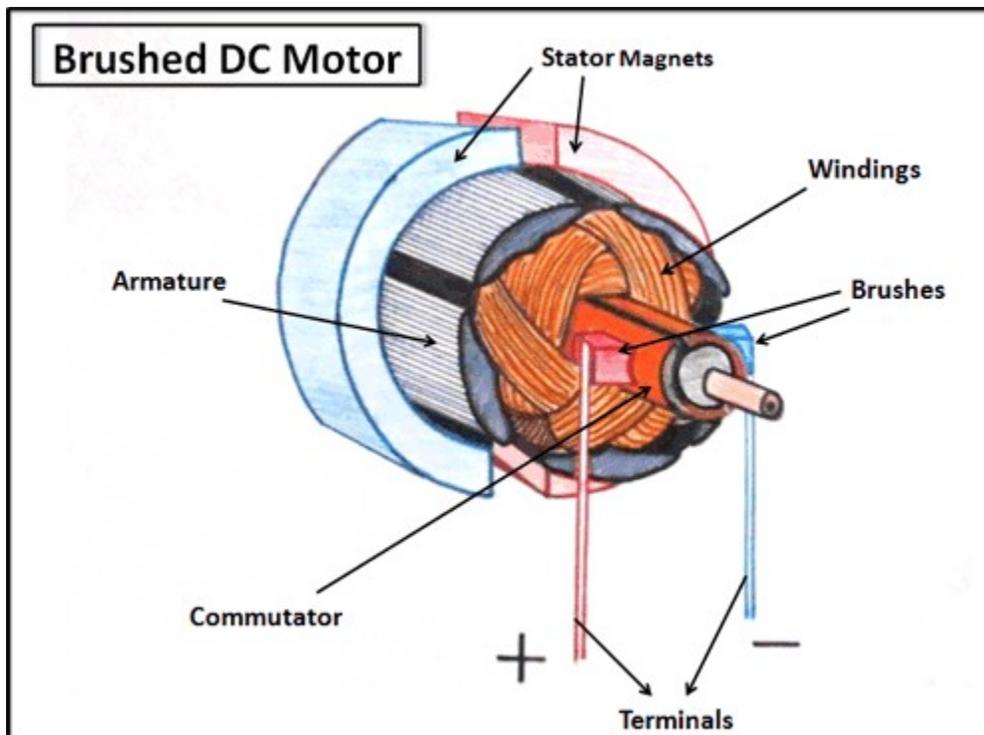
An AC electric motor operates by applying alternating current (AC) power to the electric motor. An AC electric motor consists of several parts but the main parts are the stator and rotor.

The AC electric motor's stator has coils that are supplied with the alternating current and produces a rotating magnetic field. The AC electric motor's rotor rotates inside the electric motor's coils and is attached to an output shaft that produces torque by the

rotating magnetic field. There are two different types of AC electric motors and each of them uses a different type of rotor. The first type of AC motor is called an induction motor (also known as an asynchronous motor). The other type of AC motor is called a synchronous motor.

DC motor





DC electric motors are powered from direct current (DC) power and are mechanically commutated machines. DC electric motors have a voltage induced rotating armature winding, and a non-rotating armature field frame winding that is a static field, or permanent magnet.

DC electric motors use different motor connections of the field and armature winding to produce different speed and torque regulation. Unlike AC electric motors, DC electric motor speed can be controlled within the winding by changing the voltage applied to the DC motor armature, or by adjusting the field frame current.

DC machines can be classified as self-excited, separately excited, permanent magnet (PM), and brushless. Self-excited machines can be further classified as shunt, series, and compound.

Difference

DC motors are usually seen in applications where the motor speed needs to be externally controlled. AC motors work best in applications where power performance is sought for extended periods of time. All DC motors are single phase, but AC motors can be single phase or three phase.

AC and DC motors use the same principle of using an armature winding and magnetic field except with DC motors, the armature rotates while the magnetic field doesn't

rotate. In AC motors the armature does not rotate and the magnetic field continuously rotates.

In some applications today, DC electric motors are replaced by combining an AC electric motor with an electronic speed controller, known as variable frequency drives. DC electric motors are replaced with an AC electric motor and an electronic speed controller because it is a more economical and less expensive solution.

DC electric motors have many moving parts that are expensive to replace, and DC electric motor repair is usually more expensive than using a new AC electric motor with an electronic controller.

