Optimization of Power Consumption In Cone Winding Machines

A Project Report

Submitted by

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KUMARAGURU COLLEGE OF TECHNOLOGY
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BONAFIDE CERTIFICATE

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DEPARTMENT OF MECHANICAL ENGINEERING
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VIJAY ENGINEERING WORKS

Manufacturers of : CONE WINDING MACHINES, HIGH SPEED CONE WINDING, DOUBLER WINDING & DOUBLING MACHINES,
ALL CONE WINDING SPARES, AUTO CONER SPARES, RIG SPARES AND SHEET METAL WORKS ETC.,
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Date : 19-04-2006

TO WHOMSOEVER IT MAY CONCERN

This is to certify that the following students

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3. P.Vijay Kumar 02ME63

Of Final year Mechanical Engineering, Kumaraguru College of Technology, Coimbatore have completed a project entitled "Optimization of Power Consumption in Cone Winding Machines" in our concern. It is acknowledged that their proposals have been accepted and implemented in our concern.

Company Guide

for Vijay Engineering Works

Proprietor

ABSTRACT

Food, Shelter and Clothes are the three essential components of human life. Diminution of the production cost of any these elements lead to melioration of mankind. Our project deals with the optimization of power consumption in conventional cone winding machines. By doing this the cost of the yarn which is the raw material in apparel industry is cut down and thereby leading to reduction of the cost of the clothes.

Through the project it is aimed to study every aspect of the present cone winding machine and determine various ways by which the power consumption of the cone winding machine can be optimized. The scope was restricted to the implementation of a feasible method and fabrication of the proposed machine.

Replacing the two 5 hp motors which is used in the present machines with a single 7.5 hp motor and redesigning the entire drive mechanism of the machine to incorporate the changes made in the drive are the solutions that were provided to optimize the power consumption. Also it has been proposed to replace the V belts in use by Timing and Ribbed belts and also the Ball bearings by Needle or Cylinder bearings.

In the present setup, ribbon breakers are used to avoid the undesirable overlapping of the yarn on the cone. This leads to switching on/off the motor 34,560 times a day. It has been proposed to use an inverter. The inverter helps in varying the frequency of the supply to the motor and by this the rpm of the motor can be varied which avoids forming of ribbons on the cone. And this is done with power saving than the present setup.

So, with the power consumption reduction in our minds and country's growth in our hearts we were motivated to take up this innovative project work with keen interest and enthusiasm.

ACKNOWLEDGEMENT

We thank Dr.T.P.Mani Ph. D., our able guide & Head of the Department for his helpful suggestions, valuable guidance and positive criticisms, throughout the way, which helped us to complete our project successfully. He was the propelling force behind a motivated team.

We are much obliged to Dr.K.K.Padmanaban Ph. D., our revered principal for acknowledging our efforts.

We would be failing in our duty if we do not express our sincere gratitude to Mr.V.R.SivaKumar M.E., Senior Lecturer, who had been instrumental in every stage of completion of our project.

We are deeply indebted to Mr.Vijayakumar B.E., Design Engineer, Vijay Engineering works, Avarampalayam, Coimbatore for his contribution in terms of valuable suggestions and complete external guidance.

We also express gratitude to our staff members and fellow students and parents for making this project a success.

CONTENTS

LIST OF TABLES

LIST OF FIGURES / GRAPHS / PHOTOS

CHAPTER 1

INTRODUCTION

1.1 COMPANY PROFILE:

The Vijay Group of Industries started out as trading company with a substantial capital of Rs.15,000 in 1978 under the stewardship of Mr.V.Ponnusamy.

In the eighties the Vijay group diversified into manufacturing of Borewell Adaptors and Job Orders.

It was however, in 1985 that the Vijay High Speed Cone Winder was launched. This machine was so overwhelmingly successful in terms of smooth operation & quality of packages produced & so well received by the entire Textile Industry that it soon became the leading manual Cone Winding Machine- a position & reputation it enjoys even today.

The nineties saw the launch of Vijay High Speed Doublers/Parallel Winder and Vijay Ring Doubling Machine. Both were a roaring success.

After '95, Vijay Cone Winders are being exported to neighbouring foreign countries like Bangladesh and Nepal.

Customer satisfaction through quality, service, continuous R & D, their adherence to schedule & high machine uptime is what has always mattered the most at Vijay in this long journey spanning over three decades. The group is managed by the revered Vijay family under the able leadership of Mr.V.Ponnusamy.

Today, with a strength of about 150 employees, manufacturing area of 3000 sq meters. & a turnover of over Rs.40 millions, the Vijay group is well poised to serve the needs of Indian & International Textile Industry.

1.2 INTRODUCTION TO THE PROJECT:

The project was done in the Cone Winding machine. Cone winding section is the last stage in the processing of the yarn. The scope of the project was limited to meliorate the efficiency of the machine just by concentrating on the gear end of the machine.

The following are the major components constituting the gear end of the machine:

1. Two 5 hp motors
2. One ribbon breaker
3. Three V belts
4. V-Belt Pulleys (cast iron)
5. Bearings

Among these the components of the gear end of the machine consuming power are the two motors being used to drive the drum shafts and the ribbon breaker. It has been established that the motors are oversized and the ribbon breaker is a major cause for increase in power consumption. It has been decided to reduce the overmotoring of the machine and also replace the ribbon breaker by an inverter. Implementation of these methods would result in reduced power consumption and power bills.

1.3 BACKGROUND OF THE PROBLEM:

Textiles have such an important bearing on our daily lives that everyone needs to know something about them. From time immemorial, people have used textiles of various types for covering, warmth, personal adornment and even to display personal wealth. Today, textiles are still used for these purposes and everyone is an ultimate customer. We use textiles in some form even if we are not the direct purchaser. Many industries, such as the automobile industry, are important customers of textiles in various forms. Some other consumers are home makers, dress makers, interior decorators and retail store customers.

Energy is a depleting commodity and with the increase in human activity, the use of energy consuming activity cascades. Energy, for the past few decades has become the most critical problem facing the industry. This is because; the supply of commercial fuels is tinged by uncertainties, high costs as well as the threat of depletion under growing demands. Therefore, for a more realistic energy situation new energy paths have to be found and titanic efforts have to be made to expand indigenous energy supplies from both conventional and non-conventional sources.

In a recent energy survey conducted by NPC (National Productivity Council), it was revealed that there is a good scope of energy saving in textile mills to the extent of about 5-10 % in electrical energy and 15-30 % in thermal energy. The problem with the textile mills is that the energy conservation activity has not been given the priority it deserves.

The present mode of power consumption in the textile industry is based on the pattern practiced during days when power was available at inexpensive rates. The situation now has changed, the cost of energy has escalated and therefore methods to preserve, conserve and to stretch energy have to be sought after.

From the studies conducted on the present cone winding machine it has been found that the motors being used to drive the drum shafts are oversized i.e. the problem of overmotoring is prevalent in the machine. Also it was established that the alternate switching on/off the motor by the ribbon breaker increases the current drawn by the motor, thereby increasing the power consumption of the machine. Adding to the woes of the industry people, is the problem of overheating because of the ribbon breaking mechanism used, leading to frequent burnouts of the motors and also reduced belt life. The project deals with optimizing the power consumption of the machine, by reducing the overmotoring and changing the ribbon breakers in use, so that the power bills are reduced.

1.4 IMPORTANCE:

In the past few decades there has been a notable shift in the market from being a manufacturer oriented one to customer oriented one. Therefore, in this advantage customer market, it is necessary for every manufacturer to satisfy the demands of the customer fully and also provide some attractive value added services. Moreover the competition has increased tremendously. So manufacturers have to produce the machine in a cost efficient manner to make profits or else provide a better service at the same cost to sustain their concerns.

By and large, textile machineries use electrical motors as their prime mover. It is pertinent to note that most of the design concepts used in the present textile machines are those plagiarized ones from the developed countries decades ago. The dismal situation is that, no modifications have been made in these antique machineries to suit the present day requisites.

In India, the organized textile industry compromising the composite mills and spinning mills consume millions of tones of coal and fuel oil. The costs of these fuel oils, coal and electricity bills account for thousands of crores every year. In this alarming scenario, a mere saving of about 5% is a substantial amount and it will be a reward to the country and a shot in the arm to the energy thirsty industry.

Because of the increased power consumption of the machine which in turn means increased power bills, the final cost of the yarn produced in the mill spirals up. It is hard to sustain in a highly competitive market with such an inefficient machine. Our proposals will surely bring down the power consumed by the machine, thereby cutting down the power bills which will result in reduction of production cost of the yarn. With a power saving machine, marketing it becomes an easy job and the market presence of the concern also increases. Our ideas will definitely help the concern to increase both its market share and customer base.

1.5 SCOPE

There is a wide scope for this project since the power consumption of the machine is brought down which implies lesser power bills than the competitors' machines. Also the payback period of the modified machine is just 15 months. A new machine incorporating the changes has a lesser payback period of just $4^1/_2$ months.

The other benefits of the projects are listed down which would add profit.

1. Reduced power bills since lesser power is consumed.
2. Reduced yarn cost.
3. Increase in the belt life.
4. Lesser burnouts of the motor.
5. Inverters are used to substitute the ribbon breakers which would ensure that there is not much overheating of the motors.

CHAPTER 2
LITERATURE SURVEY

LITERATURE SURVEY

The design of the present machine is what was conceptualized years ago in developed countries. The manufacturers of textile machineries in our countries copied the design from those developed countries. Since in the early days the manufacturers were monopolizing the industry in their regions, they did not resort to any measures to modify the machines to keep up with the pace of developing technology. But recently many industries have mushroomed up. So, the manufacturers have been forced to make their machines unique and efficient, than the competitors', in their own way.

Battacharya (1976) of Northern India Textile Research Association (NITRA) has modified the design of Lancashire Boilers for better efficiency in the Mahaveers Composite mill. After making a thorough study on the few Lancashire boiler installations and their operation practices, it was realized that there is enough scope for saving of fuel by adopting small modifications in the system.

Study on modification work involved the following steps:

1. Initial collection of boiler data and their performance for the past few years
2. To study and take trials to find out existing performance level of boilers and to assess various losses
3. Drawing up of a schedule of modification work to be done phase wise.
4. To carry out modification work and quantify the gains by modified trials & see that the system is sustained for continuous running.

Rai (1993) of National Productivity Council, Ahemedabad has done a study on "Cost Reduction by Integrated Electrical Energy Conservation Approach". In a recent energy survey conducted by NPC (National Productivity Council), it was revealed that there is a good scope of energy saving in textile mills to the extent of about 5-10 % in electrical energy and 15-30 % in thermal energy. The problem with the textile mills is that the energy conservation activity has not been given the priority it deserves.Power saving was achieved by,

1. Changing of 25 mm spindle wharve dia to 22 mm or 20mm wharve dia as per studies conducted by research associations there is a saving of 8 to 10% which is attractive.
2. Use of polypropylene/polycarbonate bobbins which are lighter, smoother and longer lasting. These bobbins give about 2-3% power saving.

Since doubling/winding machines account for just 11% of the total power sparse attention was paid to power consumption reduction measures in these machines. Much attention was paid to ring frames that accounted for 64% of the total power consumption. So we were motivated to take up this project to identify possible areas of power saving and suggest a few methods to achieve it.

CHAPTER 3

STUDY OF THE EXISTING SETUP

3.1 MILL CONFIGURATION

The mills receive raw fibre in bales or boxes, spin them into yarns through a series of process operations and wind the yarn into various package configurations according to the needs of the fabric forming processes. A typical cotton spinning system includes the step from input at raw cotton through winding. This process is used for both cotton and cotton type synthetics, polyester. This fabric forming and finishing steps are described in the coming paragraphs.

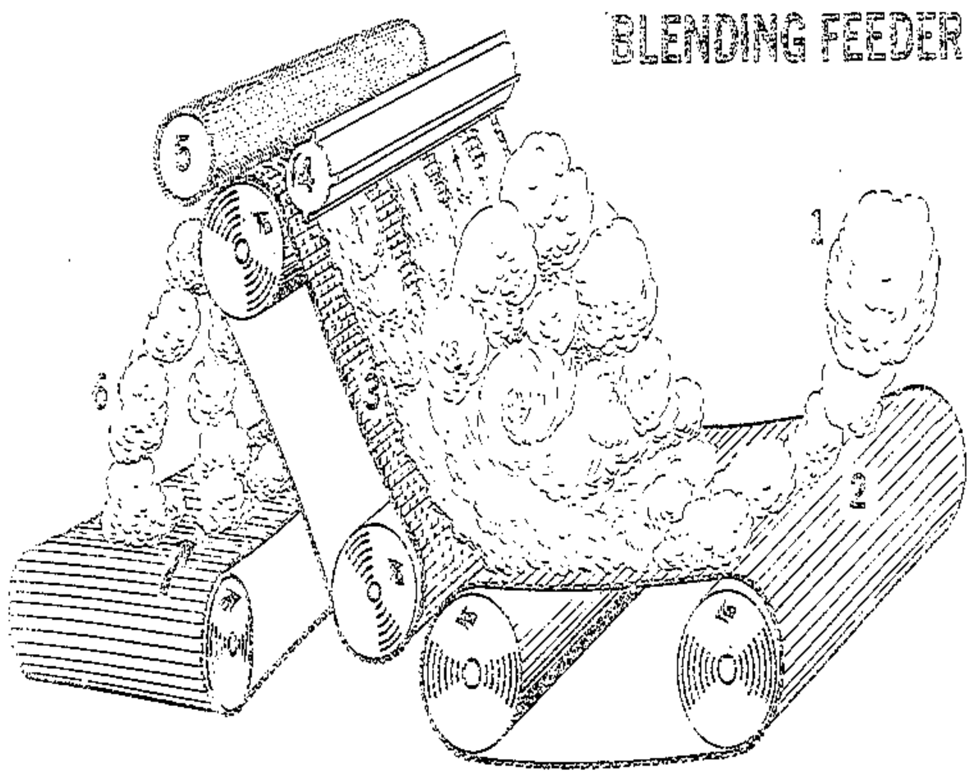


FIG 3.1 BLENDING FEEDER

3.1.1 Opening & Cleaning

Opening and cleaning are the initial operations performed on the incoming raw materials. The incoming raw fibre is so tightly compressed together that mechanical action is needed to separate clumps of fibres small enough for further processing. Raw cotton, in addition contains a significant percentage of unwanted leaf and trash from the cotton plants. If synthetic fibres are to be blended with cotton, they maybe meshed before processing by a blender feeder. But they are usually processed separately for the first few operations because they require less cleaning than the cotton.

