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# Application of Mechanical Engineering Development to Knitting Machines for Increasing Production from old Tech to New Tech

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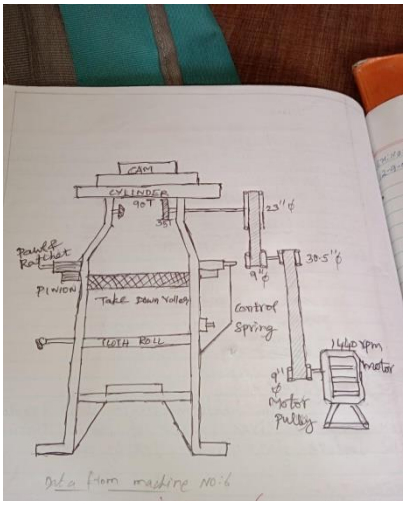
**Abstract -**The production of knitting machines which are working in India is low compared to new developed foreign knitting machines. To work in the new situations the syllabus of colleges of technician should be enhanced with all features of mechanical, electrical and electronics basics. Without proper usage of modern development it is very difficult to compete in the global market. Only the person with less quotation will get order and money will go to modern knitting machines factory only. So bearing in mind all should upgrade to current technology.

***Key Words*:** Mechanical, Electrical, Electronics, Old knitting machine, New knitting machines.

## 1. INTRODUCTION

The old knitting machine have less production compared to new knitting machine. To compensate the loss in production the old machines should be investigated for profitability, if possible replaced by new machines. This paper deals with various aspects of old and new machines features and comparison between them.




**Old Machine Production**

Figure 1.1

**Calculation procedure**

1. Speed of cylinder =1440 x (9/30.5)x(9/23)x(35/90)

=65rpm

2. Production per hours in yds or mts. = (Number of feeders x cylinder speed x 60)/(courses per inch x 36)
= (14x65x60)/(52x36)

=29.17yds = 26.54mts.

3.Production per hour in lbs (pounds) or kgs

=(no. of needles x stitch length x no. of feeders x cylinder speed x 60x efficiency) /(36xcountx840)

$$= \frac{300 \times 0.114 \times 14 \times 65 \times 60}{36 \times 30 \times 840}$$

=2.058lbs/hr
=0.934kgs/hr.

4.The theoretical GSM of fabric in gms

=(stitch density x stitch length x39.37x39.37x453.6)/(count x 840 x 0.91x39.37)

=(36 x 52 x0.114x39.37x453.6)/(30x840x0.91)

=166.19g/$m^2$.

5.GSM of fabric by electronic weight balance =(weight of sample x 100x100)/(Area of sample in $cm^2$).

=(1.724x100x100)/100

=172.4g/$m^2$.

6.Theoretical width of the fabric

Width of one wale =4x d

Theoretical width =4xdxno. Of needles /2.

=(4x300x2.54/(2x28x√30 ))

=9.94cms.

7.Actual width of the fabric =9cms.

Result

1.Speed of cylinder=65rpm

2.Production per hours in yds or mts.==29.17yds = 26.54mts.

3.Production per hour in lbs (pounds) or kgs=2.058lbs/hr

=0.934kgs/hr.

4.The theoretical GSM of fabric in gms=166.19g/$m^2$.

5.GSM of fabric by electronic weight balance=172.4g/$m^2$.

6.Theoretical width of the fabric=9.94cms.

7.Actual width of the fabric =9cms.

This is given in reference (1).

**New Machine Production**
**Knitting Calculation:**

Production calculation of knitting means calculation of knitting machine production. To calculate knitting machine production by weighing the total production of one hour or one shift or one day.

**Knitting Machine**

The practical way of calculating the production of a machine is as follows. In this method the following information for production calculation are required:

- Machine Gauge and Dia
- RPM of Knitting Machine
- Yarn Count
- Stitch Length

**Production Calculation of Knitting**

Find out the production per shift for a single jersey and rib from the following data:
For a single jersey,

1. Fabric width = 53 “, GSM = 150 , Yarn count(Ne) = 26S
2. Stitch length = 2.85 mm, Cylinder Dia(D) = 25″, Cylinder Gauge(G) = 24
3. No. of feeder = 75, R.P.M.of cyl.= 25, Time =8 hrs, Effi.= 80%

**Solution:**

Production/8hrs,
= {(πDG X S.L (mm) x No. of feeder x RPM x 60 x 8 x Efficiency) / (2.54 X 36 X 840 X 26 X 2.2046)} Kg
= { (3.1416 X 25 X 24 X 75 X 25 X 60 X 0.80) / (2.54 X 36 X 840 X 26 X 2.2046) } Kg
= 87.85 Kg

This is given in reference (2).

**Features of old Machines**
**Single Jersey Machine**

| | | |
|---|---|---|
| S.No.: 7 | Type: 53 | Diameter: 15 |
| Year: 1988 | Gauge: 24 | NPI RPM: Manual |
| Total Needles: 1200 | | Type: - |
| Total Sinkers: 1200 | | Type: - |

**Single Jersey Machine**

| | | |
|---|---|---|
| S.No.: 8 | Type: 58 | Diameter: 4 |
| Year: 1999 | Gauge: 14 | NPI RPM: 60 |
| Total Needles: 150 | | Type: 7663 |
| Total Sinkers: 150 | | Type: 3823 |

**Single Jersey Machine**

| | | |
|---|---|---|
| S.No.: 9 | Type: SB | Diameter: 6 |
| Year: 1999 | Gauge: 16 | NPI RPM: 60 |
| Total Needles: 300 | | Type: 7663 |
| Total Sinkers: 300 | | Type: 3823 |

**Single Jersey Machine**

| | | |
|---|---|---|
| S.No.: 14 | Type: 8B | Diameter: 18 |
| Year: 1999 | Gauge: 20 | NPI RPM: 24 |
| Total Needles: 1128 | | Type: 10252 |
| Total Sinkers: 1128 | | Type: 3823 |

**Single Jersey Knitting Machine**

| | | |
|---|---|---|
| S.No.: 15 | Type: 5B | Diameter: 16 |
| Year: 1999 | Gauge: 20 | NPI RPM: 24 |
| Total Needles: 996 | | Type: 102.52 |
| Total Sinkers: 996 | | Type: 38.23 |

**Description**

The machine particular taken from the machines are given in the list. It consists of S.No., Type, Diameter, Year, gauge (NPI), rpm, total needles, total sinkers, type of needle (number). The s.no. represents the machine number of manufactures. The type represents the single or double jersey. i.e principle of stitch formation. Diameter represents the cylinder diameter. Year is the manufacturing year. The gauge represents number of needles. RPM is revolution per minute which is the cylinder rpm. In case of single jersey total sinkers are given. The type represents the number given to a particular needle or sinker.

This is given in reference (3).

**Features of New Machines**

**Features of Single Jersey Machine and Modern Single Jersey Machine**

**Features of Single Jersey Circular Knitting Machine**

1. Only a cylinder is used.
2. One set of needles is used.
3. Max machine gauge 24/ 60 upto in modern S/J machine.
4. The cylinder has cams-Rising & stitch cam.
5. Sinker is used / but the dial is not used.
6. Vertical needle position.
7. Up to 120 feeders are available.
8. Machine capacity is high.
9. Machine dia of 26"-30".
10. Fiber cut up to 28 is available.