MAINTENANCE CHECK LIST FOR MOTOR

RECOMMENDED MAINTENANCE SCHEDULE

Maintenance schedule of induction motors, as recommended by Indian Standard Institution (ISI) are

Daily Maintenance

- o Examine visually earth connections and motor leads
- o Check motor windings for overheating (the permissible maximum temperature is about that which can be comfortably felt by hand)
- o Examine control equipment
- o In the case of oil-ring lubricated motors
 - Examine bearings to see that oil-rings are working.
 - Note temperature of bearings
 - Add oil, if necessary
 - Check end play

Weekly Maintenance

- Check the belt tension. In case where this is excessive, it should immediately be reduced and in the case of sleeve bearing machines, the air gap between motor stator should be checked.
- Blow out windings of protected type motors situated in dust locations
- Examine starting equipment for burnt contacts where motors is started and stopped frequently

- Examine oil in the case of oil ring lubricated bearing for contamination by dust, girt, etc. (This can be roughly fudged by the color of the oil)

Monthly Maintenance

- o Overhaul controllers
- o Inspect and clean oil-circuit breakers
- o Renew oil in high speed bearing of brushes of slip ring motors
- o Check the grease in ball and roller bearings and make it up where necessary and take care of avoiding overfilling
- o Drain all oil from bearings, wash with lubricating oil and refill with clean oil.

Half-yearly Maintenance

- Clean winding of the motors subjected to corrosive ors their elements. Also bade and varnish, if necessary
- In the case of slip -ring motors, check slip-rings for grooving on unusual wear
- Check grease in ball and roller bearings and make it up where necessary and take care of avoiding overfilling
- Drain all oil from bearings, wash with petrol to which a few drops of oil have been added flush with lubricating oil refill with clean oil.

Annual Maintenance

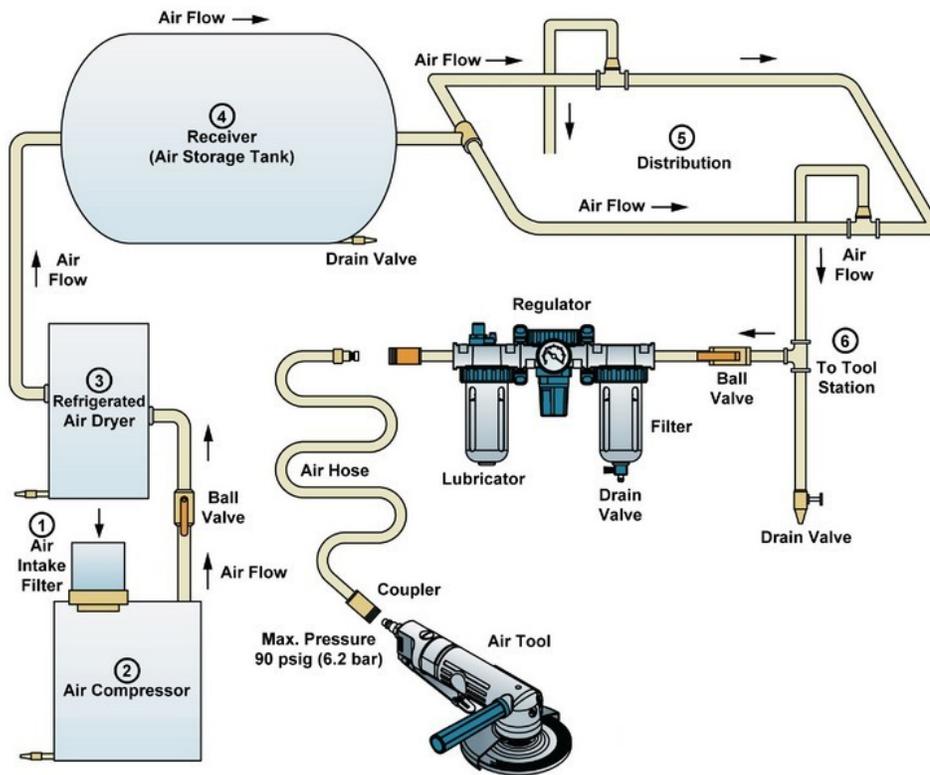
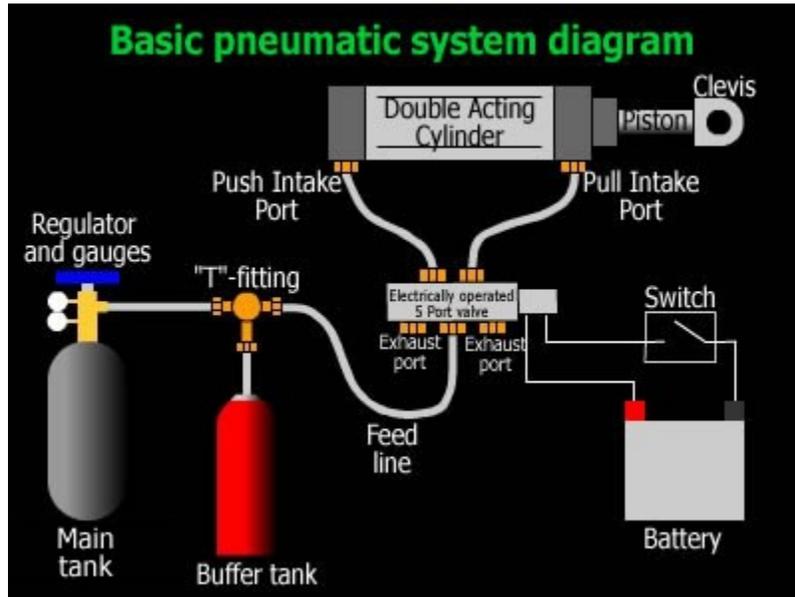
- o Check all high-speed bearings and renew, if necessary
- o Blow out all motor windings thoroughly with clean dry air. Make sure that the pressure is not so high as to damage the insulation
- o Overhaul varnish dirty and oily windings
- o Overhaul motors, which have been subjected to severe operating conditions
- Renew switch and fuse contacts, if damaged.