The opening line is used to bream up the fibre into small clumps and to do part of the cotton cleaning. The raw fibre from bales or boxes is fed manually in large clumps onto one or more speed aprons or conveyors that carry the fibre to the sketchers. Each u/c in the spinning line is equipped with one or more feed aprons or conveyors that carry fibre to the opener. Each u/c in the aparting line is equipped with one or more rotating beaters with coarse teeth to shred small tufts of fibre from the incoming mass of fibre as it is fed between pressure rolls. Stock caught on the teeth of a beater is brushed against grid bars, where dislodged pieces of trash may fall. Beyond the opening line the stock is pneumatically transported to the feed hoppers of two or three pickers. The opening line propper may consist of only one machine for synthetic fibres or two or three different machines for cotton. Some newer mills have installed bale plucker machines that automatically pluck or tear fibre clumps from several entire bales of cotton at once.

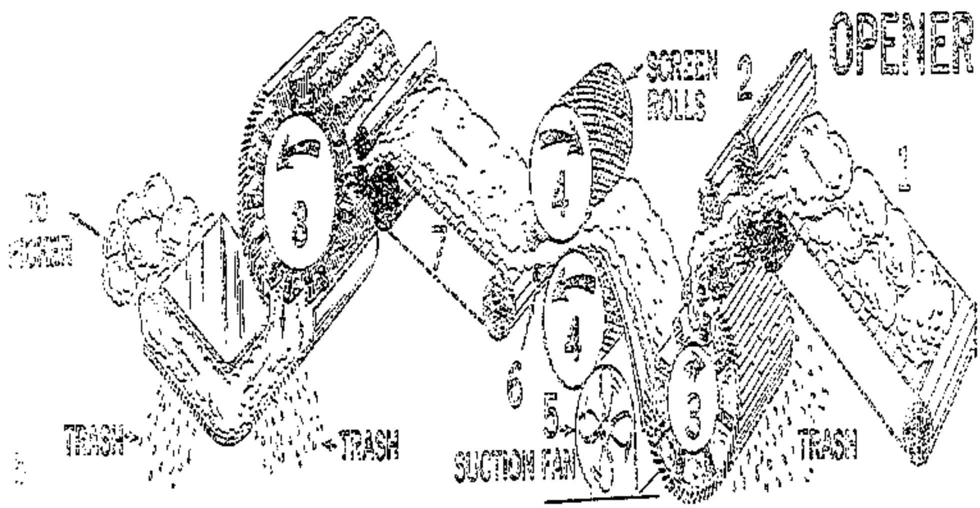


FIG 3.2 OPENER

3.1.2 Picking

The picker includes a hopper feed section with provision for controlling the weight of material fed per unit time. Most pickers have two very similar sections consisting of a feed apron, knurled pressure rolls, a beater working against grid bars and a pair of open work cylinders with suction to trap the filter when it leaves the beater. Older pickers compressed the output layer of fibre into a lap about half an inch thick and four feet wide that was rolled up for delivery to carding machines. Specially yarn mills continue to make picker laps but most of the commodity yarn mills, on the other hand have converted to automatic systems in which the fibre output from the picker is conveyed pneumatically to the chute feed units behind several carding machines.

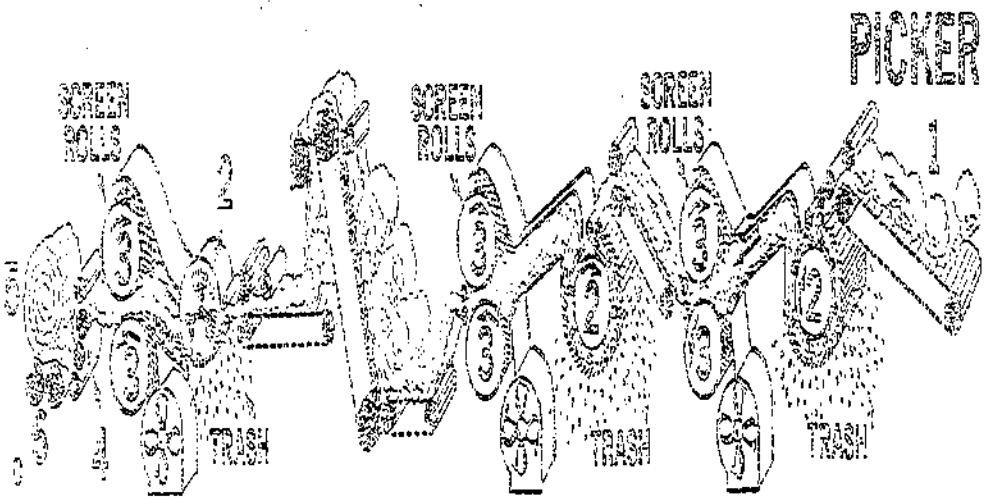


FIG 3.3 PICKER

3.1.3 Carding

Carding completes the separation of the original fibre mass into individual fibres, continues the process of trash removal and converts the material to a rope like sliver. While an opening line may produce a well over 1000 pounds of opened fibre per hour, the production of each picker is in the range of 300 to 500 pounds per hour. Whether from lap or chute the incoming fibre layer feeds through a pair of knurled feed rolls into the working zone of a toothed roll, the dickering which brushes the fibre tufts against the grid bars. The fibres then are carried around on a very large cylinder, usually 50 inches in diameter. The main cylinder of the card is surfaced with close set windings of toothed wire similar to a band saw blade. Its rotational speed is so high that a veritable fibre to fibre separation of the fed clumps is achieved. The fibres brush against wire surfaced flats that tend to trap some short fibre and trash, which they transfer to a smaller doffer roll. A vibrating comb or pneumatic mechanism removes a tenuous web of fibre from the doffer. The web may go through a pair of crusher rolls for cotton which tend to fragment any remaining vegetable trash and then into a condenser to form the sliver that is finally coiled into a sliver can.

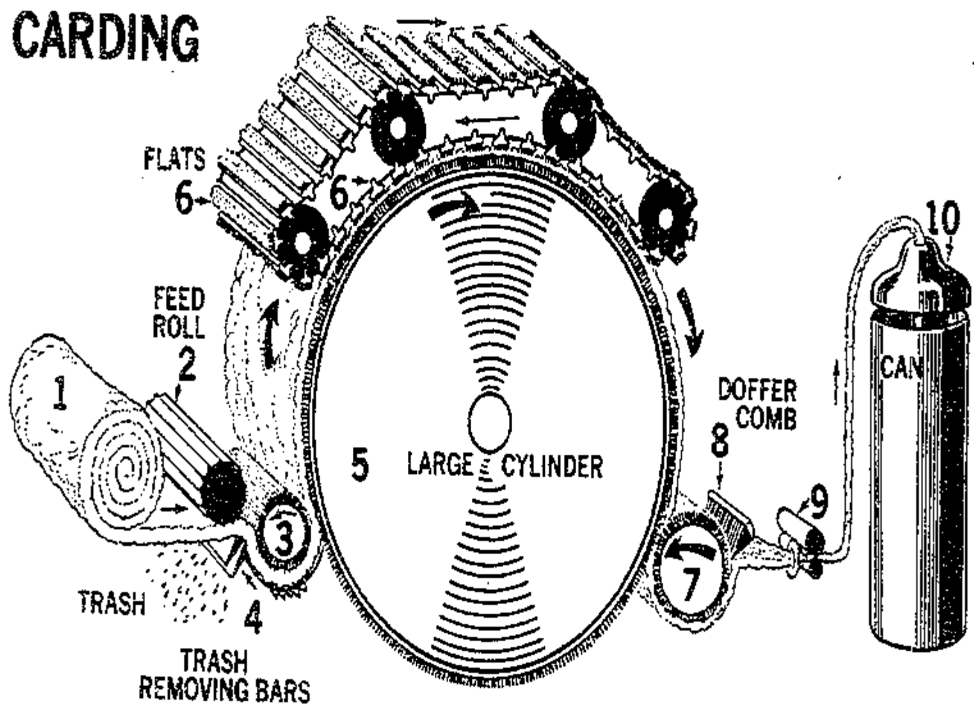


FIG 3.4 CARDING

3.1.4 Drawing

Usually the slivers are processed thrice through the next type of machine, the drawing frame. Either 6 or 8 slivers are fed together through four pairs of drafting rolls arranged so that each successive turns ay higher speed. The total speed change, or draw ratio is generally equal to the number of slivers. A web of fibre emerging from the front rolls is condensed into sliver again and coiled into a can. An electronic feedback mechanism or auto leveler monitors the uniformity of the material being processed and adjusts the rolls speeds to maximize the uniformity of the output sliver. Not only does fixed drawn sliver have improved uniformity but also the fibres are much more aligned in parallel by the drawing operation. The most common method of blending cotton with man made fibres (E.g. Polyester) is to feed card sliver of the different blend components at the first drawing operation. In most cases sufficient blend uniformity is achieved between that point and yarn spinning to prevent any barber pole effects in the yarn after dyeing.

In the manufacture of combed yarns, two extra process steps are added to the drawing sequence prior to drafting. Lapping produces a rolled layer of fibre about eight inches wide the sliver lap. The second is the combing itself.

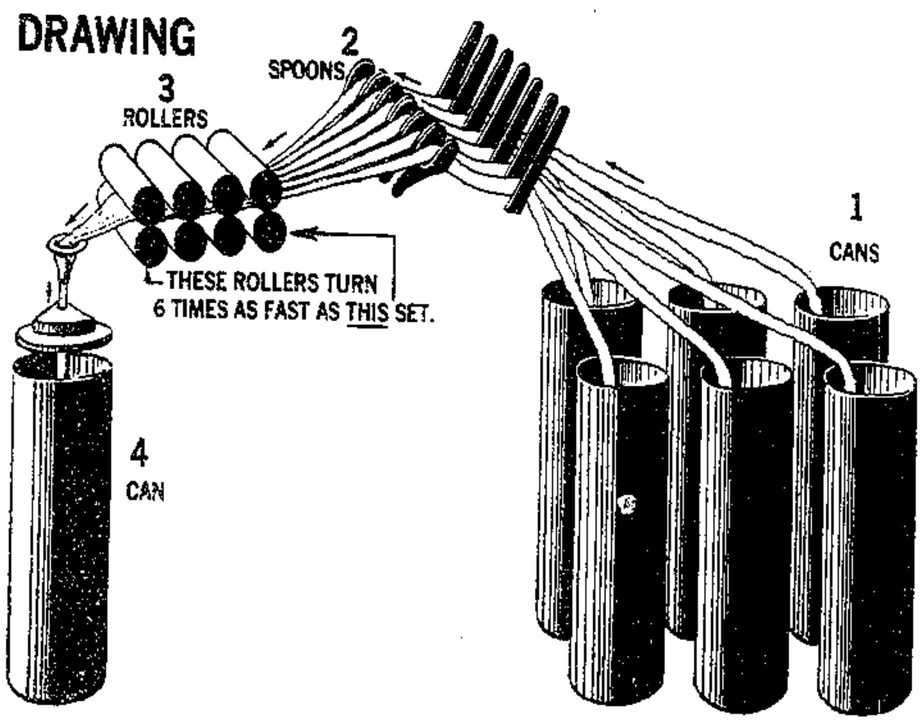


FIG 3.5-DRAWING

3.1.5 Combing

Combing is literally a process in which some shorter fibres are rendered extremely parallel. The process maximizes the strength and luster of resulting yarns and is usually applied to naturally long fibred cottons. Noils, the waste fibre from combing contains much spinnable short fibre that can be used in non combed cotton.

3.1.6 Roving

Although some sliver to yarn spinning machines have been used in industry in cotton spinning, a roving is always made from the final drawing sliver or combed sliver. Each of the ninety six processing positions on the roving frame is fed with a single sliver or occasionally two slivers.: The emerging roving passes through a rotating flyer to the winding point on bobbin. The bobbin itself fits over a rotating spindle whose speed is controlled so that the speed of the bobbin always differs by a fixed amount from the speed of the flyer. The effect is to insert enough twist into the roving to give it adequate mechanical strength for feeding into the spinning frame. Having opened, cleaned and blended the raw material and oriented the fibre into even narrow slivers through carding, lapping, drawing and roving, the fibres are now ready to be spun into yarn by means of ring spinning or newer open end spinning method.