**Features of Modern Circular Knitting Machine**

1. It has a cylindrical needle bed.
2. Consist of 3 major sections (yarn supply, knitting element & fabric take down).
3. All three types of needles can be used.
4. Sinkers and dial for dial are used.
5. Needle retaining spring is present.
6. Yarn supply from cores situated on overhead bobbins.
7. Up to 60 machine gauge is available.
8. The positive feed provides 3 different speeds.
9. Automatic lubrication system.

This is given in reference (4).

**Single Jersey Circular Knitting Machine Specification**

- Model: HFSJ
- Gauge: 16-32G
- Diameter: 12-44"
- Feeders: 24-132F
- Motor: 1.1-7.5 KW

**Features**

Adopting the 4 track cams seal design and equipped with knit cams, tuck cams and Miss Cams. High precision central raising and falling System can adjust the fabric weight conveniently and quickly. The special design of the feeding yarn carrier makes the option of Lycra more proficient. Featuring an ergonomic design, the additional middle feeding yarn transfer ring makes it easy for personnel to monitor and carry yarn, without the machine touching the operator's body; at the same time, the yarn carrying system is freer and steadier, satisfying the demand of machine operating and knitting at high speeds.

This is given in reference (5).

**Cost of Production of old knitting machine**

Old knitting machine cost = Rs. 1,00,000/-
14 old knitting machine cost = Rs. 14,00,000/-
Production = 0.934 kg/hr
Yarn rate = Rs. 115/kg
Yarn rate/hr = 0.934 x 115 = Rs. 107.41/hr
Labour charge / hr = 50,000 / (30 x 8) = Rs. 208.33/hr
Power cost = 0.746 x Rs. 6.54 = Rs. 4.88/hr
Depreciation of 10 years cost = (14,00,000) / (10 x 365 x 24) /hr= Rs. 16/hr
Total cost = Yarn cost + Labour cost + Depreciation + power cost
= (107.41 x 14)+ (208.33 x 2) + 16 + (14 x 4.85)
= Rs. 2004.72 /hr
Cost of fabric sold = 14 x 0.934 x 200 = Rs. 2615.2/hr
Profit = 2615.2 – 2004.72 = Rs. 610.48/hr.

**Cost of Production of new modern knitting machine**

New modern knitting machine cost = Rs. 7,00,000/-
2 new modernknitting machine cost = Rs. 14,00,000/-
Production = 18.37 kg/hr
Yarn rate = Rs. 115/kg
Yarn rate/hr = 18.37 x 115 = Rs. 2112.55/hr
Labour charge / hr = 50,000 / (30 x 8) = Rs. 208.33/hr
Power cost = 7 x 0.746 x Rs. 6.54 = Rs. 34.15/hr
Depreciation of 10 years cost = (14,00,000) / (10 x 365 x 24) /hr= Rs. 16/hr
Total cost = Yarn cost + Labour cost + Depreciation + power cost
= (2 x 2112.55)+ (2 x 208.33) + 16 + (12 x 34.15)
= Rs. 4726.06 /hr
Cost of fabric sold = 2 x 18.37 x 200 = Rs. 7348/hr
Profit = 7348 – 4726.06 = Rs. 2621.94/hr.

**Mechanical features of New machine compared to old machine**

**Knitting Machine Controller / Display**

**Product Description**

Detailed Product Description 1 DSP Core digital control 2 Easy for operation and installation

**Feature**

1) Suitable for all kinds of the circular knitting machine. 2) Easy for operation and installation 3) Many kinds of the protection function 4) All kinds of the lights display like Cloth lamp, Spray oil lamp, Yarn break lamp, lack oil fault, Low speed, fast speed, start, Jog, Stop, Safety door. etc. 5) Automatic saving operation data.

**Characteristics:**

1) Full digital control system with the high-performance DSP CPU as its core processing; 2) There are 3 working models as well as their value setting for the pump operation mode: Continuous, interval by the cycle; 3) vailable to set the jog rate, which could be adjusted during running; 4) It may indicate the frequency regulation of the 64 inverter; 5) Available the disable/ enable the operation of setting and adjustment; 6) Make sure that the power supply method of the interver complies with the priciple of make-before-break, ensuring that the non-loaded operation of the contactor and the reliable operation of the inverter; 7) Under the shutdown state, the fan and the pump can conduct the forced operation function; 8) The on-site data storage function at power-down and power-fail; 9) The production and the real-time display under various abnormal situation, that is, it can conduct forced jog function or super-force function under anormal function; 10) The cloth lap counting in working phase, out put satistics of the five shifts of A/B/C/D/E and the gross statistics; 11) The six yarn length counting and six independent step length sitting function; 12) Real-time clock and calendar display function; 13) It can conduct power on self-test, and independent manual detection of input and output signal in shutdown state; 14) Available to inquire the power-on time and shutdown time, and set the time range when the machine enables heating of turbine again after stop; 15) The weaving or cleaning is carries out in a countdown way, which is convenient to examine the remaining weaving turns. 16) The speed of weaving and cleaning is set separately, which makes the operation more flexible.

**Dimension:**

Style No. Outside Dimension (mm) Installation Dimension ( mm ) SC2200-M(-Y) 270 * 210 256 * 196 SC2200-L(-Y) 310 * 230 296 * 216.

This is given in reference (6).

**Reason for high production in modern knitting machine**

The Mechanical machine building development has led to more production in modern machines. It can be attributed to types of design, use of good mechanical property materials, selection of engineering materials, Types of joints used, springs used, shafts & couplings machine parts, Brakes, clutches, chain, belt drives, bearings, gear drives and power screws used in the machine.

**Types of design**

**Modes of failure**

A machine element is said to have failed, if it cannot perform the required functions. The modes of failure are

1. Yielding – by maximum stress exceeding yield point
2. Fracture – by static, fatigue or impact load
3. Excessive elastic deflection
4. Wear
5. Buckling
6. Corrosion, fatigue and caustic embrittlement.

**Design Procedure**

The procedure for designing a machine usually involves the following main steps.

1. Definition of the problem
2. Selection of suitable mechanism
3. Selection of suitable material
4. Preliminary design
5. Revising the design to suit manufacture, assembly etc.,
6. Presentation of drawing

**Use of good Mechanical property material**

Strength, rigidity and life of the members are influenced by mechanical properties of the material.

The ratio of stress to strain within proportional limit is called Modulus of elasticity of the material. The modulus of elasticity of a material is a measure of stiffness of the material. In the curve, the slope of the line is the Modulus of Elasticity and is designated by E.

The ratio of shear stress to angular strain is called the modulus of rigidity G.

**Ductility**

Ductility of a material is the capability of the material to undergo large permanent deformation without rupture.

**Malleability**

Malleability is a term which is frequently used interchangeably with ductility. If distinction is required, malleability can be considered as a compressive quality. A malleable material is one which is capable of being flattened or squeezed.

**Resilience**

Resilience of a material is its capacity to absorb energy within the elastic range. It is measured by the modulus of resilience.

**Toughness**

Toughness of a material is its ability to absorb energy in the plastic range. The modulus of toughness can be obtained similar to the modulus of resilience, by the area below the stress-strain curve in the plastic region. Sometimes the toughness is expressed as toughness index number which is obtained by multiplying ultimate strength with the strain at fracture.