5.2 PNEUMATIC SYSTEM MAINTENANCE

Pneumatics is that branch of physics that deals with the properties of air and other gases. In the printing industry we are concerned with compressed air, which serves in a number of different capacities within the plant.

. The air usually has little moisture removed and a small quantity of oil added at the compressor, to avoid corrosion of mechanical components and to lubricate them

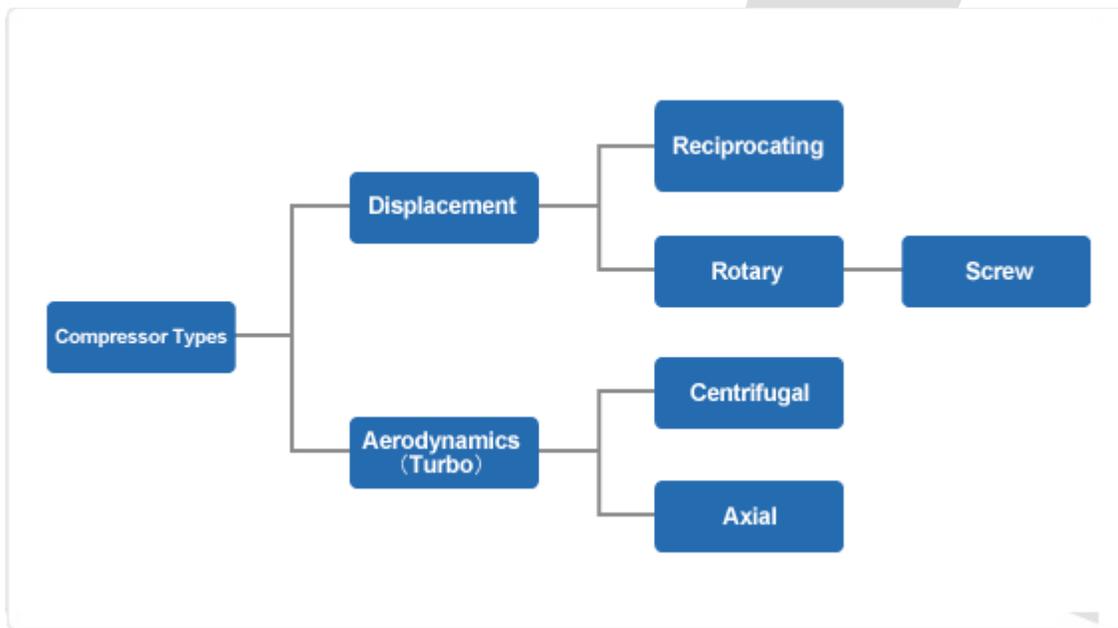
Some of the common places that we see pneumatics at work in the printing industry are the vacuum and air blast systems on sheet fed presses, air shafts and chucks on Web fed presses, air tables in the bindery, vacuum frames in plate making, pneumatic maintenance tools, and general cleaning aids.



INTRODUCTION TO COMPRESSOR

A compressor is a machine that increases air pressure by compressing it, i.e., reducing its volume. The discharge pressure from a compressor is higher than the initial intake pressure. (A vacuum pump is compressor in reverse.) The printing industry uses two distinctly different types of compressors. They are

TYPES OF COMPRESSORS



Compressor type	Capacity type		Centrifugal type
	Screw	Reciprocating	Turbo
Compression principle	Compresses by rotating screw rotor M rotor F rotor	Compresses through the reciprocating motion of the piston piston	Compresses through centrifugal force using impeller rotation Impeller