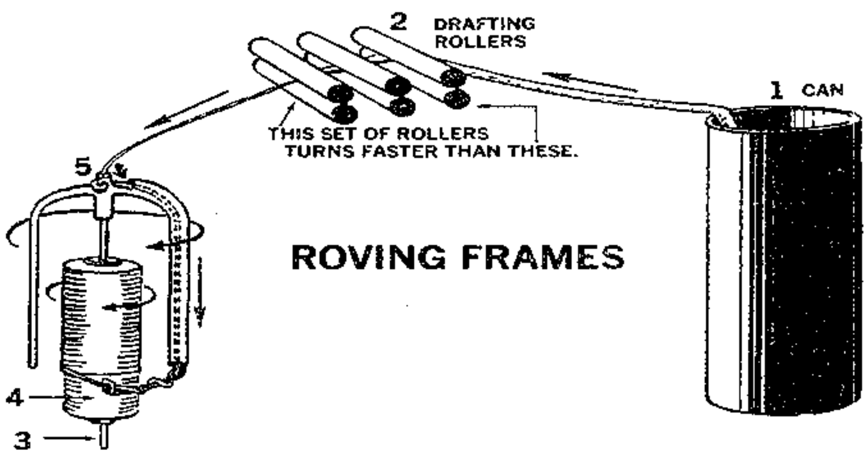


FIG 3.6 ROVING

3.1.7 Spinning

The ring spinning, bobbins of roving are suspended over spindled of a ring spinning frame. The roving feed passes between pairs of drafting rolls traveling at increasing speed to draw the roving before twist insertion. Because length uniformity of yarns is desirable much effect has gone into the twist technology of the spinning frame. Each spinning spindle carrying a bobbin for the yarn rotates at a speed of 15000 rpm or more. Above the rail hoarding, the row of spindles there is the vertically movable "ring rail" with circular apertures through the spindle bobbin project. Each aperture about three inches in dia. holds a flag ring around which moves a tiny C shaped wire traveler. Yarn emerging from the drafting roll passes around the traveler and hence on to the bobbins. During the time that an inch of yarn emerges from the front rolls, the spindle may rotate thirty times. Almost all the rotation inserts twist into the yarn because during the time the slower speed o the traveler will allow just one inch of yarn to warp on to the bobbin.

During spinning the entire ring rail moves vertically in a programmed way to wind the yarn on to the bobbin in an optimum configuration. Most modern spinning frames are equipped with automatic mechanisms, or doffers, to remove the bobbins and replace them with empty bobbins when the spinning cycle is complete.

Open end break spinning refers to any staple yarn manufacturing process in which there is a break in continuity between the feed material and the end of the forming yarn. Fibres travel individually between the feed and the yarn end. They may be guided by centrifugal force and air currents, as in the commercially successful rotor spinning. Units or other methods such as air or liquid vortexes, static electricity (which also aligns the traveling fibres in parallel) and various mechanical arrangements may be used.

The cost per spindle was ten times that of a ring spindles. While the production rate 0.15 pound per hour for average cotton yarn was only about five times that of ring spinning. However open end spinning machine is fed with sliver instead of roving and the open end spun yarn appears to have advantages in some important end uses. Another advantage of the open end machine is that if produces a large package of yarn, thus reducing the frequency of doffing and after eliminating any need for rewinding. The most rapid growth of open end spinning is in the manufacture of coarser yarn sizes where the doffing and rewinding costs are greatest.

Ring twisting frames are similar to spinning frames but without drafting rolls and with provision for feeding more than one yarn to a spindle. Hollow spindle twisting frames are used to warp covering yarns about a cone yarn to form piled yarns. Novelty attachments on twisting or frames can be used insert various sized bundles of fibre (called "nubs", "slubs", "slugs") that will be used to form fabrics with unique textures. Ring twisters are used to make two-ply or multi-ply yarns including sewing threads as well as fancy twisted yarns with loops or other irregularities.

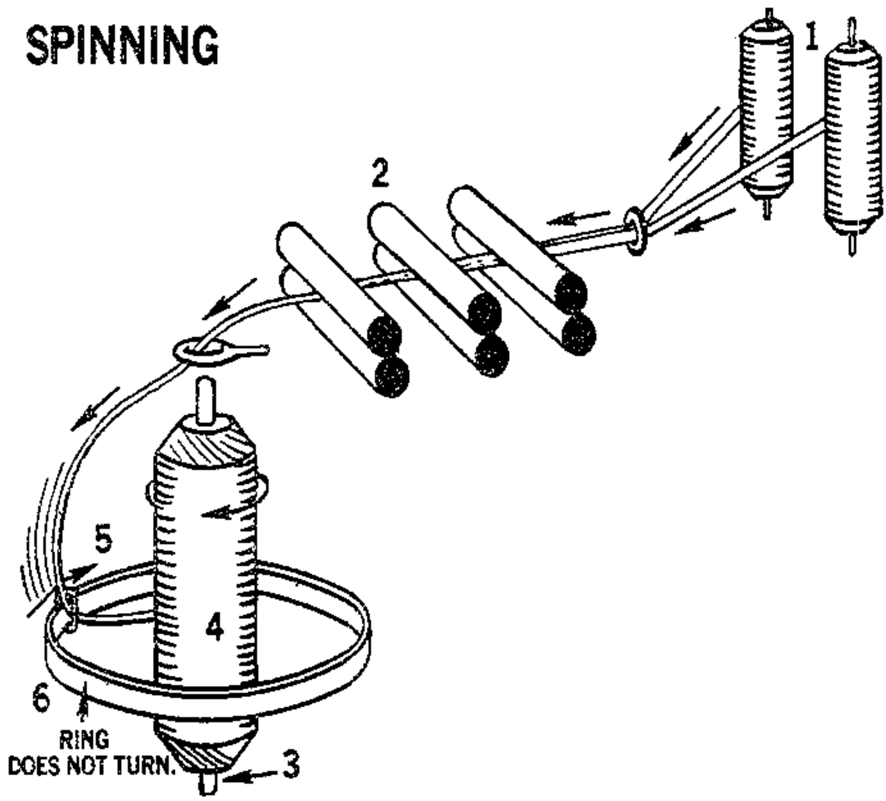


FIG 3.7 SPINNING

3.1.8 Winding

After the doffing, a winding operation is required to transfer the yarn spinning bobbins to cardboard or plastic cones holding 2-3 pounds of yarn for use in the fabric forming operation. The yarn that leaves the spinning frame is not of sufficient length to serve as warp yarn on the loom. It is first wound on bobbins or spools and placed on a large rack or frame called creel. The warp yarns on the bobbins or spools are evenly wound on the warp cone. Weaving is the final stage in the conversion of fibres to fabric interlaces two sets of yarn namely warp and weft. The basic aim of warp preparation is to improve the weavability of warp yarns, i.e., to improve strength and abrasion resistance of warp yarns.

Warp winding produces wound packages like cheeses and cones. It serves as a 'supply station' for various processes including knitting, dyeing, warping, pirn winding and has therefore to cater to a variety of demands in terms of wound package characteristics.

The main objectives of warp winding are:

1. To produce bigger and compactly wound packages
2. To eliminate objectionable yarn faults and
3. To produce suitable wound packages for package dyeing

In the cone winding machines, the yarn obtained from the ring frame spinning machines are wound on a plastic or cardboard cone. The desired pattern is obtained on the cone by passing the yarn through a grooved bakelite drum and also by varying the rpm. The drum shafts are driven separately by two induction motors. Since this is the only process in which the yarn is dealt with individually, it is necessary to eliminate all the yarn faults in this stage.

3.2 PROBLEMS IN THE PRESENT SETUP

3.2.1 Package faults

Quality of wound packages is an indication of winding performance. Ideally, it is desired to produce packages which are free of faults and which would unwind satisfactorily at the next process. However, such a situation is far from feasible in practice and deviation from ideal conditions give rise to package faults. In general, package faults occur due to inferior yarn quality, poor machinery condition, improper settings, and carelessness of the operatives and improper handling of packages during transportation and storage.

3.2.1.1 Ribbon formation or Patterning

Patterning is said to take place when the succeeding coils of yarn are placed exactly on the preceding ones. It happens when the ratio of the rotational speed of the package and that of the traversing unit is a whole number. Packages with ribbon formation show increased tendency for sloughing-off during unwinding and uneven dye pick up in the case of dye packages. Proper selection of the ratio on 'precision' winding machines eliminates the possibility of ribbon formation. On drum driven winding machines, however, the ratio changes continuously during the built up of the package and there are certain phases when the ratio tends to be a whole number. There is thus ribbon formation for short intervals. Most of the drum driven machines are therefore usually equipped with some sort of ribbon braking device to prevent the ratio tending to be a whole number. However, proper functioning of the device should be ensured.

3.2.1.2 Stitching of 'Jali' formation

An entangled web of yarn known as 'Jali' formed when the yarn during traverse falls outside the package edges. It can be due to large variations in yarn tension during traverse, excessive play of the package on the spindle, improper setting of traverse restrictors, etc. This type of package cannot be unwound smoothly and results in more end breaks at the next process. Also, considerable length of yarn is to be removed as waste, thereby increasing the hard waste level at the process.

3.2.1.3 Entanglement of yarn

Carelessness of the operators during hand knotting, excessive knotter failures and very strong suction on automatic knotters disturb the surface layers of the package and lead to yarn entanglement. The after-effect is unsatisfactory unwinding performance and increased hard waste level.

3.2.2 Electrical losses

3.2.2.1 Electrical motive load

The performance of the electrical motors installed governs the production, quality and cost in the textile industry. The power consumption in the electrical motors is of the order of 92% of the total power bill in an average textile mill. The consultants made a detailed study on the electrical motors with respect to their existing loads, performance, efficiency and power consumption. Tests were carried on the existing motors regarding the actual loads. Various factors such as the major counts, type of cloth, machine age and its deteriorated performance and the recommendations of the machinery were kept in view.

The NPC study revealed that in the spinning section, the majority of the motors were operating at 40-70% of their rated capacities. Tests were carried out in the other departments and the data were analyzed. It was felt that oversized motors were existing in the plant and the power bill was consequently high in a continuing basis .It was recommended that the oversized motors should be replaced with proper sized motors on the basis of machine loads.

The oversized were being for various reasons. Suppliers had given higher sizes because of insufficient specifications provided by the mill. Occasionally an engineer who was not fully conversant with the actual conditions had made some assumptions and this has lead to higher sizes in the motors. Also the machinery manufacturers have a proclivity to recommend the use of a larger size motor than actually needed, as an inbuilt protection to ensure against sudden overload failure. Some times an electrical engineer has no other option and he ahs to use the available motor which might be over sized, in order to keep the machinery running.

Oversized motors will remain unidentified until some electrical measurements are taken. These can be found out by measuring power factors. Oversized motors running under low loads would cause poor power factors. Fractional hp motors are even worst in this respect. The NPC recommends that replacing a motor at a coat of Rs.90, 000 would give an annual saving of Rs.55, 000.

3.2.2.2 Old motors

Also sometimes there are a number of motors that are very expensive to replace quite often. These have to be rewound 8-10 times on an average in case they burn out. It is found that these rewound motors operate on a very high current as compared to standard motors. Considerable amount of power is being lost in running these motors.

3.2.2.3 Capacitors

Energy loses in a power system are proportional to the square of the current. Transmission and distribution losses are caused by low power factor. This causes low voltage condition and results in drawing large current by electric motors. Power factor can be improved by using capacitors.

3.3 AREAS OF POWER CONSERVATION

Various areas of energy conservation are being discussed in a few coming pages.

3.3.1 Reduction of overmotoring

As such normally maximum efficiency of motors occurs at 75% of load current. The load current of all the motors should be calculated and tabulated along with its rated current. It should be done for the entire mill. Wherever it is found that loading of the motor is less than 65%, then the motor should be replaced as the efficiency of the motor will be low at lower loading. A study conducted in the machine indicated that the current drawn by the motors was just about 8.4 to 8.8 amps against a full load of 14 Amps, which means the loading is always less than 62%. It is a stark naked fact that the efficiency of the motor will be very low. One solution is to replace the motor by lower hp motor which requires some capital investment. An alternative is to increase the efficiency of the present motor itself by changing the motor connection from delta to star.

The advantages are as follows:

1. Improvement of overall system efficiency
2. Reduction of line losses
3. Reduction of heating of cables, panels, etc.,
4. Saving of capacitors

There are many other areas where lot of overmotoring exists like Ring frames, Humidification fans & pumps, etc.

3.3.2 Motor maintenance & overhauling

It is generally noted that in textile motors maintenance is being neglected very much. A basic maintenance program involving periodic inspection and correction of unsatisfactory conditions will prolong the life of motors. To reduce the maintenance cost is, in a way, equivalent to energy conservation. For example, motor cooling fans are choked with fluff, so there is no cooling effect on the motors. The motor will run at high temperatures, low efficiency and will finally burn out. Also the hot motors increases the heat load of the department so more cooling power is required resulting in lowering of motor efficiency, extra energy consumption It has been observed in a few cases in the past that a mere overhauling of all the motors had led to reduction of power bills by almost whopping 40%.

3.3.3 Change in the ribbon breaking mechanism

Patterning is said to take place when the succeeding coils of yarn are placed exactly on the preceding ones. It happens when the ratio of the rotational speed of the package and that of the traversing unit is a whole number. Packages with ribbon formation show increased tendency for sloughing-off during unwinding and uneven dye pick up in the case of dye packages. Proper selection of the ratio on 'precision' winding machines eliminates the possibility of ribbon formation. On drum driven winding machines, however, the ratio changes continuously during the built up of the package and there are certain phases when the ratio tends to be a whole number. There is thus ribbon formation for short intervals. Most of the drum driven machines are therefore usually equipped with some sort of ribbon braking device to prevent the ratio tending to be a whole number.

In the present setup to avoid formation of ribbons the motor is being switched on/off 24 times a minute and this is controlled by an electronic device. This causes the current drawn by the motor surge up every time when its state changes from OFF to ON. Also this causes undesirable overheating of the motor. If this could be altered in some way such that the motor is not being switched on/off continuously, there is certainly some scope for power conservation of a considerable percentage.

CHAPTER 4

MODIFICATIONS MADE IN THE EXISTING MACHINE

The cost breakup for a typical mill is shown in the table below:

TABLE 4.1 COST BREAKUP FOR A TYPICAL MILL

S.NO.	Cost Component	% Break up
1	Raw material	26.0
2	Stores & Chemical	13.5
3	**Power & Fuel**	**13.9**
4	Wages & Salaries	33.3
5	Other administrative Expenses	6.3
6	Interest	4.7
7	Depreciation	2.3

We, in our project are trying to reduce a sizeable percentage of power through various remedial measures explained below.