**Hardness**

Hardness is a relative characteristic. There are several methods to measure hardness, all of them are arbitrary in nature. The commonly used methods are Brinell hardness number and Rockwell hardness number. In determining the hardness of material. Brinell Hardness Number (BHN) is obatained by applying a standard load F by means of a steel ball of standard diameter D mm. If d be the diameter of impression, then

$$BHN = \frac{2F}{\pi D\left[D - \sqrt{D^2 - d^2}\right]}$$

Standard ball diameter, D = 10 mm and

Standard F = 3, 000 kg for steel and iron 500 kg for soft metals.

The Rockwell hardness is determined by the depth of indentation or impression of a load tip under static load, and not by the diameter of indentation as in Brinell hardness determination.

**Creep & Effect of Temperature**

At elevated temperatures, materials yield and undergo permanent deformation, at a stress lower than the yield stress. The continuous deformation under load is known as creep.

**Fatigue**

It is observed that members, which are subjected to cyclic stresses, fail at a stress well below the ultimate stress of the material. In such case, the material is said to have failed by fatigue.

**Selection of Engineering Materials**

The commonly used engineering materials are grey iron, malleable iron, S.G. iron, alloy cast iron, plain carbon steels, alloy steels, cast steels, alloys of copper, aluminum, tin, zinc, magnesium and lead. Recently the use of non-metallic materials such as plastics, nylons and rubber are also on the increase.

**Grey cast iron**

Grey cast iron is the unpurified form of iron and is the most widely used material in engineering. The raw materials for making grey iron, namely pig iron, cast iron scrap, steel scrap, coke and air are cheap and it can be melted in a simple equipment such as cupola.

**Cast iron**

Cast iron contains carbon from 2 to 4% and it is not malleable at any temperature. It contains many impurities such as silicon, manganese, phosphorus and sulphur.

**Malleable iron**

Malleable iron is a form of cast iron, in which mallebility is achieved by proper chemical control and heat treatment.

**Ductile Iron/S.G. Iron**

It has been found that small amount of magnesium added to cast iron converts flake graphite to spherical or nodular graphite. The conversion results in a greater increase of strength, elastic limit, hardness and elongation. Because of its ductility it is called ductile iron.

**Alloy Cast Iron**

Addition of nickel will refine the grains and increase the strength of cast iron. Addition of molybdenum upto 1.5% is the most effective means of increasing the tensile strength. Deoxidising cast iron by the addition of calcium silicide at the ladle produces ‘Meehanite’ a strong, uniform iron with the tensile strength from 23 to 32 kg/sq.mm. Heat treatment increases the tensile strength and modulus of elasticity.

High resistance to corrosion by acids, especially nitric acid may be obtained by increasing the silicon content of white iron to 14.5%. This is very hard and is machineable only by grinding. Nickel-chromium cast iron, also called Ni-resist, has good corrosion resistance and machining characteristics.

**Cast Steel**

Cast steel normally contains not over 0.45% of carbon and usually poured from a melt made in an open hearth or electric furnace. Addition of alloying elements such as nickel, chromium and manganese improve the properties.

**Wrought Iron**

Wrought iron is the purest form of iron with carbon content less than 0.008%. It is resistant to corrosion in ordinary atmosphere and welds readily. It has good magnetic properties and is widely used as magnet.

**Plain Carbon Steel**

Steel differs from cast iron is that it has no carbon in the free state. The percentage of carbon varies from 0.08% to 1.5% with consequent difference in properties. When the carbon percentage is below 0.15%, it is called mild steel, when it is 0.15 to 0.30%, it is called low carbon steel and steels with carbon content 0.3 to 0.6% are called medium carbon steels and high carbon steels contains carbon percentage between 0.6 and 0.8.

**Heat Treatment of Steels**

The mechanical properties of steels such as strength, ductility and hardness are modified by heat treatments on the steels. The important processes are annealing, normalizing, quenching, tempering and case hardening.

**Alloy Steels**

When steel contains any element other than carbon, it is called Alloy Steel. The common materials added as alloying elements are Nickel, Chromium, Silicon, Vanadium, Tungsten, Manganese, Copper etc.,

**Non-Ferrous Metals and Alloys**

Resistance to corrosion, which is lacking in ferrous alloys, frequently justifies the use of more expensive non-ferrous metals. Other special characteristics, such as thermal conductivity, non-magnetic properties, good machinability, bearing characteristic may influence the use of non-ferrous metals and alloys.

**Copper and Its Alloys**

Copper and its alloys are used to resist corrosion. Being very malleable, copper can be rolled, drawn and spun easily. Because of its good conductivity of heat and electricity, it is widely used in condensers for conducting heat and used as conductor of electricity. Alloy of copper and zinc is called Brass and alloys of copper with tin, aluminum or manganese are called Bronze. Beryllium copper is a copper alloy of great strength and fatigue resistance obtained by the addition upto 3% of Beryllium, an expensive light metal.

**Aluminum and Its Alloys**

Pure aluminum is weak and its use is confined to rolled, pressed and drawn articles such as kitchen utensils. Parts requiring strength are made of aluminum alloys which may be cast, rolled, forged and extruded. Aluminum – Magnesium alloy contains 3.25 to 4.25 percent magnesium and this alloy has low specific gravity, excellent combination of strength and ductility and machinability. Silicon upto 12% is added to increase fluidity, corrosion resistance etc.

**Other Alloys**

Tin-lead alloys are widely used as bearing materials and they are designated as Bearing alloy grade 90, 84, 75 and so on indicating the percentage of Tin present in the alloy. Magnesium, since it is lighter than aluminum, is used where light weight is the criterion. But magnesium is sensitive to salty air and salt water and hence its application is limited.

**Non Metals**

Wood is employed because of its light weight high strength to weight ratio and its workability. Plywood construction minimises the tendency to wrap and has many applications for strong light structures. Plastics are used primarily to absorb shocks and for quite operation. Bakelite is used in moulded state for many parts of instruments, electrical devices etc. Leather, cotton and canvas are used as belting materials. Rubber in various degree of hardness is used as belting material, insulators, seals, gaskets, and other linings. They are also used to cushion the vibration. Asbestos is a base material for brake and clutch linings. Refractory and glass materials are also used for different purposes.

**Types of Joint used**

Every machine is made up of a number of parts and they are manufactured separately and joined together to perform the duties of the machine. The types of joints may be classified as follows:

**Permanent Joints**

1. Welded, brazed, soldered and adhesive bonded joints
2. Riveted and flanged joints
3. Interference fit, expanded joints

**Detachable Joints**

1. Cotter, pin joints
2. Keyed, splined and other shaped joints
3. Threaded joints

**Riveted Joints**

Until recently riveted joint was the main type of permanent joints extensively used in the construction of pressure vessels, ships, bridges etc. Rapid development of welding techniques has considerably reduced the sphere of their applications. Riveted joints are preferable where vibrations are present, since the riveted joints damp out vibrations better than welded joints and also where weldability of the metal is poor. Riveted joints are widely used for joining light metals.

Riveted joints can be classified according to

i. The purpose for which it is used such a structural or leak proof joints
ii. The method of placing joining member such as lap or butt joints
iii. The type of rivet employed such as solid, tubular or explosive rivets and
iv. The number of rows of rivets such as single, double, triple or quadruple riveted joints.

**Rivets**

Rivets are made of tough and ductile low carbon steel (C15) or nickel steel. The following Indian standard may be referred for rivets.

1. IS 1928–1961 Boiler rivets.
2. IS 1929-1961 Rivets for general purposes.
3. IS 2907-1964 Non-ferrous rivets.
4. IS 4040-1967 Tubular and semi-tubular rivets.