The three basic types of air compressors are

- Reciprocating compressors
- Rotary compressors
- Rotary centrifugal

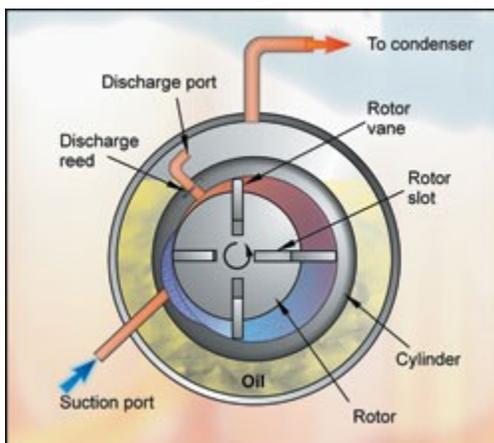
Reciprocating Air Compressors

Reciprocating air compressors are **positive displacement** machines, meaning that they increase the pressure of the air by reducing its volume. This means they are taking in successive volumes of air which is confined within a closed space and elevating this air to a higher pressure. The reciprocating air compressor accomplishes this by a piston within a cylinder as the compressing and displacing element.

Single-stage and two-stage reciprocating compressors are commercially available.

Rotary Compressors

The **rotary vane compressor** employs a series of rotating vanes or blades, which are installed equidistant around the periphery of a slotted rotor. The rotor is mounted eccentrically in a steel cylinder so that the rotor nearly touches the cylinder wall on one side, the two being separated only by an oil film.



The suction vapour drawn into the cylinder through suction ports in the cylinder wall is entrapped between adjacent rotating vanes. The vapour is compressed as the vanes rotate from the point of maximum rotor clearance to the point of minimum rotor clearance. The compressed vapour is discharged from the cylinder through ports located in the cylinder wall near the point of minimum rotor clearance. The rotary vane compressor is a rotary positive displacement type, which has the advantage of simplicity.

Screw compressors are extensively used in large air conditioning and industrial refrigeration applications.



The rotary screw compressor is a positive displacement helical-axial design. In the twin-screw compressor, compression is achieved by two intermeshing rotors housed in a close fitting casing. As the rotors continue to rotate, the intermeshing of the lobes on the discharge side of the compressors progressively reduces the space occupied by the gas causing compression. Compression continues until the inter lobe space becomes exposed to the outlet port in the casing and the gas is discharged. The machine has few moving parts (seven): slide valve, two rotors and two sets of heavy-duty industrial bearings.

Since the cooling takes place right inside the compressor, the working parts never experience extreme operating temperatures. The rotary compressor, therefore, is a continuous duty and easy to maintain and operate. Advantages of the rotary screw compressor include smooth, pulse-free air output in a compact size with high output volume over a long life.

The oil free rotary screw air compressor utilizes specially designed air ends to compress air without oil in the compression chamber yielding true oil free air.

Centrifugal Compressors

The centrifugal air compressor is a **dynamic** compressor which depends on transfer of energy from a **rotating impeller** to the air.

Centrifugal compressors produce high-pressure discharge by converting angular momentum imparted by the rotating impeller (dynamic displacement). In order to do this efficiently, centrifugal compressors rotate at higher speeds than the other types of compressors. These types of compressors are also designed for higher capacity because flow through the compressor is continuous.

The centrifugal air compressor is an oil free compressor by design. The oil lubricated running gear is separated from the air by shaft seals and atmospheric vents.

MAINTENANCE OF PNEUMATIC SYSTEMS

The following maintenance checklist is intended to be general in nature and should not be considered complete.

The importance of opening and draining moisture traps on a regular basis cannot be stressed enough, because it must be done regularly, it seems to be forgotten or overlooked, but it is essential.

Before any maintenance work is done on a compressor, the electrical power to the machine must be looked off or disconnected.

MAINTENANCE CHECK LIST FOR PNEUMATIC SYSTEMS

Daily:

- Check for noise and vibration
- Drain all condensation traps
- Check oil level

Weekly:

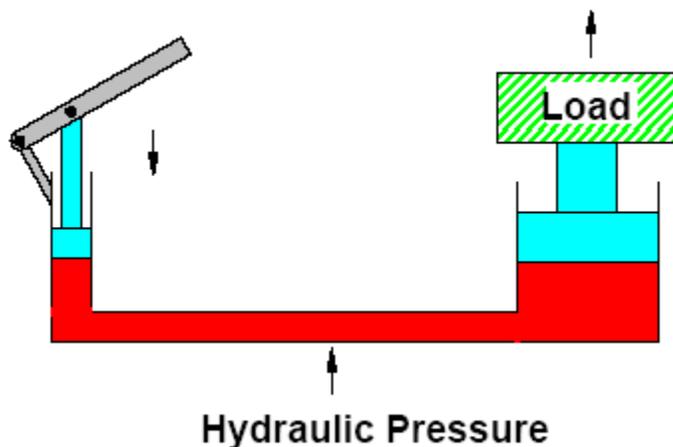
- Clean air filter (if not self-cleaning).
- Check relief and safety valves for sticking