4.1 ADDRESSING THE CHALLENGE OF OVERMOTORING:

It is being observed that electrical motors and their power consumption are in the order of 92% of the total power consumption. The performance of the electrical motors installed governs the production, quality and cost in the textile industry. The studies conducted by consultants in NPC in various mills often have showed the fact the investment made towards replacing oversized motors, age old 'full torque' motors and installing capacitors would be offset in less than two years in terms of savings in their annual power bill. As such normally maximum efficiency of motors occurs at 75% of load current. The load current of all the motors should be calculated and tabulated along with its rated current. It should be done for the entire mill. Wherever it is found that loading of the motor is less than 65%, then the motor should be replaced as the efficiency of the motor will be low at lower loading. A study conducted in the conventional cone winding machine under study indicated that the current drawn by the motors was just about 8.4 to 8.8 amps against a full load of 14.5 Amps, which means the loading is always less than 61%. It is a stark naked fact that the efficiency of the motor will be very low. So it has been suggested to replace the existing two 5 hp motors by a single 7.5 hp motor.

TABLE 4.2 POWER CONSUMPTION PATTERN IN THE EXISTING MOTORS AND THE SUGGESTED MOTORS IN WINDING SECTION

Existing Motor HP	Running Current Amps	Suggested Motors HP	Full load Rated current Amp	Excess Power Consumption Kwh ($\sqrt{3}$ VIcos θ)	Excess Power Bill (Rs.)
10	8.4-8.8	7.5	14	1670	5010

Remarks: The electricity charge calculations have been made on the basis of Rs. 3/Kwh. The savings indicated are per month.

An alternative solution to the problem of overmotoring is to increase the efficiency of the present motor itself by changing the motor connection from delta to star.

TABLE 4.3 ENERGY CONSERVATION IN DOUBLING & TFO

S.No.	Connection	Load current Amps	HP	Rated current Amps	Power saving (KWh)	Current Amps	Power Factor
1	Delta	15.0	25	32.0	1.2	8.5	0.4-0.8
	Star	6.5					
T F O							
2	Delta	32.0	50	64.0	2.5	9.0	0.6-0.9
	Star	23.0					
3	Delta	32.0	60	78.0	2.6	7.0	
	Star	25.0					
4	Delta	40.0	60	78.0	2.0	10.0	
	Star	30.0					
5	Delta	18.0	20	28.0	0.75	8.0	0.5-0.9
	Star	10.0					

4.1.1 Slip Ring or Wound Rotor Motors

The slip ring or wound rotor motor is an induction machine where the rotor comprises a set of coils that are terminated in slip rings to which external impedances can be connected. The stator is the same as is used with a standard squirrel cage motor. By changing the impedance connected to the rotor circuit, the speed/current and speed/torque curves can be altered.

The slip ring motor is used primarily to start a high inertia load or a load that requires a very high starting torque across the full speed range. By correctly selecting the resistors used in the secondary resistance or slip ring starter, the motor is able to produce maximum torque at a relatively low current from zero speed to full speed. A secondary use of the slip ring motor is to provide a means of speed control. Because the torque curve of the motor is effectively modified by the resistance connected to the rotor circuit, the speed of the motor can be altered. Increasing the value of resistance on the rotor circuit will move the speed of maximum torque down. It the resistance connected to the rotor is increased beyond the point where the maximum torque occurs at zero speed, the torque will be further reduced. When used with a load that has a torque curve that increases with speed, the motor will operate at the speed where the torque developed by the motor is equal to the load torque. Reducing the load will cause the motor to speed up, and increasing the load will cause the motor to slow down until the load and motor torque are equal. Operated in this manner, the slip losses are dissipated in the secondary resistors and can be very significant. The speed regulation is also very poor.

4.1.2 Motor Characteristics

The Slip Ring motor has two distinctly separate parts, the stator and the rotor. The stator circuit is rated as with a standard squirrel cage motor and the rotor is rated in frame voltage and short circuit current. The frame voltage is the open circuit voltage when the rotor is not rotating and gives a measure of the turns ratio between the rotor and the stator. The short circuit current is the current flowing when the motor is operating at full speed with the slip rings (rotor) shorted and full load is applied to the motor shaft.

4.1.3 Secondary Resistance Starters

The secondary resistance starter comprises a contactor to switch the stator and a series of resistors that are applied to the rotor circuit and gradually reduced in value as the motor accelerates to full speed. The rotor would normally be shorted out once the motor is at full speed. The resistor values are selected to provide the torque profile required and are sized to dissipate the slip power during start. The secondary resistors can be metallic resistors such as wound resistors, plate resistors or cast resistors, or they can be liquid resistors made up of saline solution or caustic soda or similar, provided there is sufficient thermal mass to absorb the total slip loss during start.

To select the values of the resistors, you need to know the frame voltage and the short circuit current. The maximum torque occurs approximately at the point where the rotor reactance equals the termination resistance. The final stage of the resistance should always be designed for a maximum torque close to full speed to prevent a very large step in current when shorting the final stage of resistance. If a single stage was used and the maximum torque occurred at 50% speed, then motor may accelerate to 60% speed, depending on the load. If the rotor was shorted at this speed, the motor would draw a very high current (typically around 1400% FLC) and produce very little torque, and would most probably stall.

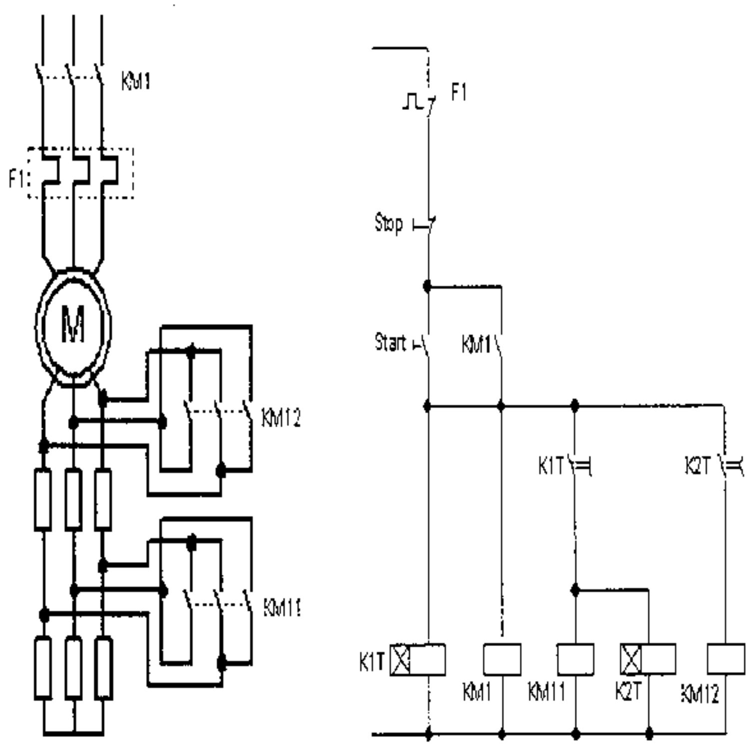


FIG 4.1 SECONDARY RESISTANCE STARTER

4.1.4 High Inertia Loads:

Slip ring motors are commonly used on high inertia loads because of their superior start efficiencies and their ability to withstand the inertia of the loads. When a load is started, the full speed kinetic energy of that load is dissipated in the rotor circuit. With a standard cage type induction motor, there only some motors that can be used on high inertia loads. Most will suffer rotor damage due to the power dissipated by the rotor. With the slip ring motor, the secondary resistors can be selected to provide the optimum torque curves and they can be sized to withstand the load energy without failure. Starting a high inertia load with a standard cage motor would require between 400% and 550% start current for up to 60 seconds. Starting the same machine with a wound rotor motor (slip ring motor) would require around 200% current for around 20 seconds. This is a much more efficient solution. Shorting the rings out on a slip ring motor with a high inertia load is not an option as the load energy must be dissipated in the rotor winding during start. This will cause insulation failure in the rotor circuit.

A slip ring motor uses resistors in the rotor circuit to modify the starting characteristics of the slip ring motor. Increasing the resistance in the rotor circuit has two effects:

1. It reduces the starting current
2. It increases the slip at which maximum torque occurs.

If the slip ring motor has been employed to provide a very high starting torque across the entire speed range during start, then the slip ring or secondary resistance starter can not be replaced. In this case, the first stage of the resistors would be selected to provide a high torque at 100% slip (zero speed) and a number of stages are then employed, each with reducing resistance to move the Slip point in steps from 100% towards 0%. The effect of this is to provide maximum torque at all speeds and at a reduced start current. (Typically 200 - 300%).

Shorting out the slip rings and attempting any form of reduced voltage start in the stator supply, will result in a much reduced start torque at a much higher start current. Effectively, the motor could exhibit a Locked Rotor Current in excess of 1000% and a Locked Rotor Current less than 100%. If we reduce the start current down to say 400%, then the start torque would be less than 100 x (400/1000) x (400/1000) or less than 16%.

If the driven load does not require a high start torque, then the slip ring motor can be set up to emulate a standard cage motor by applying rotor resistance that will cause a full voltage start current of about 550%. A reduced voltage starter can now be applied, and the rings should be shorted out once the machine reaches full speed. If you do not short the rings at full speed, the slip will be higher than ideal and the motor .efficiency will be reduced. There will be high power dissipation in the resistors.

4.1.5 Slip ring motor on a variable speed drive:

A slip ring motor will perform well on the output of a variable speed drive. Short the rotor out, preferably on the rotor itself rather than on the output of the brush gear. There can be problems if the brush gear arc while in circuit. A motor operating on the output of a variable speed drive does not operate under high slip conditions so the high slip characteristics of the slip ring motor with a shorted rotor are not relevant.

4.1.6 Recent developments in motors and drives:

During the Past 10 Years, considerable changes have taken place in the designs of motors and drives. Primarily, these changes were induced on account of two major reasons; firstly the "Oil Crisis" in 1973 and the consequent rise in the cost of energy and secondly due to a steep fall in prices of electronics hardware. The trend in motor designs till about 1973 was savings in materials even at the cost of performance. This has been reversed since then and the trend now is energy effectiveness even at higher initial costs. Solid state control devices whose prices plummeted down during the post 1973 period came in as a timely help to achieve this aim of energy efficiency in motor control and drives.

The following text describes the present motor design practices, trends in the principal materials used in motors and the performance requirements. A review is also made about the new generation of solid state controls which are more and more in vogue and the benefits offered by these controls in reducing operating costs and possibly even the initial costs when compared with some of the conventional drives.

A review of the standard motors manufactured progressively for the past 25 years in India and abroad reveals that up till very recent years, there has been a trend towards reduction of the motor weights and the active materials. The performance in many cases also reduced in spite of advances in designing technology, materials and manufacturing practices. For example, if we take a 10HP 4-pole motor, the changes in performance and weight have been of the order of the values shown in the table below:

TABLE 4.4 CHANGES IN PERFORMANCE AND WEIGHT OF 10 HP 4-POLE MOTOR

Year	Motor Weight (Kg)	Efficiency (%)	Power factor
1958	85	87	0.85
1968	75	86	0.84
1978	68	85	0.84

During the early seventies, in fact, the trend was to upgrade the thermal rating of standard motors from class B insulation to class F and thereby reduce the active materials still further. If this was done, naturally, the performance would have, also most probably reduced still further. But in 1973, a new dimension, "the cost of energy" became predominant due to the oil crisis. As a result, during the past ten years, the most important issue under consideration has been energy conservation and the philosophy changed towards energy efficient motors and drives. This paper covers some aspects of the above subject. During the past 15-20 years, many innovative ideas have been introduced and several new varieties of motors have appeared in the market. The merits and applications of some such motors are discussed. Another major factor which has influenced the development of newer types of motor controllers and drives is the substantial reduction in the price of electronic components during the past ten years. The present trend in the use of some such electronic controllers and drives is also discussed.

4.1.7 Energy efficient motors:

An American Survey conducted in 1976 revealed that about 64% of the total electrical energy produced in the USA is consumed for driving electric motors. In India, accepting that this factor would be probably lower, the importance of energy efficiency in motors and drives cannot still be undermined.

There are three principal methods of achieving energy efficiency in motors. These are:

1. Voltage adjustment at partial loads.
2. Over sizing of motors by using larger active components.
3. Employing a more expensive technology.

4.1.8 Voltage adjustment at partial loads:

In a motor, two types of losses take place. These are the constant losses which are practically independent of the load and consist of the friction and windage losses, iron losses and losses caused by the magnetizing current. The other losses caused in the stator and the rotor windings on account of the load and the stray losses constitute the load dependent losses. The efficiency of a motor is a function of these losses. Lower the losses, better is the efficiency.

Most motors are so designed that the maximum efficiency occurs at about 75% of the rated load. At partial loads, the efficiencies are poorer. If we take any standard motor, it is possible to operate the motor at its maximum efficiency at any partial load by adjusting the supply voltage. This can be done by simply using a Star/Delta switch or, for example, by using an electronic voltage controller for a step less voltage variation. The efficiency improvement attainable and the reduction in losses by employing the two voltage adjustment methods is indicated.

It is seen that the reduction in the load dependent losses is small compared to the constant or unavoidable losses. Only at very low loads, the gains are significant. The disadvantages of this method are discontinuous mode of operation while switching from Delta to Star or the extra cost of the electronic voltage controller. Also, the electronic voltage controllers give a non-sinusoidal voltage which results in some additional losses.

4.1.9 Over sizing of motors and employing a more expensive technology:

Several studies have been made in this area. It is observed that, contrary to the widespread be life, an oversized motor generally operates with an improved efficiency in the region where the efficiency characteristic is flat.