**Method of Riveting**

The rivet consists of a head and a shank. It is applied by passing its shank through a hole (drilled or punched) in the members to be fastened. The clearance between the hole and the rivet is 1 mm for rivets up to 24 mm diameter and 1.5 mm for large diameter.

**Failure of Riveted Joints**

Riveted joints may fail in a number of ways. Failure of riveted joints by tension, shear and crushing in various parts of the joint.

**Welded Joints**

Welding is a process of joining metals in which the parent metals are fused together to form a single piece. Welding differs from soldering and brazing where a filler material is used whose melting temperature is lower than that of the parent metals.

Welding can be classified on the basis of heat source required for welding such as chemical, which make use of heat by burning fuel (gas and oxygen welding), Chemico-mechanical welding (Forge welding and thermit welding), Electro-chemical welding (Atomic hydrogen welding), Electro-mechanical welding (Resistance welding) and Electric welding (Arc welding). Of these Electric and Electro mechanical welding are widely employed.

In electric or arc welding, the heat for melting of the metal is provided by an electric arc, the ionised stream of which at steady burning reaches a temperature upto $5000^0$c.

All carbon steels except spring steel and tool steel can be welded satisfactorily but the low-carbon steels are most readily welded. Cast iron is difficult to weld but satisfactory welds can be produced if due care is taken in preheating and welding operations. Arc welding, submerged arc welding and electro slag welding are employed for ferrous materials and gas welding for non-ferrous metals like brass, bronze and other alloys.

**Detachable Joints**

The detachable joints permit dismantling of the components for replacement, repair, transportation or overhauling.

The detachable joints are classifies as Follows.

a. Threaded joints left hand or right hand
   - bolt and nut
   - Stud
   - Screw
     - Cap Screw
     - Machine Screw
     - Set Screw
   - Taper thread
   - Pipe thread
b. Cottered joints, pin joints
c. Friction joints
d. Key Joints
   - Woodruff key
   - Parallel key
   - Round key
   - Taper key
   - Splines
e. Circlips

**Springs**

**Classification**

A spring is an elastic member used to connect two bodies or two parts of a machine. The functions of a spring are

1. To cushion, absorb or control the energy either due to shock or vibration. E.g. springs

in railway wagons, automobiles, shock absorbers, flexible couplings.
2. To excert force e.g. spring loaded safety valve, magnetic brakes, clutches, tensioning devices for rope or belts.
3. To control motion by maintaining contact between two elements e.g. valve springs, car accelerating pedal, cam and follower etc.
4. To measure forces e.g. measuring instruments, engine indicators, spring balance etc.
5. To store energy e.g. clocks, toy motors, springs in magazine of a gun, kick starters etc.

Springs can be classified according to its shape and the type of stress coming over it. Types of springs are tabulated. Of these, helical springs of circular section and leaf springs are widely used.

Helical springs are made up of round or rectangular wire wound to form a helix. The spring may be wound in hot or cold condition depending on the application and the material.

Helical springs take up axial loads and in some cases take up torque also. Helical springs have the following advantages over other types of springs.

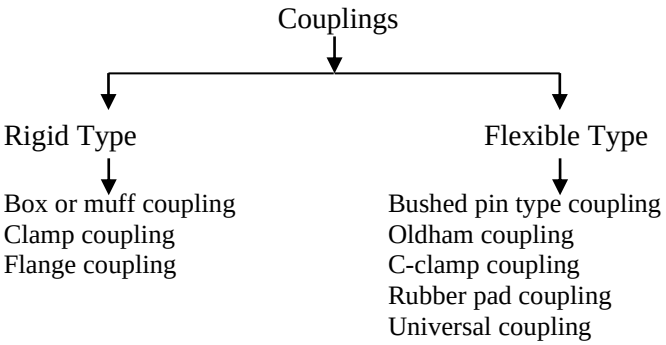
1. They are simple to manufacture.
2. Their performance can be predicted more accurately.
3. A wide range is available.
4. Their characteristics can be varied by changing its dimensions.
5. They are more reliable.
6. Their spring rate remains constant.
7. They can be accommodated in any casing since they are circular.

**Shafts and Couplings**

Shaft is a rotating member used to transmit power by torsion. An axle is a machine member loaded mainly in bending and carries rotating parts such as wheels and gears. An axle may either be stationery or rotating. Short shafts and axles are called as spindles. Transmission shafts are those used to transmit power from the source to the machines. Counter shafts or jack shafts, line shafts and head shafts and all other factory shafting come under transmission shafts. Machine shafts are those which are integral with the machine itself.

**Couplings**

Couplings are used to connect sections of long transmission shafts and to connect the shaft of a driving machine to the shaft of a driven machine. This provides a permanent connection. Clutches permit easy and quick engagement and disengagement of two shafts. Couplings are classified into two main types viz. Rigid. and flexible and further classification as is shown




Rigid couplings are employed where shafts are properly aligned. Flexible couplings take care of small misalignment in the shaft axes, either lateral or angular, depending on the type of coupling.

**Machine Parts**

Pistons are sliding members in engines or pumps. In the case of engines, power is produced in the cylinder, and is transmitted to the crank shaft through piston and connecting rod. In the case of pumps or compressors, the piston is used to produce pressurized fluid which may be liquid or gas. Piston is also used in fluid motor, where pressurized fluid gives reciprocating motion to piston which can be converted into rotary motion by connecting rod and crank shaft.

**Wire Ropes**

Among the flexible elements used for hosting and hauling purposes, steel wire ropes are extensively used.

Wire ropes are manufactured from plough steel wires having ultimate strength of 1200 to 2400 $N/mm^2$. In the process of manufacture, wire ropes are subjected to special heat treatment, which combined with cold drawing, imparts high mechanical properties to the wire. Ropes intended for operation in damp premises are galvanized to protect them against corrosion.

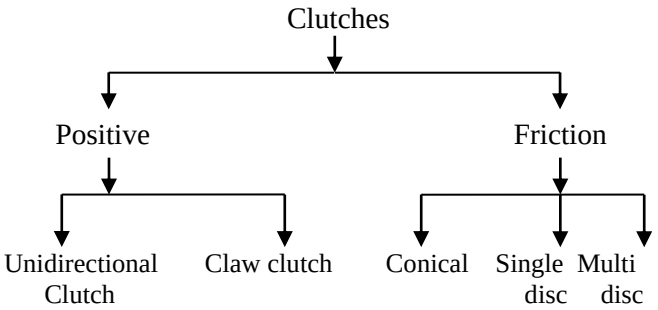
**Brakes**

The function of a brake is to control the motion of a machine or a machine member. A brake may be used to slow down, stop or hold a load or release a load and control its speed.

**Clutches**

Clutch is a device to effect engagement or disengagement between two shafts at will.

**Types of Clutches**




## Chain Drives

Chain drives are used to transmit power between two parallel shafts comparatively at a longer distance. The chain drive is in between the belt drives and gear drives.

Simple chain drive consists of two sprockets and an endless chain. Smaller sprocket is called pinion and bigger one called is called wheel. The sprockets are toothed wheels of special profile for teeth. In some cases idlers are used as tensioning device. The chain is made up of links, pins and bushings all fabricated from high grade steel with the pins and bushings ground to ensure accuracy of pitch.

## Belt Drives

Belts are flexible machine elements used for transmission of power between shafts at comparatively long distances. Belts run over the pulleys keyed to the driving and driver shafts. Power is transmitted by friction between the belt and contact surfaces of the pulleys.