Monthly:

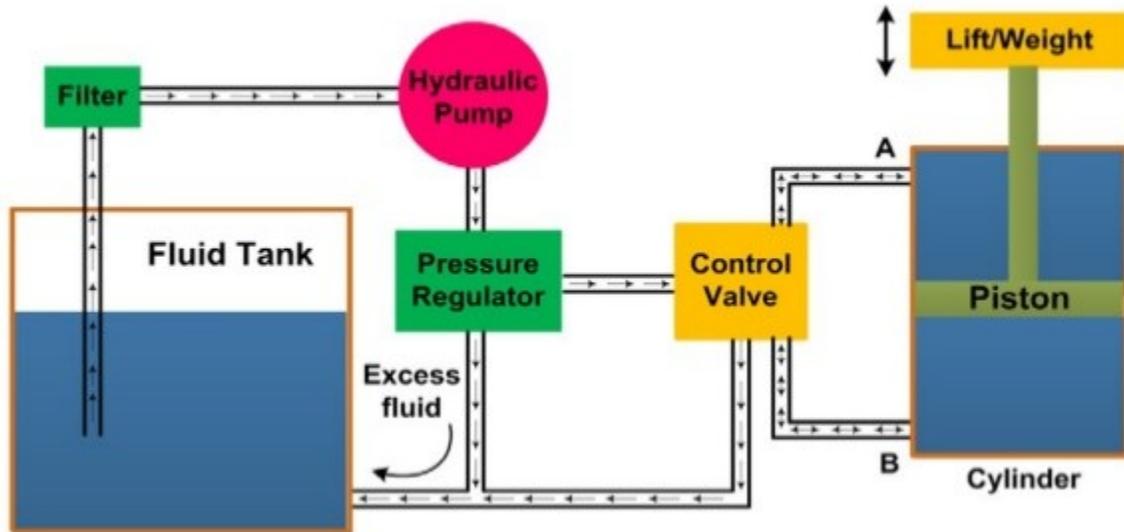
- Check entire system for leaks
- Check oil for contamination and change if necessary
- If there is a drive belt, check tension

5.3 HYDRAULIC SYSTEM MAINTENANCE

HYDRAULICS



Basic layout of Hydraulic System



Hydraulic is the use of liquids to transfer power from one area to another. The word “hydraulic” was originally Greek and means “water pipe”. However, our concern in the printing industry is with oil hydraulics as applied to force amplification. Therefore, a hydraulic power system is a means of transmitting power by the use of a relatively incompressible fluid. This system transfers energy from one location to another and converts that energy to useful work.

Hydraulic systems are used in several areas within the printing plant, including the clamp on paper cutters, plate and blanket impression units on large lithographic presses, and hydraulic lifts on presses, and roll handling trucks.

MAINTENANCE OF HYDAULIC SYSTEMS

A planned preventive maintenance program minimizes operational failures. Since, hydraulic fluid is generally a petroleum-based oil, refill drums should be stored in a dry, cool place.

The spout of the drum should always be cleaned before oil is withdrawn, and portable filters should be used when pouring fluid from the original drum to the hydraulic reservoir.

While the oil is in the hydraulic system, it must be kept clean by filtration.

Only filters of the correct mesh size for your operation should be used, and they should be cleaned or replaced on a regular, predetermined schedule.

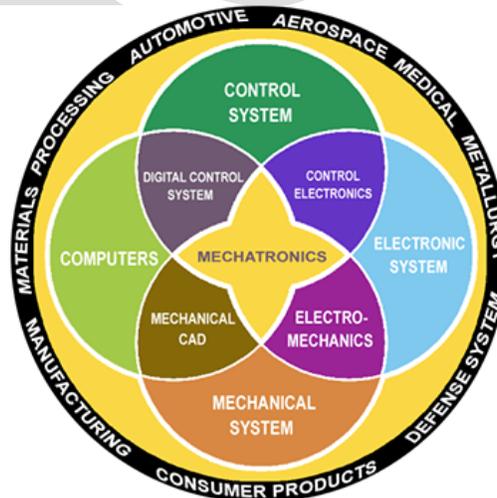
The reservoir and piping should be emptied, flushed, and thoroughly cleaned periodically. Failure to follow such a maintenance program will bring unwanted problems. The system can be expected to fail to deliver the proper volume of fluid at the required pressure and noise will become apparent, indicating improper internal lubrication, a possibility of excessive internal wear, and even the possible breakage of internal parts.