Over sizing of motors and employing a more expensive technology in practice means the following:

1. Increase in the size and quantity of the active materials, i.e., the core and the copper.
2. Higher copper fill-factor in slots.
3. Rotor cage made of copper instead of aluminium.
4. Superior quality laminations.
5. Unidirectional fans.
6. Special slot wedging.

However, the above actions would involve a higher cost and it has to be ascertained that this higher initial cost is justified in terms of the net savings in the operational costs. The various studies conducted show that the advantages are predominant in smaller motors and over sizing of motors in practice is justified normally for outputs below about 50 kW. This happens because the larger motors inherently have a higher efficiency and the gain in efficiency and the gain tin efficiency becomes progressively smaller. For smaller motors, over sizing is quite beneficial and it is estimated that for outputs below 1kW, the savings in the cost of electricity consumption would repay the additional cost of over sizing the motor in about 2000-5000 operating hours at full load.

4.1.10 Recent innovations in small and medium size motors

During the past 15 years, many innovations have taken place in the designs of motors and several newer types of motors have displaced the conventional ones. Many of these motors are really suitable for special applications be cause of their unique features. The special features of some of the popular motors are described below:

4.1.10.1 PAM motors

PAM motors or Pole-amplitude modulated motors have really come into vogue during about the last 15 years. These motors offer the advantage of giving two speeds with a single winding even when the speed ratios are other than 1:2 Conventional two speed motors need two separate stator windings when the speed ratios are other than 1:2 But, a PAM winding can offer speeds such as 15000/1000 rpm, 1000/750 rpm, etc. with a single winding. This has resulted in a substantial material economy and higher outputs being offered in a frame as compared to conventional two speed motors. PAM motors are being extensively used abroad these days whenever two or three speed applications desired,

4.1.10.2 Reluctance motors

In appearance, these motors look exactly similar to induction motors. The actual difference lies in the construction of the rotor magnetic circuit which locks on to the rotating field produced by the stator winding. If the loading is kept within limits, the motor operates at synchronous speed without any slip. Hence, this is an ideal motor where constant speed operation unaffected by variations in load and voltage is required. Typical applications are computer peripheral drives, sound recording equipment and synthetic fibre spinning.

4.1.10.3 Printed circuit motors

These are d.c. motors which have experienced a phenomenal growth in recent times. The output range is from 3 watt to about 5 kW. Initially, the rotors were like a printed circuit, but now they are made up of conductors punched out of circular copper plates. A number of finished plates are as assembled together to form what is called a pancake construction. The plates are insulated to form a rotor winding. The complete rotor can be as thin as 0.25 mm and it is sandwiched between two sets of permanent magnets leaving air-gaps on either side.

This motor is an extremely versatile machine. Its low inertia makes it eminently suitable for fast start-stop duties, Because of the absence of iron in the rotor, the commutation is near perfect and hence the motor can be subjected to very high current pulses and fast acceleration. The starting torques obtainable can be almost five times the normal starting torques. These motors are used for tape drives, machine tool drives and in the process industry as a part of a packaged controller unit. They can be used to give a stepped output at its shaft by using a suitable pulsed supply. It is estimated that in U.K., the present production of these motors is well over a million sterling.

4.1.10.4 Tapped winding motors for looms

For modern loom drives, the starting torque requirement of motors is extremely high. In some cases, the starting torque required can be as high as 500% of the rated torque. In such a case, even a well designed motor is likely to operate at a poor power-factor and efficiency. To counter this, a tapped winding motor is used which starts on a winding tap to give the desired high starting torque and then the motor is switched over to the full winding to reduce the magnetization for operation with improved power-factor and efficiency. Of course, the idea of using a tapped winding is not new;

but its actual implementation in practice for loom drives is a recent development.

4.1.10.5 Others

The motors covered above in above paragraphs are some of the more relevant and popular motors. There are many other innovations and ideas being implemented in motor designs at present and to cover these could need a lot of space. A brief review of some of these motors is given in the coming paragraphs.

4.1.10.6 Wanlass windings

The wanlass winding consists of two windings in parallel known as the main winding and the control winging. The main winding is connected in series with an external capacitor to match the required characteristics. The control winding provides a load dependent variable current. At light loads, the control winding acts as a generator and at 50% load, it draws no current. The motor operates at unity power-factor over a wide range of loads and thus improves efficiency.

Experiments were carried out by Brush Wellman Co. USA on a 100HP motor with wanlass windings and it was found out that the savings in the cost of energy amounted to around 22% because of improved efficiency and overall reduced power consumption.

4.1.10.7 Mild steel corrugated frames for motors

ASEA of Sweden and some other European manufacturers have introduced recently M.S.corrugated frames for medium size motors. These frames provide a unique constructional feature of air circulation within the frame to operate in a similar way to a heat exchanger. The motors are about 20-25% lighter than conventional motors, the comparable temperatures are about 30 C less and the overall performance is considerably improved.

4.1.10.8 Motors with mounting options

A new range of motors in 63-100 frame are now offered b a British manufacturer with considerable mounting options. The feet can be removed and bolted into 3 positions – 3, 6 and 9 O' clock. The motors can be mounted horizontally or vertically in feet mounted, flange mounted, face mounted and pad mounted configurations with or without feet allowing the customer to exercise options of his choice at any time.

4.1.10.9 Thyristor-assisted communication

The system makes use of solid state devices to take the making and breaking duty off the commutator brushes. With such a system, d.c.machines can be manufactured in ratings and speeds exceeding the earlier thresholds.

4.1.10.10 Square-frames for d.c.motors

A substantial increase in the power to weight ration of d.c.motors can be achieved by changing over from a round frame to a square frame. Many European manufacturers have already switched over to square frames during the past 10 years.

4.1.10.11 Capacitor braking of motors

A rapid and reliable method of braking cage induction motors to a standstill has been introduced in practice. It is achieved by the method of self excitation by introducing capacitors across the stator winding when the supply is interrupted. This method uses less energy than braking with d.c. injection and has attracted significant commercial interest.

4.1.10.12 Axial flux induction motors

Recently, a patented machine has been developed by a manufacturer in Australia which can punch slots on a continuous strip of steel that can be wound to form a toroidal core of a motor. Motors made from such cores would have some unique advantages of not requiring costly punching slots, air gap variation possibility without machining of the rotor and other reduced manufacturing costs. Also development for non-standard and special requirements can be done in very short time-spans.

4.1.10.13 Drives for motors

Variable speed drives have been one of the most common requirements for many industrial applications. In the past, cage induction motors could not be used for such drives on account of their in speed for a given load and voltage. Hence, for variable speed applications, use of d.c.motors was quite common. With the advent of different types of static controllers, the cage induction motor has now become available for variable speed drives. This gives the benefit of operating the motor on he universally available a.c.supply and using the almost maintenance free and cheap cage induction motor as against the more vulnerable and expensive d.c.motor. The other use of the different types of static controllers is in the area of energy saving. Some of the present practices in this field are discussed below:

4.1.10.14 Static inverters

An inverter is unit that accepts the standard fixed frequency and voltage electric supply and delivers a variable frequency and voltage outputs. When this variable frequency and voltage output is fed to a standard cage induction motor, it operates as a variable speed motor due to frequency variations. The equipment comprises two main parts; a converter section which is basically a rectifier which converts the a.c.supply to d.c., and an inverter section which reconverts the d.c. output to produce a variable frequency and voltage output for supply to the motor.

The advantages offered by the variable speed inverter drive can be summarized as below:

4.1.11 Energy saving

Inverter drives are now being used more and more for running pumps and fan drives requiring variable outputs. Figure 10.4 gives a comparison of energy consumption for a constant speed pump drive with throttling for discharge control against a variable speed drive.

1. Soft start of a motor and controlled acceleration to reduce the starting stresses.
2. Smoother process operation when compared with on-off switching particularly in areas where process must always be kept running.
3. Reduced starting current loads on the supply systems.

Static inverters are now available in many countries off the shelf for motor outputs as low as 0.37 kW at reasonable prices and their use and importance is increasing day by day.

4.1.11.1 Load sensing motor controllers

Many controllers have now come to the market designed to cut down energy consumption of motors operating during their running at partial loads or at higher supply voltages. The first such device was developed and patented by NASA. The devices sense the load and then control the voltage being supplied to the motor terminals such that the motor operates at its highest efficiency and power-factor. It is estimated that power consumption of the order of 50% can be saved in many drives by using these devices. Prominent amongst the makers of such devices are Condor Electronics, U.K., a patented device by Dr. Unworth of Sussex University and the Watt-miser being marketed by Compton Parkinson of U.K.

4.1.11.2 Solid state motor starters

Solid state motor starters have been developed to give to induction motors a smooth and soft start. This is done by using back to back connected power thyristor in the three phases between the supply and the motor terminals. The voltage to the motor terminals is supplied in an uninterrupted and controlled manner from a low value at the time of switching, rising smoothly to full voltage at full speed. Such starters have been used in the textile industry for driving carding machines or other reel drives and for crane drives.

4.1.11.3 Phase shift controllers

Phase shift controllers are devices which control the voltage applied to the terminals of the motor. The devise can be used to operate with motors having a flat torque-speed characteristic over a wide range of its speed to achieve a constant speed operation under varying load torques or a variable speed operation. Phase shift controllers have become quite popular in the textile industry for dyeing and coiling drives.

Recently, several newer types of motors and drives have become available to users. The choice of motors now is much wider, ranging from energy efficient motors to the other newer varieties such as the reluctance motors, printed circuit motors, etc. Standard induction motors can now be operated at almost unity power factors under varying load conditions or for variable speed applications. Starting and control of motors can be achieved with a very high degree of sophistication. Cost of energy has become a very significant parameter. If all these factors are carefully considered while selecting motors and the drives, significant economies can be achieved in the long run.

4.1.12 Economics of high efficiency motors

High efficiency (HE) motors offer numerous advantages over conventional motors. The benefits include savings in energy cost, improved power factor, reduction in the peak demand, lo9wer load, less noise, cooler running, longer service life and reduced sensitivity to voltage fluctuations.

The returns from high efficiency motors are primarily decided by three factors: the increase in motor efficiency, cost of high efficiency motor and the number of hours the motor is run during a year. The savings from high efficiency motors largely arise from a reduction in power in put consequent to the improved motor efficiency. Besides, the higher power factor (high efficiency motors have improved in efficiency) leads to a reduction in the requirement or maximum power demand, which in turn results in a better utilization of available electrical power. As the efficiency curve of high efficiency motor is flatter at higher loads, these motors have relatively higher efficiency at full load as compared to conventional motors. Also high efficiency motors can take overloads for short durations without the hazard of crossing the limiting temperature rise.

4.1.12.1Savings

A general expression has been derived to arrive at the economics of high efficiency motors, taking into account savings in energy cost and demand charges on the one hand, and increases in price of the high-speed motors on the other is given at the end of this section.

The savings from a high efficiency motor, assuming annual capital charges at 15%, are given in Table 8 taking different hours of working in a year and various levels of increase in efficiency. The figures are worked out for a 20 HP (15 KW) high efficiency motor. This motor costs about Rs. 18,000, that is, 50% more than the conventional motor. Cost of one unit of electricity is taken as Rs. 1.35 and the demand charges are assumed as Rs. 900 per KVA per year.

TABLE 4.5 NET SAVINGS OF 20 HP MOTOR (15 KW)

% Increase in motor efficiency	No. of hours worked per year (Duration)				
	8000	**6000**	**5333**	**4000**	**2667**
1	1738	1184	999	630	261
2	4311	3216	2851	2121	1391
3	6821	5197	4655	3572	2490
4	9270	7128	6414	4987	3560
5	11660	9013	8130	6366	4602

The net annual saving is about Rs. 6800 for a 3% higher efficiency for a HE motor, which works for three shifts a day about 85% of the savings come from reduced energy consumption cost and the remaining 15% from lower demand charges. For every 1% increase in efficiency the average saving is about Rs. 310 over 1000 motor running hours. Only in the very unlikely situations when the efficiency increase is hardly 1% and only one shift is worked, there would be practically no savings from the use of HE motors.

4.1.12.2 Returns

The return on investment of HE motors over the conventional motors is given below.

TABLE 4.6 RETURNS ON INVESTMENT (%) OF HIGH-EFFICIENCY MOTOR 20 HP (15KW)

% increase in motor efficiency	No. of hours worked per year (Duration)				
	8000	**6000**	**5333**	**4000**	**2667**
1	44.0	34.7	31.6	25.5	19.3
2	86.8	68.6	62.5	50.3	38.2
3	128.6	101.6	92.6	74.5	56.5
4	169.4	133.8	121.9	98.1	74.5
5	209.3	165.2	150.4	121.1	91.7

As it can be seen, HE motors are very economical: the return for a three-shift working (8000 hours) ranges from 40 to 42% for every 1% increase in efficiency. Normally a HE motor gives about 3% higher efficiency. This would mean that for a 3-shift working the entire investment on a HE motor can be recovered in less than one-year's time (Fig.3). For the 3% higher efficiency, the return is as much as 90% for two-shift working (5333hours) and about 56% for single shift working (2667 hrs.). As can be seen, even a 1% improvement in efficiency gives an attractive pay back period of 2.5 years. A HE motor wirth4% greater efficiency and 50%higher cost can break even in just 6 months` time for a 3-shift working.

The economics presented in the above tables is applicable when the mill has to choose between a standard motor and a high efficiency motor. In practice, however, a mill may like to replace the existing motor by a high efficiency motor. Assuming a resale value of the existing motor at 20% of the cost of the new motor, the returns are presented in the table below.