## Types of Belts

There are basically five types of belts used for transmission of power.

1. Flat belts
2. V-Belts
3. Ribbed belts
4. Toothed belts and
5. Link belts.

## Bearings

Bearing is a machine member, which supports a moving part and confines its motion. They can be classified broadly into two, namely, sliding contact and rolling contact bearings. In sliding contact bearings, a lubricant, inserted or supplied between mating surfaces, reduces friction and wear and in some cases, carry away the heat generated. In rolling bearings, rolling motion is utilized to minimize friction. Types of sliding bearing commonly used are

1. Full journal bearing
2. Partial journal bearing
3. Thrust bearing (step, collar or conical)
4. Slider bearing and
5. Hydrostatic bearing.

## Spur and Helical Gear Drives

Gearing is the means of transmitting power through toothed wheels.

Toothed gears can be classified according to

1. Relative position of shafts such as shafts whose axes are parallel (spur, helical and herringbone), intersecting (straight bevel and spiral bevel) and non-intersecting (hypoid and worm).
2. Number of steps, single, two and multistage.
3. The relative motion of shafts, simple, planetary, differential etc.
4. Type of engagement, internal and external
5. Position of tooth in wheel rim such as spur, helical, herringbone and curved teeth.

## Bevel and Worm Gears

Bevel gears are used to transmit power between two intersecting shafts. Bevel gears are cut on conical pitch surfaces while spur gears are cut on cylindrical pitch surfaces.

Bevel gears are classified according to the pitch angle. Those having pitch angle, 8, less than $90^0$ are called external gears. Those having a pitch angle of $90^0$ are called crown gears. Those having a pitch angle greater than $90^0$ are called internal gears. In bevel gears if the pitch angles of mating gears are equal and $45^0$, they are called mitter gears.

## Spiral Bevel Gears

Bevel gears with teeth lying in spiral paths on the pitch cone are called spiral bevel gears. More than one pair of teeth are in contact simultaneously. Hence smoother and quieter action can be obtained in this type of gearing. Different pressure angles are used in order to obtain the best operating conditions for each velocity ratio.

## Hypoid Gears

Hypoid gears are similar in appearance to spiral bevel gears. The correct pitch surface for hypoid gears is the hyperboloid of revolution. In this type of gears, the axes of the shafts do not intersect. The advantages of this type of gears are the comparatively smoother action and the possibility of extending the shafts past each other so that bearings can be used on both sides of the gear and the pinion. This makes the drive more rigid and hence higher power can be transmitted than bevel gears.

## Skew Gears or Crossed Helical Gears

This comprises two helical gear wheels used to transmit torque between axes at right angles. Since in such a gear, the contact taking place is only a point contact, the power that can be transmitted is low and is limited to a few watts.

## Worm Gears

Worm gears are used to transmit power between non intersecting shafts whose axes are at right angles to each

other. In worm gears, the driving unit is an Archimedian screw whose cross-section will be a basic rack of pressure angle $20^0$. This is called worm and the driver member is called worm wheel or worm gear. This represents a helical gear with curved face to fit a portion of worm periphery.

### Gear Box

The toothed gears are used as independent units to reduce or increase the input speed. The unit is enclosed in rigid closed housings which support the shafts, hold lubricants inside, protect the gears from dust and moisture. Also the housing provide necessary cooling surface to dissipate the heat generated during operation. When the unit is used to get only one reduced output speed for a given input speed it is called a "Speed Reducer". While for one input speed more than one output speeds are obtained, the unit is called a Gear Box.

Speed reducers are widely used for reduction of speed in turbine generator set, rolling mills etc. Gear boxes are used in machine tools and automobiles.

### Multi-Speed Gear Box

In the case of machine tools, the cutting speed varies with the material of the job, cutting tool used, nature of operation etc. For optimum results, the cutting speed should be maintained within limits. In order that same machine tool may be used for different working conditions, provisions is necessary for changing the spindle speeds. This is achieved by employing a single motor and a gear box between the motor and work spindle.

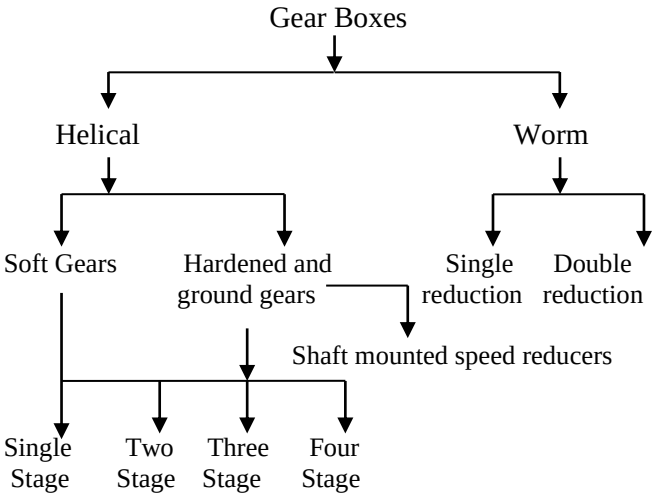
In the case of automobile, the engine should be running at economical speed range irrespective of speed of the vehicle. This is achieved by providing a multi-speed gear box between the engine and road wheels.

### Speed Changing

In the conventional gear box speed changing is obtained by sliding mesh gears. With reference to figure power is transmitted from driving shaft A to the driver shaft B through the compound sliding gear 1-3-5. By virtue of the position of compound gear, gear pairs 1-2, 3-4 or 5-6 can be engaged in turn and different speed ratios are obtained.

### Selection of Standard Gear Boxes

Helical and worm gear boxes are manufactured as standard units to transmit required power at an input speed and to provide required reduction. The standard gear boxes can be classified as follows.




### Power Screws

Power screws are power transmitting devices which convert rotary motion into rectilinear motion. It consists of a screw and nut. The screw is coupled to the power source and nut moves either direction depending on the direction of rotation and hand arrangement of screw thread. The work is connected to the nut to get required linear motion.

### Thread Forms

Thread used for power screws are Acme, Square and buttress, the shapes of which are shown in figure. V threads are not used because of their higher friction and consequent poor efficiency.

Out of these three thread forms, buttress thread is very suitable for unidirectional loads such as screw jacks etc. Square threads are more efficient than Acme or Trapezoidal threads. But square threads can be cut only in lathes and they are less sturdy than Acme and clearances caused by wear cannot be adjusted. Acme threads can be cut in thread milling machines and efficient cutting is possible. In practice, Acme and Trapezoidal threads are widely used for power screw application.

The selection of electric motors for high production is done for modern knitting machine.

### Classification of Electric Motors

Electric motors are classified as follows.

1. By source of supply
   i. Dc
   ii. 3 Phase AC
   iii. Single Phase AC
   iv. Stepper (pulsed supply)
2. By its winding
   i. Squirrel cage induction
   ii. Slip ring induction
   iii. Synchronous
3. By Mounting
   i. Foot mounted
   ii. Flange mounted
4. By speed

2880, 1440, 960, 740 rpm

## Characteristics of Motors

Any motor is specified by

i. Rated speed
ii. Torque at rated speed or KW at rated speed
iii. Frame size
iv. Mounting
v. Supply voltage and full load current
vi. Cooling and enclosure
vii. Class of insulation

In the case of slip ring motors, rotor voltage will be specified.

A typical torque speed characteristics of a squirrel cage induction motor is given below.

It can be seen from figure that an induction motor will develop torque with a specified slip. If torque exceeds pull out torque, then motor will stall. At synchronous speed, torque is zero.