Sometimes the original reservoir is too small, a situation creating excessive heat in the systems because there is not enough time for fluid to cool down sufficiently between cycles. If this occurs, the reservoir should be replaced with a larger one.

Other caused of excessive heat are a poorly functioning air cooler (if the system has one); leakage from pump, valves and cylinders; incorrect clearances between pump parts; relief valve that is set for too high a pressure; clogged pipes or replacement pipes that are too small; and oil of incorrect viscosity.

Mechatronics

Basic Definitions



“The synergistic integration of mechanical engineering, with electronics and intelligent computer control in the design and manufacturing of industrial products and processes”.

It is a design process that includes a combination of mechanical engineering, electrical engineering, control engineering and computer engineering. Mechatronics is a multidisciplinary field of engineering. A mechatronics engineer unites the principles of mechanics, electronics, and computing to generate a simpler, more economical and reliable system.

Key Elements of Mechatronics

The study of mechatronic systems can be divided into the following areas of specialty:

1. Physical Systems Modeling
2. Sensors and Actuators
3. Signals and Systems
4. Computers and Logic Systems
5. Software and Data Acquisition

Application

- Automation and robotics
- Servo-mechanics
- Sensing and control systems
- Automotive engineering, automotive equipment in the design of subsystems such as anti-lock braking systems
- Computer-machine controls, such as computer driven machines like IE CNC milling machines
- Expert systems

- Industrial goods
- Consumer products
- Mechatronics systems
- Medical mechatronics, medical imaging systems
- Structural dynamic systems
- Transportation and vehicular systems
- Mechatronics as the new language of the automobile
- Diagnostic, reliability, and control system techniques
- Computer aided and integrated manufacturing systems
- Computer-aided design
- Engineering and manufacturing systems
- Packaging
- Microcontrollers / PLCs
- Mobile apps

UNIT – I**2 Mark Questions****1. What is Maintenance?**

Maintenance is usually viewed, as a repair function but it is composite in nature. A wide range of activities are involved in it. In fact maintenance keeps our entire system to be reliable, productive and efficient

2. What are the types of maintenance?

- Scheduled Maintenance
- Preventive Maintenance
- Prediction Maintenance
- Restoration Maintenance/Break down/Emergency
- Contract Maintenance

3. What is planned maintenance?

It is done in planned manner to avoid breakdown

4. What is unplanned maintenance?

It is always done after the machine breakdown

5. Define housekeeping?

It is an orderly arrangement of operations, tools equipment, storage facilities and supplies. It is a practical method of increasing production, reducing accident and improving morale and public relations.

6. What is scheduled maintenance?

In this type of maintenance is done to avoid break down. A schedule is framed for an instrument or machine. According to that all works like inspection, lubrication, repair done.

7. What is Predictive maintenance?

Predictive maintenance is to recognize the cause of any change of physical condition of a system to inspect the troubles of internal parts without disassembly.

8. What is minor repair?

Repairs which are carried by not interrupting the production by small adjustments

9. What is major repair?

Repairs which need the machine to be stopped and special tools required to correct.

10. What is preventive maintenance?

Preventive Maintenance is naturally carried out before any interruption of production and major breakdown. This maintenance is carried out in predetermined intervals.

11. What is breakdown/Emergency maintenance?

It is basically a fix-it-when-it breaks function, where it leads to equipment downtime, loss of money & manpower.

12. What is contract maintenance?

it is adopted by small companies by the way of AMC (Annual Maintenance Contract) by using outside manpower, tolls and consultancy

3 Marks

1. Write the advantages of preventive maintenance
2. Write the advantages of contract maintenance
3. Write the advantage of housekeeping
4. What is Repair Cycle?
5. What are the merits and demerits of Unplanned Maintenance?
6. What are the five steps of housekeeping?
7. What are the functions of Preventive maintenance?

12 Mark Questions

4. Explain detail about the planned maintenance and write down its advantages?
5. Write about the safety precautions to be followed in press?
6. Why housekeeping is most essential for the printers?
7. What are the 5S means and write down its advantages?
8. What are the functions of preventive maintenance and explain them in detail?
9. Explain about repair cycle with neat diagram?
10. What are the types of maintenance and explain them in detail.

UNIT – II

2 Mark Questions

1. What is chain drive?

It is a positive transmission and consists of endless chain links over sprockets.

2. What are the types of chain drive?

1. Roller chain
2. Silent chain
3. Ewart chain
4. Bead Chain_

3. What is belt drive?

The belt drive system is widely used to transmit power from one shaft to another by means of pulleys.

4. What are the types of belt drive?

1. Flat belt drive
2. V-belt drive
3. Circular belt or Rope drive
4. Ribbed belt drive
5. Toothed or timing Belt drive

5. What is gear drive?

A gear is a mechanism that transmits power from one shaft to another at shorter distance, smoothly and positively, where constant velocity ratio is essential.