TABLE 4.7 RETURNS (%) FOR REPLACING AN EXISTING MOTOR BY A HIGH EFFICIENCY MOTOR

% increase in motor efficiency	No. of hours worked per year (Duration)				
	8000	**6000**	**5333**	**4000**	**2667**
1	16.9	13.4	12.2	9.8	7.4
2	33.4	26.4	24.0	19.4	14.7
3	49.5	39.1	35.6	28.7	21.7
4	65.2	51.5	46.9	37.7	28.6
5	80.5	63.5	57.9	46.6	35.3

Replacement of an existing motor by a new high efficiency motor also has an attractive pay-back period of about 2years for a 3%increase in motor efficiency. Even a 2% increase in motor efficiency is economical if it is worked for more than one shift. However, for increases in motor efficiency of 1% replacement by high efficiency motors at 50% higher cost just breaks even only in case of three-shift working.

4.1.12.3 Break-even Points

For any investment on modernization to break even, the first-year saving should be about 18% of the investment. The mill should, however, aim to realize a saving of not less than 25%. The figures in Table 10 show that this saving is attainable for a 2% increase in efficiency for a HE motor which costs 1.5 times the cost of the standard motor.

The break-even points (i.e., for a 18% return) in terms of increases in motor efficiencies required for various prices are presented in Table 11 for the two situations : New standard motor vs. new high efficiency motor and replacement of an existing motor by and high efficiency motor

TABLE 4.8 BREAK EVEN POINTS OF INCREASE IN MOTOR EFFICIENCY FOR DIFFERENT MOTOR PRICES 20 HP (15 KW) 8000 HOURS WORKING

Price increase % of H.E. motor	% increase in motor efficiency	
	New Standard Vs. New H.E. Motor	**Replacement of existing motor by H.E. motor**
10	0.08	0.74
20	0.16	0.82
33	0.27	0.93
50	0.41	1.06
100	0.82	1.47

It can be seen that replacement of an existing motor by a new high speed motor costing 50% more than the former breaks even at about 1.0% higher efficiency. Or, as an alternative choice to conventional motor, an increase in efficiency of 00.4% would be enough to recover the additional investment on H.E. Motor. It is significant to note that a H.E. motor with double the cost of a conventional motor can break even if it yields just 0.8% higher efficiency when considered as an alternative choice and about 1.5% greater efficiency when replacement of existing motor is contemplated.

Generally, high efficiency motors cost about one-third more than conventional motors but have about 3% better efficiency which is very much greater than the break even levels required by a factor of 3.3 in the case of replacement of existing motor by HE motor and by a factor of 11.1 in the case of choosing between new standard and high efficiency motors

General Expression for arriving at Savings and Returns from High Efficiency Motors

Notations

1.	Capacity of motor (KW)	= H
2.	Efficiency of Standard Motor as a Ratio	= E_s
3.	Efficiency of high-efficiency motor	$=E_s(1+x)$
4.	Power factor of standard motor	= P_s
5.	power factor of high efficiency motor	$=P_s(1+x)$
6.	Energy rate per unit (Rs.)	= r
7.	Maximum demand rate per KVA (Rs. per Year)	= d
8.	Number of hours run per year	= n
9.	Cost of standard motor (Rs.)	= C
10.	Cost of high efficiency motor (Rs.)	$=C(1+a)$
11.	Annual capital charges (ratio)	= f
12.	Return on investment (%)	= R

Savings per year in energy cost Of high efficiency motor (Rs.) $=Hnrx/E_s(1+x)$

Savings per year in demand charges $= Hdx(x+2)/E_sP_s(1+x)^2$

Increase in motor cost per year = Caf

Net Savings per Year from H.E. Motor $= S = [Hnrx/\ E_s\ (1+x) + Hdx(x+2)/E_sP_s\ (1+x)^2\ ]$

$R = [(S+Caf)/Ca] * 100$, for new H.E. Motor

$= [(S+Caf)/Ca+0.8c] * 100$, for replacement of an existing motor by a new H.E. motor

The circuit diagram of the current supply to the present cone winding machine is shown below:

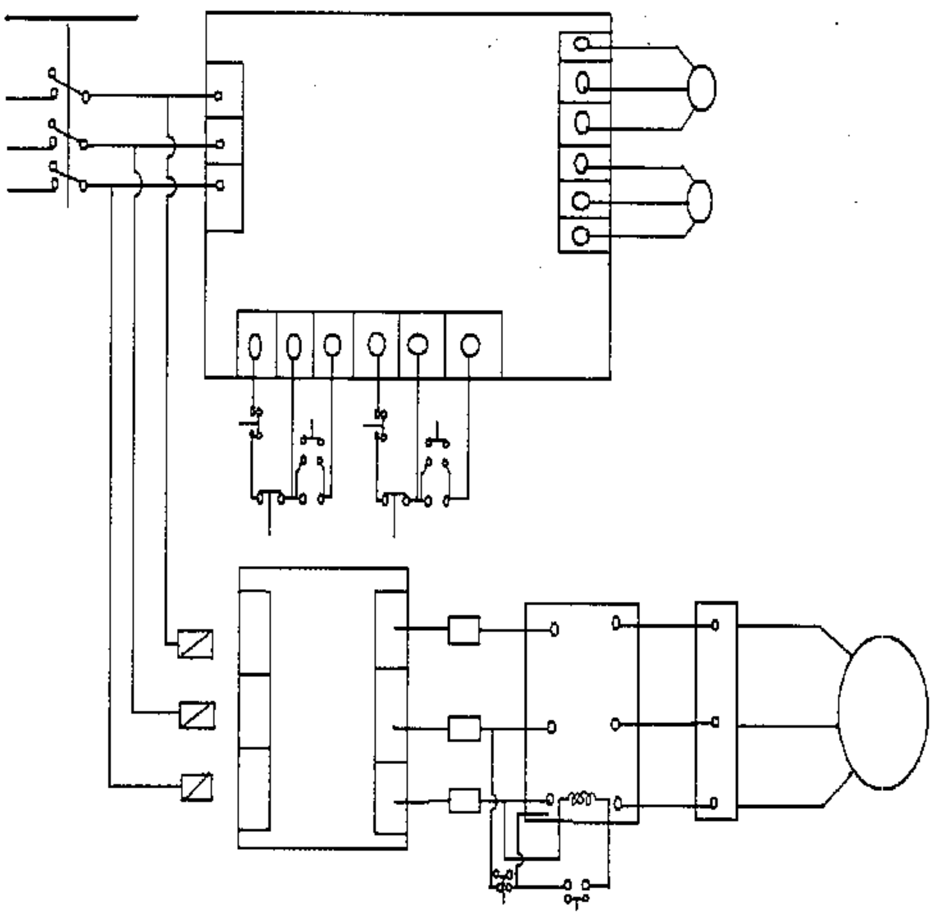


FIG 4.2 CIRCUIT DIAGRAM OF THE CURRENT SUPPLY TO THE PRESENT CONE WINDING MACHINE

4.2 MODIFICATIONS OF RIBBON BREAKING MECHANISM

Patterning or Ribbon formation is said to take place when the succeeding coils of yarn are placed exactly on the preceding ones. It happens when the ratio of the rotational speed of the package and that of the traversing unit is a whole number. Packages with ribbon formation show increased tendency for sloughing-off during unwinding and uneven dye pick up in the case of dye packages. Proper selection of the ratio on 'precision' winding machines eliminates the possibility of ribbon formation. On drum driven winding machines, however, the ratio changes continuously during the built up of the package and there are certain phases when the ratio tends to be a whole number. There is thus ribbon formation for short intervals. Most of the drum driven machines are therefore usually equipped with some sort of ribbon braking device to prevent the ratio tending to be a whole number.

4.2.1 Inverter circuit description

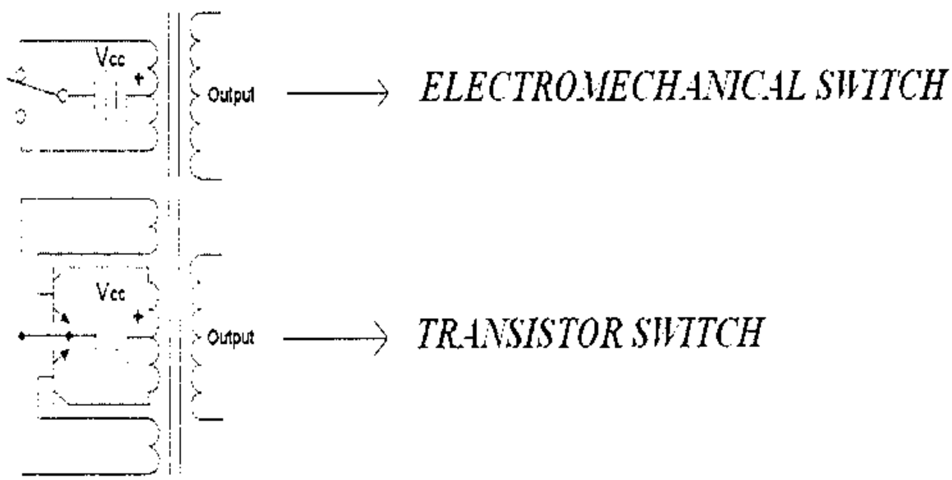


FIG 4.3 SIMPLE INVERTER CIRCUIT

Simple inverter circuit shown with an electromechanical switch and with a transistor switch

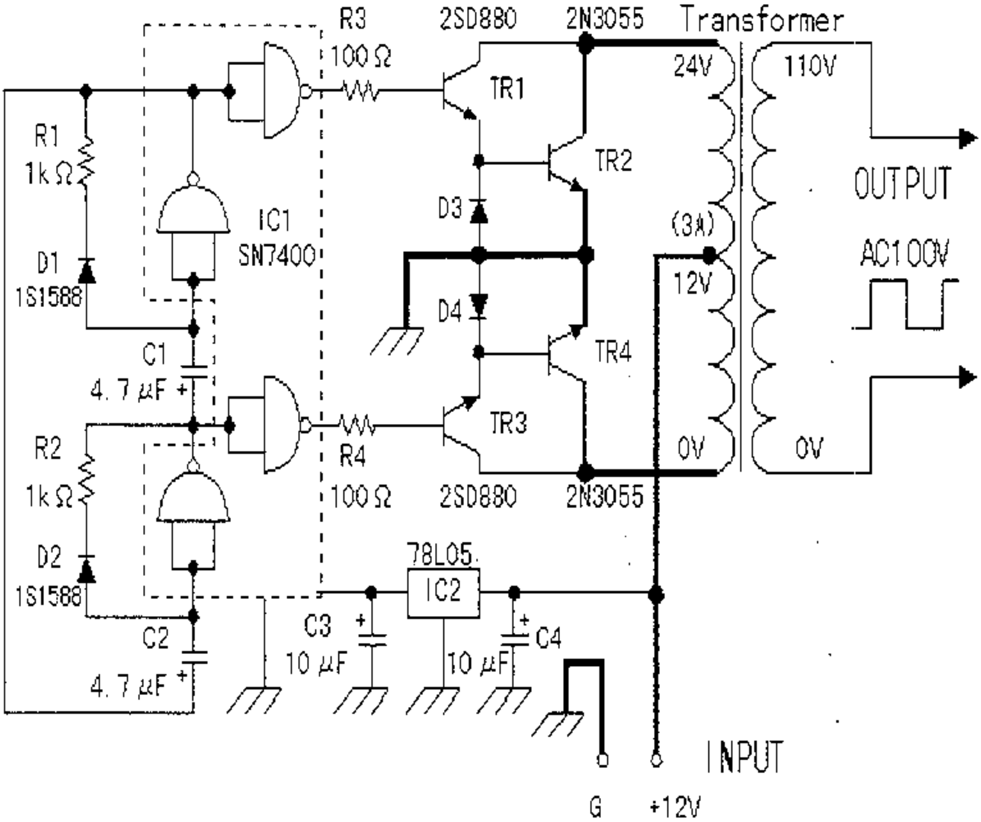


FIG 4.4 DC TO AC INVERTER

4.2.2 Basic inverter designs

In one simple inverter circuit, DC power is connected to a transformer through the center tap of the primary winding. A switch is rapidly switched back and forth to allow current to flow back to the DC source following two alternate paths through one end of the primary winding and then the other. The alternation of the direction of current in the primary winding of the transformer produces alternating currentt (AC) in the secondary circuit.

The electromechanical version of the switching device includes two stationary contacts and a spring supported moving contact. The spring holds the movable contact against one of the stationary contacts and an electromagnet pulls the moveable contact to the opposite stationary contact. The current in the electromagnet is interrupted by the action of the switch so that the switch continually switches rapidly back and forth. This type of electromechanical inverter switch, called a buzzer, was once used in automobile radios. A similar mechanism has been used in door bells, buzzers and tattoo guns.As they became available, transistorse and various other types of semiconductor switches have been incorporated into inverter circuit designs.

4.2.3 More advanced inverter designs

In more advanced inverter designs various techniques are used to improve the quality of the sine wavee at the transformer input, rather than relying on the transformer to smooth it. Capacitors and inductors (but not freewheel diode, remember, it's AC) can be used to filter the waveform at the primary of the transformer. Also, it is possible to produce a more sinusoidal wave by having split-rail direct current inputs at two voltages, or positive and negative inputs with a central ground. By connecting the transformer input terminals in sequence between the positive rail and ground, the positive rail and the negative rail, the ground rail and the negative rail, then both to the ground rail, a stepped sinusoid is generated at the transformer input and the current drain on the direct current supply is less choppy. These methods result in an output that is called a "modified-sinewave". Modified-sine inverters may cause some loads, such as motors, to operate less efficiently.