## Factors Influencing Selection

The following factors influence selection of electric motors.

1. Average power required
2. Maximum torque required
3. Inertia of system
4. Frequency of starting / reversal
5. Mounting
6. Radial and axial loads
7. Duty cycle (number of hours of working per day)
8. Continuous or intermittent service

These are given in reference (7).

The various types of electrical development used in machines are push button switches, selector switches, drum switches, limit switches, rotary cam type limit switches, heavy duty limit switches, speed actuating sensing switches, solenoid valves. Other electrical development used are transducers, different types of motors, generators. Various generators are simple loop generator & other types motors used are DC motor, AC motors.

The various electrical equipments attached to the knitting machines are cloth lamp, spray oil lamp, yarn break lamp, low, fast speed, start, jog stop motors, safety door switch, fan, pump, the mechanical devices attached to the machine are spray oil continuous, interval, by the cycle methods.

The electronic devices attached to the machines are full digital control DSP CP. Variable jog rate frequency regulation enable/disable operation of setting, invertor, data storage, power cut fail operations output statistics A/B/C/D/E & gross, six yarn length counting, independent step length sitting function clock, calendar display, after heating of machine enable time range, knitting after stop, remaining time, cleaning time, separate time, speed of knitting power on, self test, manual detection of input/output signal in shut down, power on time, shut down time.

The electric functions are carried out using various electrical developed devices.

## Push Button Switches

It is a pilot device which provides control of equipment by pressing an actuator which looks like a button. Push button switch can be divided into two parts. One part is the mechanical actuator or button assembly and the second part is the electrical portion or contact assembly called the contact block.

Push button switches can be of different types depending upon the type of actuator assembly. They are:

- Recessed button type
- Mushroom head type
- Illuminated type
- Key lock type

Red push buttons are used for stop and emergency stop operations, while green push buttons are used for start operations. When two or three push button switches are mounted on a steel or plastic enclosure it is known as a push button station. For example, in a three push button station, one push button may be for running the motor in forward direction, the second for running the motor in reverse direction, and the third for stopping the motor.

## Selector Switches

The three different modes of operation may be Manual, Semi-automatic and Automatic. A selector switch will enable the operator to predetermine the manner in which his machine is to operate. As with push-button switches, selector switches also have two main parts, the mechanical actuator and the contact block.

## Drum Switches

Drum switches, also referred to as Master Controllers are identical in function but out of a different type of construction than selector switches. A selector switch uses components similar to a push-button while a drum switch consists of a shaft attached to the operating lever (actuator), which has a number of cams mounted on it.

## Limit Switches

Limit switch s an important control element. Limit switch contacts change over their position when its actuating lever or knob is actuated by the mechanical part of a machine. The mechanical part attached to the machine which actuates the limit switch lever or knob is known as actuator or dog. Limit switches are used to stop a particular movement, and initiate another movement. The simple application of a limit switch is in producing automatic to and fro movement of a planar machine bed shown in figure. It must be understood here that a limit switch is not used as a mechanical stop. A

limit switch controls the electrical signal which is responsible for mechanical stop/movement.

### Rotary Cam Type Limit Switches

In this type of limit switches, the contacts are mounted on the stationary frame. The cams, which have to actuate the contacts, are mounted on the rotating shaft. The position of the cams is adjustable. The rotating shaft is coupled to the driving motor of the machinery either through chain and sprockets or by gear arrangement.

### Heavy Duty Limit Switches

The basic difference between an ordinary limit switch and a heavy duty limit switch is that the former is used in the control circuit while the latter is used in the power circuit. Actuation of a heavy duty limit switch cuts off power supply to the motor. Heavy duty limit switch requires a minimum of two normally closed contacts because to stop a motor two phases have to be cut off. A heavy duty limit switch may be either lever type or rotary cam type.

### Speed Actuating Sensing Switches

These are also commonly known as plugging switches or zero speed switches. These switches have two sets of contacts, one each for either direction or rotation of the motor. The contacts for a particular direction of rotation open or close when a predetermined rotational speed in that direction is achieved. These switches are used in circuits where the motor is to be stopped quickly (i.e., to be brought to standstill quickly by plugging method of braking). In plugging, the motor is stopped by reversing its two supply leads till motor comes to standstill. The torque developed during reversing causes the motor to come to standstill in a short time.

### Solenoid Valves

Solenoid valves are electromechanical devices like relays and contractors. A solenoid valve is used to obtain mechanical movement in machinery by utilizing fluid or air pressure. The fluid or air pressure is applied to the cylinder piston through a valve operated by a cylindrical electrical coil. The electrical coil along with its frame and plunger is known as the solenoid and the assembly of solenoid and mechanical valve is known as solenoid valve. The solenoid valve is thus another important electromechanical device used in control of machines. Solenoid valves are of two types:

i. Single solenoid spring return operating valve
ii. Double solenoid operating valve

### Transducers (Pick UPS)

A transducer is an energy converting device that

- receives stimulation (signal) from a physical situation or condition that is the object of measurement (the measurand) and
- converts that stimulation into a definitely associated signal that is more appropriate to use as the input to a measurement system.

### Types of Transducers

The important types of transducers are listed below:

a) Primary transducers
b) Secondary transducers
c) Passive transducers
d) Active transducers
e) Elastic transducers
f) Analog transducers
g) Digital transducers
h) Electrical transducers
i) Mechanical transducers

### Generator Principle

An electrical generator is a machine which converts mechanical energy (or power) into electrical energy (or power).

### Types of Generators

Generators are usally classified according to the way in which their fields are excited. Generators may be divided into

a) Separately- excited generators and
b) Self Excited generators

**a) Separately- excited generators**

Generators are those whose field magnets are energized from an independent external source of d.c. current.

**b) Self- excited generators**

Generators are those whose field magnets are energized by the current produced by the generators themselves. Due to residual magnetism, there is always present some flux in the poles. When the armature is rotated, some e.m.f. and hence some induced current is produced which is partly or fully passed through the field coils thereby strengthening the residual pole flux.

There are three types of self-excited generators named according to the manner in which their field coils (or windings) are connected to the armature.

**i. Shunt wound**

The field windings are connected across or in parallel with the armature conductors and have the full voltage of the generator applied across them.

**ii. Series wound**

In this case, the field windings are joined in series with the armature conductors. As they carry full load current, they consists of relatively few turns of thick wire or strips.

Such generators are rarely used except for special purposes i.e as boosters etc.

**iii. Compound wound**

It is a combination of a few series and a few shunt windings and can be either short shunt or long shunt. In a compound generator, the shunt field is stronger than the series field. When series field aids the shunt field, generator is said to be differentially compounded. Various types of d.c generators have been shown separately.

## Basic Principle

A.C. generators or alternators (as they are usually called) operate on the same fundamental principles of electromagnetic induction as d.c. generators. They also consists of an armature winding and a magnetic field. But there is one important difference between the two. Whereas in d.c. generators, the armature rotates and field system is stationary, the arrangement in alternators is just the reverse of it. In their case, standard construction consists of armature winding mounted on a stationary element called stator and field windings on a rotating element called rotor.