6. What is direct drive technology?

The direct drive motor is brushless and gearless so it eliminates friction from its power transmission since the feedback element is coupled directly to the load; system accuracy and repeatability are great.

7. What is V belt?

The V-belts are made of rubber impregnated fabric with angle V between 30 to 40 degrees. They are made endless and particularly suitable for short drives where greater amount of power is to be transmitted.

8. What is spur gear?

It has teeth parallel to the shaft, and used to transmit power to only parallel shafts. Use of spur gears will eliminate the end thrust and axial displacement at moderate speeds.

9. What is helical gear?

Helical gear has teeth that form a helical angle around the center. Helical gears are most accurate and stronger than spur gears. This type of gears eliminates the shock and jarring under heavy loads.

10. What is herring bone gear?

They are called as double-helical gear. Two opposite-angle helical gears are fastened together. These gears are used to transmit heavy loads with a minimum of noise.

11. What kind of lubrication is best suited for Chain drive?

Oil, as it passes through all parts of chain mechanism

3 Mark Questions

1. What are the advantages of chain drive?
2. State the disadvantages of belt drive?
3. What are the advantages of Belt drive?
4. What are the advantages of Gear drive?
5. What are the advantages of direct drive?
6. What is the main purpose of bevel gear?
7. What is the main purpose of worm gear?
8. Why V belts are better than flat belts?
9. What are the advantages of direct drive technology?

12 Mark Questions

1. Explain in detail about the types of chains with neat diagrams?
2. Explain in detail about the types of belts with neat diagrams?
3. What is gear drive and explain the types of gears with neat diagrams?
4. Explain in detail all about direct drive technology?
5. Write in detail about the maintenance of chain drive?
6. Write in detail about the maintenance of belt drive?

7. Write in detail about the maintenance of gear drive?

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UNIT – III**1 Mark Questions****1. What is the role of bearing?**

Bearings are one of the most important machine elements. Bearings have contact with rigid frame and movable parts.

2. What is cams and follower?

Cam is a machine part that either rotates, move back and forth or remain stationary to produce a prescribed motion by contacting a follower

3. What are the types of cams?

- Disk cam
- Translation cam
- Groove plate cam
- Cylindrical cam
- Eccentric cam
- Tow & Wiper cam

4. What are the types of followers?

- Roller follower
- Knife Edged follower
- Flat edge

5. What is the purpose of contactors?

A contactor is a mechanical switching device, used to switch on and off the power circuit.

6. What is limit switch?

These types are generally used to limit or indicate the travel of some moving part of the machine

7. What is meant by overload relay switches?

Overload relay switches are normally used to protect the motor from various problems like, low voltage, excessive loads, high temperature, etc

8. What is electric panel?

It is the supplying and monitoring units used in industries. Size of the panel and its operation facility is depending on the nature of job we handle

9. What are the elements an electrical panel contains?

Indicator panel for phase current, voltage, frequency

10. What are the types of bearings?

1. Sliding bearings
2. Antifriction bearings

11. What is antifriction bearing?

This bearing is suitable for high-speed operation and requires less maintenance, and carry greater radial and thrust loads.

12. What are the types of springs?

- Helical Spring
- Conical & Volute Spring
- Torsion Springs & Laminated Springs

13. What is sliding bearing?

Sliding bearings may be used to support the rotating, reciprocation or oscillating shafts. This type of bearings is also called as plain bearing.

14. What is meant by ball bearing?

Ball bearing in which a shaft or journal turns in contact with hardened steel balls usually. These balls are placed between and outer race

15. What is meant by needle bearing?

Needle bearing is a cage less bearing, but the needle is long and thin. It carries high loads with more accuracy.

16. What is meant by roller bearing?

These are similar to the ball bearings where the balls are replaced by hardened short cylindrical rollers in order to carry greater radial loads than the ball bearings.

17. What is helical spring?

The helical springs are made up of a wire coil in the form of helix and are primarily intended for compressive or tensile loads.

18. What is torsion spring?

These springs may be of helical or spiral type. The helical type may be used only in applications where the load tends to wind up the spring.

19. What is sensors/detectors?

A sensor or a detector is a device that responds to a stimulus. It then generates a signal that can be measured or interpreted.

20. What is bearing?

A bearing is a device to permit fixed direction motion between two parts.

21. What is the purpose/use of bearing?

The purpose of a ball bearing is to reduce rotational friction and support radial and axial loads.