More expensive power inverters use Pulse Width Modulation (PWM) with a high frequency carrier to more closely approximate a sine function. The quality of an inverter is described by its pulse-rating: a 3-pulse is a very simple arrangement, utilising only 3 transistors, whereas a more complex 12-pulse system will give an almost exact sine wave. In remote areas where a utility generated power is subject to significant external, distorting influences such as inductive loads or semiconductor-rectifier loads, a 12-pulse inverter may even offer a better, "cleaner" output than the utility-supplied power grid, and are thus often used in these areas. Nevetheless, there do exist inverters with greater pulse ratings.

Simple inverters generate harmonics which affect the quality of power obtained using them. But PWM inverters eliminate this by means of a sine wave cancellation using the properties of Fourier Series.

4.2.4 Inverter applications

The following are examples of inverter applications.

4.2.4.1 DC power source utilization

FIG 4.5 INVERTER

Inverter designed to provide 115 VAC from the 12 VDC source provided in an automobileAn inverter allows the 12 volt DC power available in an automobile to supply AC power to operate equipment that is normally supplied from a mains power source.Inverters are also used to provide a source of AC power from solar cell and fuel cell power supplies.

4.2.4.2 Uninterruptible power supplies

One type of uninterruptible power supply uses batteries to store power and an inverter to supply AC power from the batteries when mains power is not available. When mains power is restored, a rectifier is used to supply DC power to recharge the batteries.

4.2.4.3 Induction heating

Inverters are used to convert low frequency mains AC power to a higher frequency for use in induction heating. To do this, AC power is first rectified to provide DC power. The inverter then changes the DC power to high frequency AC power.

4.2.4.4 High-voltage direct current (HVDC) power transmission

With HVDC power transmission, AC power is rectified and high voltage DC power is transmitted to another location. At the receiving location, an inverter in a static inverter plant converts the power back to AC.

4.2.4.5 Variable frequency drives

A variable frequency drive controls the operating speed of an AC motor by controlling the frequency and voltage of the power supplied to the motor. An inverter provides the controlled power. In most cases, the variable frequency drive includes a rectifier so that DC power for the inverter can be provided from mains AC power. Since an inverter is the key component, variable frequency drives are sometimes called inverter drives or just inverters

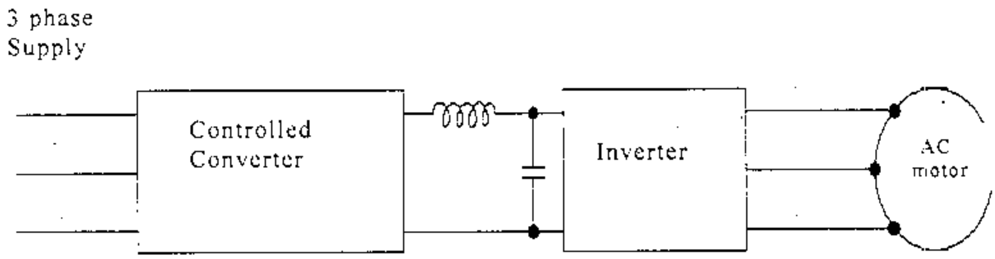
4.2.5 DC to AC Inverter

An inverter which converts a D.C. supply into a variable frequency is the basic power modulator of a variable speed A.C. motor drive.

In applying inverters for both V and f (keeping V/f constant) need to be varied. Further, the inverters apply essentially non sinusoidal A.C voltage to the motor. External filter circuits cannot be employed due to the difficulty in operating inverters over a wide range of frequencies. It is therefore necessary to keep down the harmonic content of the AC output of the inverters. While the inverter frequency is adjusted by varying the rate of thyristor firing, the voltage can be controlled in the following ways:

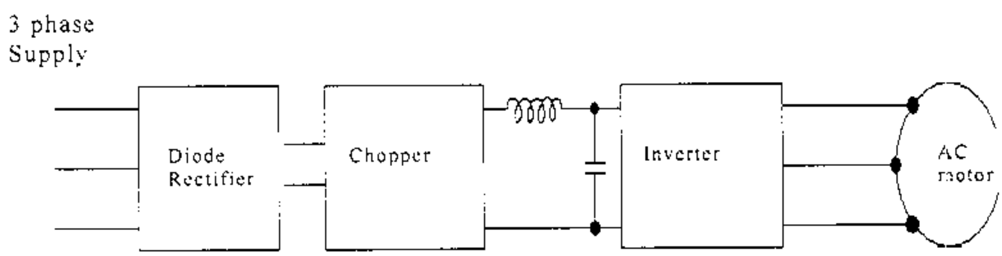
4.2.5.1 Control of D.C Input voltage

In this scheme a controlled converter supplies variable D.C voltage to the inverter as shown in the figure. This method has the advantage of fixed harmonic voltage content in the inverter output. It presents the difficulty of doubtful reliability of the commutation circuitry at low values of the D.C input as the commutation voltage in many inverter circuits is proportional to the D.C input voltage.



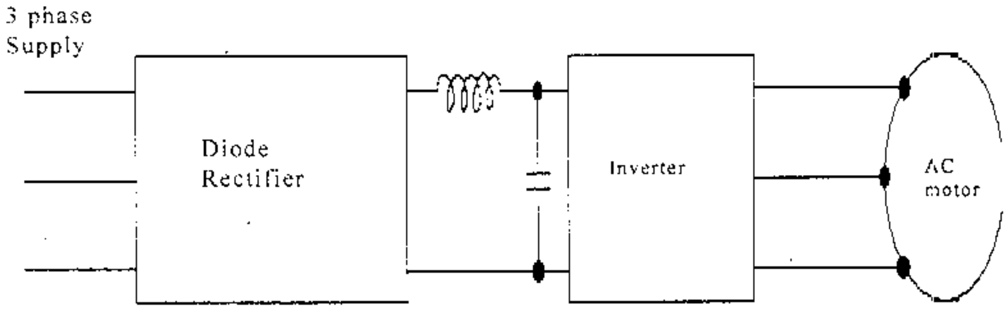
4.2.5.2 Chopper Control of D.C Input Voltage

Here the fixed D.C output voltage of an uncontrolled 3-phase full wave bridge rectifier is controlled by a chopper circuit as shown in figure. This scheme has the advantage of good power factor at the A.C input of the rectifier and a faster response voltage owing to a smaller time-constant pf the LC-filter on the output side of a frequency chopper. This scheme also suffers from the disadvantages of poor commutation (of inverter) at low input DC voltages and the fact that two power controllers have to be used in series.



4.2.5.3 Use of Inverters with Independent Voltage Control

Inverters have been designed so that they permit independent control of both the output voltage and frequency. This method id illustrated schematically.



4.2.6 Implementation of Inverters to avoid patterning:

Ribbon formation is said to take place when the succeeding coils of yarn are placed exactly on the preceding ones. It happens when the ratio of the rotational speed of the package and that of the traversing unit is a whole number. Packages with ribbon formation show increased tendency for sloughing-off during unwinding and uneven dye pick up in the case of dye packages. On drum driven winding machines, however, the ratio changes continuously during the built up of the package and there are certain phases when the ratio tends to be a whole number. There is thus ribbon formation for short intervals. Most of the drum driven machines are therefore usually equipped with some sort of ribbon braking device to prevent the ratio tending to be a whole number.

In the present setup to avoid formation of ribbons the motor is being switched on/off 24 times a minute and this is controlled by an electronic device. This causes the current drawn by the motor surge up every time when its state changes from OFF to ON. Also this causes undesirable overheating of the motor.

From the energy meters installed in the present machine a few observations have been made. They are explained as follows:
In the present setup there are two 5 hp motors (one for each drum shaft). The full load rated current of one 5 hp motor is about 7.5amps. Also, it has been observed that when the supply to the motor is about to be cut-off, one motor draws about 4.5 amps and the other one about 3.9 amps. When the supply id restored, one motor draws about 5.5 amps and the other one about 6.1 amps. Thus on an average each motor draws around 5 amps. This switching on/off of the motor is done to vary the rpm so that the patterning of yarn on the cone is avoided. When the supply is cut-off the rpm falls down to 1950 from 2150.

It has been observed that continuous switching on/off the motor results in more current being drawn (since motors draw more current when being switched on) and also there is some overheating of the motor which reduces its life (frequent burnouts). It was found out all these ill effects could be eliminated by using an inverter for the ribbon breaking. This can be achieved by using the inverter for a variable frequency drive. An inverter which converts a D.C. supply into a variable frequency is the basic power modulator of a variable speed A.C. motor drive. A variable frequency drive controls the operating speed of an AC motor by controlling the frequency and voltage of the power supplied to the motor. An inverter provides the controlled power. In most cases, the variable frequency drive includes a rectifier so that DC power for the inverter can be provided from mains AC power. Since an inverter is the key component, variable frequency drives are sometimes called inverter drives or just inverters.

The inverters vary the operating speed of the ac motor just by varying the frequency of the supply to the motor. For a rpm of 2150 the current is supplied at a normal frequency of 50 Hz. To reduce the rpm to 1950 the frequency of the supply is brought down to the necessary level (approx. around 43 Hz). It has been observed from the energy meter readings that after installation of the inverter and replacing the two oversized 5 hp motors by a single 7.5 hp motor, the current drawn is just 8.1 amps(rpm=2150) to 7.5 amps(rpm=1950) . On on average, the modified setup draws a current of just 7.8 amps. It is quite obvious that there will be a substantial amount of power saving by the modifications made in the existing setup. It is to be noted at this juncture that, the change of replacing the two oversized 5 hp motors by a single 7.5 hp motor necessiates the total redesign of the gear end since, two drum shafts have to be driven by a single driver motor. Also, the existing ribbon breaking mechanism cannot be coupled with the 7.5 hp motor sice it will lead to early burnout of the motor. So both the modifications have to be made together to obtain a better efficient drive.

4.3 BEARINGS

Commercial unground ball bearings are available as radial, thrust, or combination types. Basically, these ball bearings are made of a machined or stamped inner race, a full complement of hardened steel balls, and an outer race of one, two, or more machined or stamped parts. Race and casing material is usually carbon steel. Because surfaces are unground, and because some parts are stamped, the ball bearing has greater radial and axial freedom than a precision bearing.

Unground ball bearings generally are suited to light loads at low speeds. Lower the speed, the greater the ball bearing's load capacity. Generally, the ball bearings are not suited to speeds above 1,200 to 1,500 rpm. At these speeds, loads may range from 50 to 500 lb, depending on bearing size and construction. On the other hand, loads of 2,500 lb may be practical with a ball bearing operating at 50 rpm.

Misalignment has little effect on commercial unground ball bearing assemblies because of their greater internal clearances. Excessive misalignment destroys any bearing, but far less production accuracy is required with unground ball bearings. As a result, the entire assembly can be much simpler in construction than a precision bearing.

The major advantage of unground ball bearings over the higher precision ball bearings discussed earlier is price. Unground ball bearings are far less expensive than the higher precision types. On the other hand, life of unground ball bearings is less than precision bearings. Also, unground ball bearings generally feature inch rather than metric external dimensions. Unground ball bearings also operate at higher noise than precision bearings. This may be overcome, when necessary, by using a nonmetallic material on outer cases.

4.3.1 Ball Bearings - Lubrication:

Ball bearings may be lubricated with either oil or grease. Although oil is preferred, grease is often used for convenience. Lubrication minimizes ball bearing rolling resistance due to deformation of the balls and raceways, and reduces sliding friction between the balls, raceways, and retainer. Ball bearing lubricants carry heat away from the contact zone, prevent corrosion, and help exclude contaminants.

Grease quantity and characteristics must satisfy operating conditions. Too much or too viscous a lubricant generates heat due to friction within the lubricant itself or between lubricant and ball bearing. Too little or too light a lubricant provides insufficient film protection.

Many ball bearings are supplied factory-lubricated, also known as lubricated-for-life bearings. These bearings have seals and an initial supply of grease for inaccessible locations or where re lubrication is impractical.

Another important characteristic of ball bearings is internal clearance. Radial ball bearings have internal clearances between rings and balls to absorb the effects of press fitting. They compensate for thermal expansion of ball bearing, shaft, and housing, and provide a contact angle in ball bearings after mounting. Before mounting any ball bearings, check the manufacturer's specifications for required shaft and housing

4.3.2 Radial ball bearing

There are two basic types of radial ball bearings: the non-filling slot or Conrad type, and the filling slot or maximum capacity ball bearings.

Conrad ball bearings have a deep, uninterrupted raceway in inner and outer rings. This design carries heavy radial and moderate bidirectional thrust loads. The filling slot or maximum capacity ball bearing contains more balls than an equivalent-sized Conrad type, and therefore, a higher radial load capacity. However, because of the filling slots, thrust loads must be light and applied only in combination with a heavier radial load. Exceeding rated thrust causes balls to roll over the filling slots, causing severe damage to the ball bearing. Ball Bearings feature a load capacity, which can also be increased by using double row ball bearings instead of the max type.

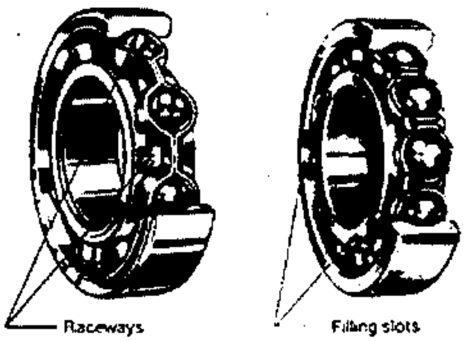


FIG 4.6 CONRAD-TYPE BALL BEARING, LEFT, AND MAXIMUM-CAPACITY (FILLING SLOT) TYPE, RIGHT.

4.3.4 Thrust ball bearings

A thrust ball bearing provides axial shaft location and supports axial (thrust) load. Angular-contact ball bearings support radial as well as thrust loads. The ratio of radial to thrust loading depends on the angle of contact between the races and the ball bearing axis.