Different a.c. motors may, however, be classified and divided into various groups from the following different points of view:

1. As regards their principle of operation
   - A) Synchronous motors
     - i) Plain
     - ii) Super
   - B) Asynchronous motors
     - a) Induction motors
       - i) Squirrel cage
         - Single
         - Double
       - ii) Slip – ring (external resistance)
     - b) Commutator motors
       - i) Series
         - Single phase
         - Universal
       - ii) Compensated
         - Conductively
         - Inductively
       - iii) Shunt
         - Simple
         - Compensated
       - iv) Repulsion
         - Straight
         - Compensated
       - v) Repulsion-start induction
       - vi) Repulsion induction
2. As regards the type of current
   - i. Single Phase
   - ii. Three Phase
3. As regards their speed
   - i. Constant Speed
   - ii. Variable Speed
   - iii. Adjustable Speed
4. As regards their structural features
   - i. Open
   - ii. Enclosed
   - iii. Semi-enclosed
   - iv. Ventilated
   - v. Pipe-ventilated
   - vi. Riverted frame eye etc.

Single phase motors may be classified as under, depending on their construction and method of starting

1. Induction motors (split-phase, capacitor and shaded pole etc.)
2. Repulsion motors (sometime called inductive-series motors)
3. A.C. series motor
4. Un-excited synchronous motors.

## Types of Capacitor-Start Motors

Some of the important type of such motors are given below

**1. Single-Voltage, Externally-Reversible Type**

In this motor, four leads are brought outside its housing; two from the main winding and two from the starting-winding circuit. These four leads are necessary for external reversing. As usual. internally, the starting winding is connected in series with the electrolytic capacitor and a centrifugal switch. The direction of rotation of the motor can be easily reversed externally by reversing the starting winding leads with respect to the running winding leads.

**2. Single-Voltage, Non-Reversible Type**

In this case, the starting winding leads are connected internally to the leads of the running winding. Consequently, there are only two external leads in such motors. Obviously, direction of rotation cannot be reversed unless the motor is taken apart and leads of the starting winding reversed.

**3. Single-Voltage Reversible and Thermostat Type**

Many motors are fitted with a device called thermostat which provides protection against over load, overheating, and short-circuits etc. The thermostat usually consists of a bimetallic element that is connected in series with the motor and is often mounted on the outside of the motor.

The wiring diagram of a capacitor-start motor fitted with this protective device is shown in figure. When due to some reasons, excessive current flows through the motor, it produces abnormal heating of the bimetallic strip with the result that it bends and opens the contact points thus disconnecting the motor from the supply lines. When the thermostat element cools, it automatically closes the contacts.

In this case of capacitor-start motors used for refrigerators, generally a terminal block is attached to the motor. Three out of the four block terminals are marked R, TL and L as shown in figure. Thermostat is connected to T and TL, capacitor between L and the unmarked terminal and the supply lines to TL and L.

4. **Single-Voltage, Non-Reversible with Magnetic Switch Type**

Such motors are commonly used in refrerattors where it is not possible to use a centrifugal switch. The circuit diagram is similar to that shown in figure. Since their application requires just one direction of rotation, these motors are not connected for reversing.

One disadvantage of a capacitor-start motor having magnetic switch lies in the possibility that slight overloads may operate the plunger thereby connecting the starting winding circuit to the supply. Since this winding is designed to operate for very short periods (3 seconds or less) it is likely to be burnt out.

5. **Two-Voltage, Non-Reversible Type**

These motors can be operated from two a.c. voltage either 110V and 220V or 220V and 440V. Such motors have two main windings (or one main winding in two sections) and one starting winding with suitable number of leads brought out to permit changeover from one voltage to another.

When the motor is to operate from lower voltage, the two main windings are connected in parallel. Whereas for higher voltage, they are connected in series. As will be seen from the above circuit diagrams, the starting winding is always operated on the low-voltage for which purpose it is connected across one of the main windings.

6. **Two-Voltage, Reversible Type**

External reversing is made possible by means of two additional leads that are brought out from the starting ending.

Figure shows connections for clockwise and anticlockwise rotations respectively when motor is operated from lower voltage. Similar wiring diagram can be drawn for higher voltage supply.

7. **Single-Voltage, Three-Lead Reversible Type**

In such motors, a two-section running winding is used. The two sections $R_1$ and $R_2$ are internally connected in series and one lead of the starting winding is connected to the mid-point of $R_1$ and $R_2$.

The second lead of the starting winding and both leads of the running winding are brought outside as shown in figure. When the external leadoff the starting winding is connected to pint A, the winding is connected across $R_1$ and the motor runs clockwise. When the lead of starter winding is connected to point B, it is connected across $R_2$. Since current flowing through starting winding is reversed, the motor runs in counter-clockwise direction.

8. **Single-Voltage, Instantly-Reversible Type**

Normally, a motor must be brought to complete rest before it can be started in the reverse direction. It is so because the centrifugal switch cannot close unless the motor has practically stopped. Since starting winding is disconnected from supply when the motor is running, reversal of starting winding leads will not affect the operation of the motor. This reversal is achieved by a triple-pole double-throw (TPDT) switch as shown in figure. The switch consists of three blades or poles which move together as one unit in either of the two positions. In one position of the switch (shown in one figure) motor runs clockwise and in the other, incounter-clockwise direction. Obviously, in this type of arrangement, it is necessary to wait till motor stops.

In certain applications where instant reversal is necessary while the motor is operating at full speed, a relay is fitted in the circuit to short-circuit the centrifugal switch and connect the starting winding in the circuit in the reversed direction.

It will be seen that when at rest, the double-contact centrifugal switch is in the ‘start’ position. In this position, two connections are made:

1. the starting winding and capacitor C are placed in series across the supply line and
2. the coil of the normally-closed relay is connected across C.

With the TPDT switch in the ‘forward’ position (a) running winding is connected across the line (b) starting winding and C are in series across the line and (c) relay coil is connected across C. The voltage developed across C is applied across the relay coil which results in opening of the relay contacts. With increase in the speed of the motor, the centrifugal switch is thrown in the ‘running’ position. Thos cuts out C from the circuit and leaves starting winding in series with the relay coil. Since relay coil has high resistance, it permits only enough current through the starting winding as to keep the relay contacts open.

During the fraction-of-a-second interval while TPDT switch is shifted from ‘forward’ to ‘reverse’ position, no current flows through the relay coil as aresult of which the relay contacts close. When TPDT switch reaches the ‘reverse’ position, current flows through the now-closed relay contacts to the starting winding but in opposite direction. This produces a torque which is applied in a direction opposite to the rotation. Hence, (i) rotor is immediately brought to rest and (ii) centrifugal switch falls to the ‘start’ position. as before, C is put in series with the starter winding and the motor starts rotating in the opposite direction.

9. **Two-Speed Type**
   Speed can be changed by changing the number of poles in the winding for which purpose two separate running windings are placed in the slots of the stator, one being 6-pole winding and the other, 8-pole winding. Only one starting winding is used which always acts in conjunction with the higher speed running winding. The double action or transfer type centrifugal switch S has two contact points on the 'start' side and one on the 'run' side. An external speed switch is used for changing the motor speed. The motor will always start on high speed irrespective of whether the speed switch is on the 'high' or 'low' contact. If speed switch is set on 'low', then as soon as the motor comes up to speed, the centrifugal switch

a) cuts out the starting winding and high-speed running winding and
b) cuts in the low-speed running winding.

10. **Two-Speed with Two-Capacitor Type**
    This motor has two running windings, two starting windings and two capacitors. One capacitor is used for high-speed operation and the other for low-speed operation. A double centrifugal switch S is employed for cutting out the starting winding after start.