21. What are the types of overload relay switches?

- Thermal
- Magnetic

3 Mark Questions

1. What is the purpose of conical and volute spring?
2. Write down the application of springs in printing machines.
3. Write down the application of cam & followers in printing machines
4. Write down the application of Sensors / detectors in printing.
5. Write down the distinct application of needle bearing.
6. Differentiate thermal from magnetic relay switch.

12 Mark Questions

1. What is bearing and explain its types with neat sketches?
2. Explain in detail about the cams and their types with neat diagrams?
3. Explain detail about the follower and their types with neat diagrams?
4. State the types of springs with neat diagram?
5. Write the short notes on the electrical elements i) Limit switches ii) contactors iii) electrical panels.

6. Write the short notes on the electrical elements i) sensors/detectors ii) over loadrelay switches.
7. Explain in detail about the role of sensors and detectors in printing machine.
8. What is overload relay switch and explain its types?

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UNIT – IV**1 Mark Questions****1. What is meant by lubrication?**

Lubrication is a procedure to separate the surfaces with a thin film of lubricant to minimize friction and to restrict wear & tear.

2. What are the types of lubricants?

- Solid lubricants
- Semi solid lubricants
- Liquid lubricants

3. What is meant by test run?

The purpose of a test run is to check the print accuracy and performance of the machine whether it complies with the manufacturer specification.

4. What are the types of test runs?

- Idle-run tests
- Performance test under load
- Accuracy tests
- Rigidity tests
- Vibration – resistance tests

5. Give an example for solid lubrication?

Soap stone, graphite, talc, chalk, mica Teflon, molybdenum disulphide etc.

6. Give an example for semi-solid lubrication?

Grease, Vaseline and etc.

7. Give an example for liquid lubrication?

- Animal and vegetable oils
- Mineral oils

- Synthetic oils
- Blended oils

8. What is lubrication chart?

Printing plants should use lubrication charts, is the only way to be sure that the proper types of lubricants have been used at the proper intervals.

9. What is paint mark in lubrication?

It is kind of paint marks indicates the type and frequency of lubrication to be applied

10. What are the equipment & tools used in erection and reconditioning?

- Spirit level
- Dial Indicator
- Feeler Gauge
- Cranes
- Wrenches
- Spanners

11. Name the equipment used for machine leveling.

Spirit Level

12. What is reconditioning?

Restoration maintenance consists of repairing a broken or damaged piece of equipment to restore necessary operation conditions

3 Mark Questions

1. Why paint mark is essential for lubrication?
2. Write down the purpose of spirit level?
3. Write down the purpose of feeler gauges?
4. Write down the purpose of dial indicator?
5. Write down the purpose micrometer?
6. Why Lubrication is essential for the machineries?
7. Write down the importance for test run.

12 Mark Questions

1. Explain the types of lubrication in detail with examples?
2. Explain the following equipment's with diagrams: i) Spirit Level ii) Dial indicator iii) Feeler Gauges
3. Explain the following equipment's with diagrams i) Micrometer ii) Vernier caliper iii) Wrenches
4. Explain in detail about the types of test run used in the printing industry?
5. Prepare a sample Lubrication schedule/chart for an offset machine and explain the importance of paint mark for lubrication?

UNIT – V**1 Mark Questions****1. What is AC motor?**

An AC electric motor operates by applying alternating current (AC). It consists of stator and rotor.

2. What is DC motor?

DC electric motors are powered from direct current (DC) to produce different speed and torque regulation.

3. What is Pneumatic system?

Pneumatics is that branch of physics that deals with the properties of air and other gases

4. What are the types of compressor?

- Reciprocating compressors
- Rotary compressors
- Rotary vane compressor
- Screw compressor
- Centrifugal Compressor

5. What is Hydraulic System?

A hydraulic power system is a means of transmitting power by the use of a relatively incompressible fluid. This system transfers energy from one location to another and converts that energy to useful work.

6. Name the medium used in Pneumatic system.

Air

7. Name the medium used in Hydraulic system.

Liquid

8. What is Mechatronics?

It is a design process that includes a combination of mechanical engineering, electrical engineering, control engineering and computer engineering

3 Mark Questions

1. What are the common problems faced by electricity?
2. Write down the application of Mechatronics in printing field?
3. Write down the advantages of Rotary compressor over the reciprocating compressor.
4. Write down the application of pneumatics in printing field.

12 Mark Questions

- 1) Prepare a maintenance check list for electrical motors.
- 2) Prepare a maintenance check list for Pneumatic system.
- 3) Write about AC and DC motors with neat sketch?
- 4) Prepare a maintenance check list for Hydraulic system.
- 5) Write down the applications of mechatronics in the printing field.
- 6) What are the types of compressors and explain them with neat sketch?
- 7) Write down the common problems encountered in day to day life by electricity.
- 8) Write in detail about pneumatic system functioning with neat sketch.