## Repulsion Type Motors

### 1. Repulsion Motor

It consists of (a) one stator winding (b) one rotor which is wound like a d.c. armature (c) commutator and (d) a set of brushes, which are short-circuited and remain in contact with the commutator at all times. It operates continuously on the 'repulsion' principle. No short-circuiting mechanism is required for this type.

### 2. Compensated Repulsion Motor

It is identical with repulsion motor in all respects, except that (a) it carries an additional stator winding, called compensating winding (b) there is another set of two brushes which are placed midway between the usual short circuited brush set. The compensating winding and this added set are connected in series.

### 3. Repulsion-Start Induction- Run Motor

This motor starts as a repulsion motor, but normally runs as an induction motor, with constant speed characteristics. It consists of (a) one stator winding (b) one rotor which is similar to the wire-wound d.c. armature (c) a commutator and (d) a centrifugal mechanism which short-circuits the commutator bars all the way round (with the help of a short-circuiting necklace) when the motor has reached nearly 75% of full speed.

### 4. Repulsion Induction Motor

It works on the combined principle of repulsion and induction. It consists of (a) stator winding (b) two rotor windings: one squirrel cage and the other usual d.c. winding connected to the commutator and (c) a short-circuited set of two brushes.

## Universal Motor

A universal motor is defined as a motor which may be operated either on direct or single-phase.

In fact, it is a smaller version (5 to 150 W) of the a.c. series motor described in Art.36.16. Being a series-wound motor, it has high starting torque and a variable speed characteristic. It runs at dangerously high speed on no-load. that is why such motors are usually built into the device they drive.

Generally, universal motors are manufactured in two types:

1. Concentrated-pole, non-compensated type (low power rating)
2. Distributed-field compensated type (high power rating).

## Speed Control of Universal Motor

The following methods are usually employed for speed-control purposes:

**a) Resistance method**
The motor speed is controlled by connecting a variable resistance R in series with the motor. This method is employed for motors used in sewing machines. The amount of resistance in the circuit is changed by means of a foot-pedal.

**b) Tapping-Field method**
In this method, a field pole is tapped at various points and speed is controlled by varying the field strength. for this purpose, either of the following two arrangements may be used
i) The field pole is wound in various sections with different sizes of wire and taps are brought out from each section.
ii) Nichrome resistance wire is wound over one field pole and taps are brought out from this wire.

**c) Centrifugal Mechanism**
Universal motors, particularly those used for home food and drink mixers, have a number of speeds. Selections is made by a centrifugal device located inside the motor and connected. The switch is adjustable by means of an external lever. If the motor speed rises above that set by the lever, the centrifugal device opens two contacts and inserts resistance R in the circuit, which causes the motor speed to decrease. When motor runs slow, the two contacts close and short-circuit the resistance, so that the motor

speed rises. This process is repeated so rapidly that variations in speed are not noticeable.

The resistance R is connected across the governor points as shown in figure. A capacitor C is used across the contact points in order to reduce sparking produced due to the opening and closing of these points. Moreover, it prevents the pitting of contacts.

### Hysteresis Motor

The operation of this motor depends on the presence of a continuously-revolving magnetic flux. Hence, for the split-phase operation, its stator has two winding which remain connected to the single-phase supply continuously both at starting as well as during the running of the motor. Usually, shaded pole principle is employed for this purpose giving shaded pole hysteresis motor. Alternatively, stator winding of the type used in capacitor-type motor may be used giving capacitor type shaded pole motor.

### Unexcited Single-phase Synchronous Motor

These motors

1. Operate from a single phase a.c. supply
2. Run at a constant speed-the synchronous speed of the revolving flux
3. Need no d.c. excitation for their rotors (that is why they are called unexcited)
4. Are self-starting

These are of two types (a) reluctance motor and (b) hysteresis motor.

### Stepper Motors

These motors are also called stepping motors or step motors. The name stepper is used because this motor rotates through a fixed angular step in response to each input current pulse received by its controller. In recent years, there has been wide spread demand of stepping motors because of the explosive growth of the computer industry. Their popularity is due to the fact that they can be controlled directly by computers, microprocessors and programmable controllers.

### Types of Stepper Motors

There is a large variety of stepper motors which can be divided into the following three basic categories:

1. **Variable Reluctance Stepper Motor**
   It has wound stator poles but the rotor poles are made of a ferromagnetic material. It can be of the single stack type or multi-stack type. Which gives smaller step angles. Direction of motor rotation is independent of the polarity of the stator current. It is called variable reluctance motor because the reluctance of the magnetic circuit formed by the rotor and stator teeth varies with the angular position of the rotor.

2. **Permanent Magnet Stepper Motor**
   It also has wound stator poles but its rotor poles are permanently magnetized. It has a cylindrical rotor. Its direction of rotation depends on the polarity of the stator current.

3. **Hybrid Stepper Motor**
   It has wound stator poles and permanently-magnetized rotor poles. It is best suited when small step angle of $1.8^0$, $2.5^0$ etc. are required.
   These are given in reference (8).

Various electronic devices developed are used in knitting machines. They are selected according to the required purposes. Various developments of the electronic devices are electrical indicating and test instruments. Variable conversion elements, signal transmission, digital computation and intelligent devices, display, recording and presentation of measurement data, measurement reliability and safety systems, sensor technologies, temperature measurement, pressure measurement, flow measurement, level measurement, mass, force and torque measurement, translational motion transducers, rotational motion transducer.

According to the requirement electronic devices are selected and used in knitting machines with programmable logic controller attached to the machine, the various operations are controlled in the machine. These are given in reference (9).

## RESULTS AND DISCUSSIONS

The old knitting machine production calculations are given in the paper. New knitting machine production calculations is also given in the paper. The feature of old and new knitting machines are given here. The cost of production of old and new knitting machines are calculated from the data. It has been foundthat the profit of new knitting machine per hour is Rs. 2000/- higher than the old knitting machine. It can be due to mechanical features, electrical and electronic features added to the new machines. The various mechanical features are discussed in the paper. The identification of suitable features is essential in designing our own knitting machine. The purchase of new knitting machines is costly. Anyhow developments can be made with suitable research. The electrical developments used are applied here. They can be manufactured with suitable identification and fitted in our new making of machines. Although electronic developments does not contribute to increase in production, they are used for convenience, quick response and other extra work with sensors. Together

with these three developments higher production is achieved is new foreign developed knitting machines.

## CONCLUSIONS

The use of knitting foreign developed machine gives higher profit. So to cope with the new situation the mingling of syllabus with textile, mechanical, electrical and electronics is essential. Indian companies should manufacture quality machines with all developments.

## REFERENCES

1. Knit Structures – I Practical, EIT Polytechnic College, Kavindapadi
2. https://www.textilecalculations.com / production – calculation - of - knitting/
3. Basics weft Knitting practical, EIT Polytechnic College, Kavindapadi
4.https://textiledetails.com/single-jersey-circular-knitting-machine/
5. List https://textilelearnerss.net/
6. https://www.indiamart.com/proddetail/knitting-machine-control-panel-20189716362.html
7. T.V. Sundararajamoorthy, N.Shanmugam, "Machine Design", M.Sethuraaman, Anuradha Agencies, Publisher, 2003
8. B.L.Theraja, A.K.Theraja, "Electrical Technology Ac & DC MAchines", Vol II, S.Chand and company ltd, 2020
9. Allan S Morris, "Measurement and Instrumentation principles", Butterworth-Henemann an inprint of esevier, 2009.

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