4.3.5 Grooved race, flat-seat ball bearings, flat race, flat seat ball bearings

Flat race, flat seat ball bearings, consists of two flat washers and a ball retainer assembly. Thrust ball bearings are used where the ball retainer assembly must carry thrust loads without restraining shaft oscillation or flexures. They serve best with light loads and are economical. This ball bearing's load capacity is approximately 28% that of comparable grooved-race ball bearings

Grooved race, flat-seat ball bearings, Figure 5B, are the most common type of thrust ball bearings. These ball bearings consist of a shaft-mounted small-bore washer, a large housing-mounted bore washer, and a ball retainer assembly.

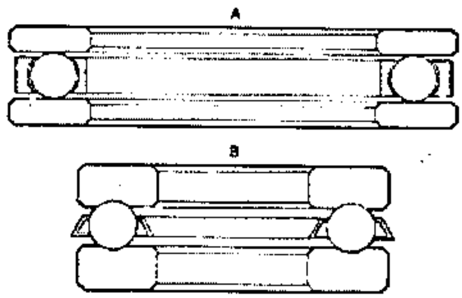


FIG 4.7 FLAT-RACE, FLAT-SEAT THRUST BALL BEARING, A, AND GROOVED-RACE, FLAT-SEAT THRUST BALL BEARING, B.

4.3.6 Banded thrust ball bearings

Banded thrust ball bearings, are self-contained, have grooved races, have a stationary and rotating race with full ball complement, and are encased in a containing band. These ball bearings are most commonly used where the bearing's outer circumference must be protected from contamination, for blind installation, or where separating forces cause substantial axial motion of ball bearing components.

Aligning, grooved race ball bearings are available in single and double-acting types. Double-acting thrust ball bearings consist of two retainer assemblies separated by a flat washer and have washers on the top and bottom of the unit. Aligning members compensate for initial misalignment due to shaft deflection or mismatch, while allowing uniform distribution of load through the bearing. Aligning, concave surface washers are generally soft, to ensure proper seating through wear-in.

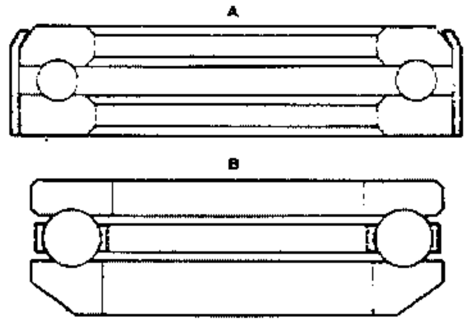


FIG 4.8 BANDED THRUST BALL BEARING, A, AND ALIGNING, SINGLE-ACTING, GROOVED-RACE THRUST BALL BEARING, B.

4.3.7 Double-acting, grooved-race ball bearings

Double-acting, grooved-race ball bearings, have two identical flat seat washers, two ball retainer assemblies, and a center washer. They carry thrust loads in either direction. One ball assembly carries load in one direction, the other assembly in the reverse direction.

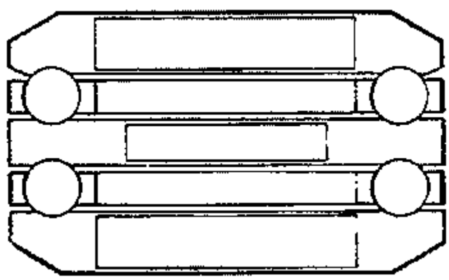


FIG 4.9 ALIGNING, DOUBLE-ACTING, AND GROOVED-RACE THRUST BALL BEARING.

4.3.8 Unground ball bearings

Commercial unground ball bearings can reduce cost of assemblies, decrease the number of parts required, and reduce labor costs by speeding assembly for original equipment ball bearing manufacturers. Because tolerances are much looser than in precision ball bearings - commonly 0.005 in. for OD and ID - extra fasteners and locking plates are often unnecessary with unground ball bearings. A split race type simplifies assembly. A press-fitted flange radial ball bearing, for example, seats itself. Drilled and tapped inner races or square or hex bore inner races provide an inexpensive means of locating the bearing on the shaft. In many cases, the shaft itself serves as an inner race.

4.3.9 Thin section bearings

Thin-section bearings are used mainly where space and weight must be conserved. Cross-sectional area of these bearings remains constant within a series, regardless of bore diameter. Thin-section bearings have much lower inertia than conventional bearings of equal bore, and they require much smaller envelopes, which can significantly reduce overall drive weight.

Thin-section bearings come in ball and roller types. To choose a specific type, use the same criteria you would use to select a conventional bearing.

By nature, thin-section bearings have a much lower load capacity than equally sized conventional bearings. When load, life, and speed permit their use, thin-section bearings allow lighter, more compact designs than conventional extra-light series bearings.

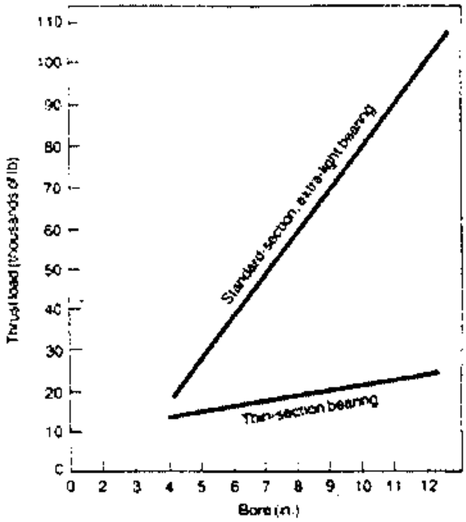


FIG 4.10 TYPICAL LOAD CAPACITIES OF THIN-SECTION AND STANDARD-SECTION, EXTRA-LIGHT SERIES, ANGULAR-CONTACT BALL BEARINGS.

Thin-section bearings are designed for light to medium-duty drives operating at medium and slow speeds. Conversely, they are not well suited for heavy-duty or high-speed drives operating continuously. Speed limitations (DN) are shown.

Because rolling elements and races are so small in thin-section bearings, they must be properly supported in the drive's assembly. Be sure that axial, radial, or moment deflection of the thin-section bearing does not prohibit its use. Also, imperfections in bore or shaft diameter will be transmitted to rolling paths, reducing life or increasing torque drag of the bearing.

Thin-section bearings may also reduce the number of required components in a design. For example, rotating kingpost assemblies using two standard bearings and a long shaft can be replaced with a more compact design using large diameter thin-section bearings. In the conventional kingpost design, standard bearings are mounted back-to-back to maximize rigidity under moment loading. The thin-section design uses large-diameter thin-section bearings to increase rigidity of the structure. The bearings, mounted back-to-back, support a hollow shaft that is more rigid than the small diameter shaft. As an added benefit. wiring and hoses can be routed through the hollow shaft, protecting them from damage

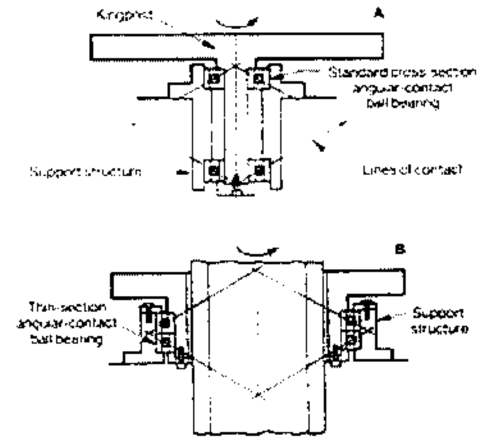


FIG 4.11 ROTATING KINGPOST ASSEMBLIES: CONVENTIONAL DESIGN, A, AND IMPROVED DESIGN USING THIN-SECTION BEARINGS, B.

4.3.10 Roller bearings

Because roller bearings have greater rolling surface area in contact with inner and outer races, they generally support greater loads than comparably sized ball bearings. Rolling-element geometries include cylindrical rollers, of rectangular cross section; spherical rollers, which are barrel or hourglass-shaped; and tapered rollers, of trapezoidal cross section.

Cylindrical roller bearings are designed primarily to carry heavy radial loads. Spherical roller bearings carry primarily radial loads but, in addition, accept some thrust loading and accommodate wide variation of shaft-to-housing misalignment. Tapered roller bearings carry radial and thrust loads.

4.3.11 Cylindrical roller bearings

Cylindrical roller bearings have the highest radial capacity for a given cross section, and the highest speed capability of any type of roller bearing. A nonlocating bearing, allows axial movement of the inner or outer ring to accommodate thermal axial expansion of the shaft and tolerance buildup in an assembly. Cylindrical roller bearings with ridges on the inner and outer rings accommodate some thrust. The amount depends primarily on the rate of heat generation and the rate of heat dissipation by conduction and oil circulation.

Limiting speed of a cylindrical roller bearing depends on the roller length-to-diameter ratio, precision grade, roller guidance, cage type and material, type of lubrication, shaft and housing accuracy, and heat dissipation properties of the overall mounting. For general use, roller length equal to roller diameter provides the best balance of load and speed capacities. The limiting speed of a "square" roller bearing is considered equal to that of a comparable series ball bearing. The limiting speed for outer ring rotation is about 2/3 the limiting speed for inner ring rotation. Because limiting speed depends on many variables, consult the bearing manufacturer's catalog for specific values.

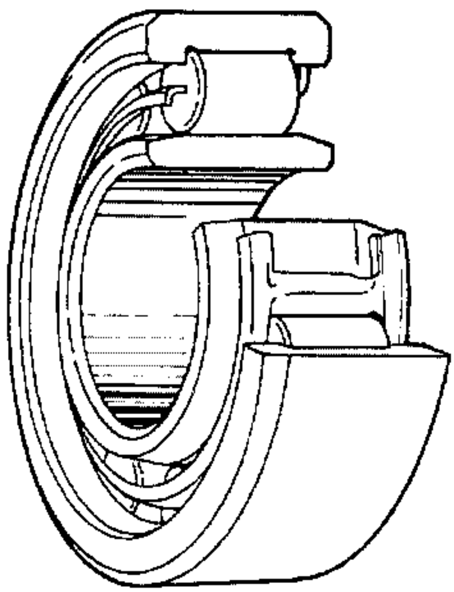
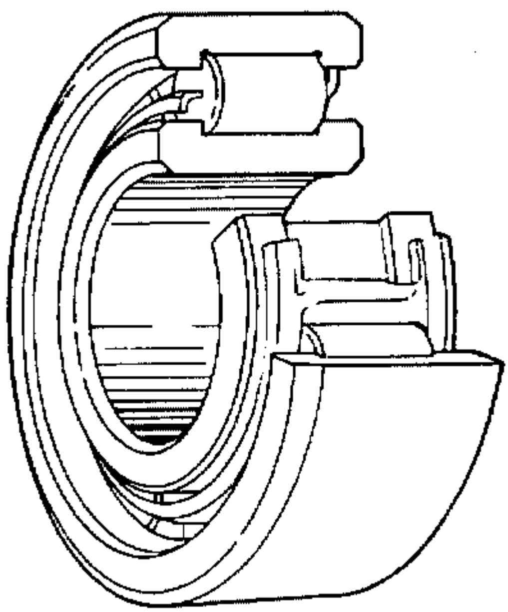


FIG 4.12 NONLOCATING CYLINDRICAL ROLLER BEARING

The bearings must position a rigid shaft in a rigid housing so that the shaft rotates freely with minimum radial and axial movement.

To do this, the bearings must support the shaft at only two points - usually at each end of the shaft. One bearing should locate the shaft axially, while the bearing at the other end of the shaft allows axial expansion or contraction.

Although roller bearings support greater loads than ball bearings, roller bearings are more sensitive to misalignment. Angular misalignment between the shaft and housing causes non uniform loading of rollers, resulting in reduced bearing life. Poor alignment of the bearing on the shaft is another cause for misaligned inner and outer rings. Such misalignment occurs even with unloaded bearings. The external load may deflect the shaft or housing, which is another source of bearing misalignment. This bearing allows no axial displacement of the shaft and is usually used in conjunction with an axially free bearing.



4.13 CYLINDRICAL ROLLER BEARING WITH AXIALLY FIXED INNER AND OUTER RINGS.

4.3.12 Needle bearings

Needle roller bearings - Similar in appearance to cylindrical roller bearings, needle roller bearings have a much smaller diameter-to-length ratio. By controlling circumferential clearance between rollers, or needles, rolling elements are kept parallel to the shaft axis.

A needle roller bearing's capacity is higher than most single-row ball or roller bearings of comparable OD. The bearing permits use of a larger, stiffer shaft for a given OD, and provides a low-friction rolling bearing in about the same space as a plain bearing.

The basic needle roller bearing is the full-complement, drawn-cup bearing. The outer race is a thin, drawn cup that has been surface hardened. Roller ends are shaped so that lips on the outer race keep them from falling out. Because the outer race is thin, it must be installed in a correctly sized and properly backed-up housing to transmit load effectively. In most instances, a hardened shaft acts as the bearing's inner race, although an inner race can be supplied when the shaft cannot be hardened.

The grease-retained, drawn-cup needle roller bearing is not used as extensively as the basic, mechanically retained version because rollers may fall out if the shaft is removed. Also, the heavy grease that retains rollers is incompatible with some applications. The advantage of this type of bearing over the basic bearing is the higher load-carrying capacity because rollers have spherical ends.

A caged needle roller bearing is designed for heavier-duty, higher-speed applications. The heaviest-duty needle roller bearing has a machined cage. Both machined-outer-race and drawn-cup caged bearings have sufficient voids to allow pregreasing the bearing for lifetime lubricated applications. Even with these bearings, operating life can be extended if provision is made for periodic relubrication.

4.3.13 Guidelines to be considered when selecting needle roller bearings

The most compact and economical arrangement uses the equipment shaft as the bearing's inner race. In this situation, manufacturer requirements for shaft hardness and surface finish must be followed.

Typical values for hardness range from Rockwell 58C to 60C; surface finish, 16 min. or better. Shaft parallelism is to be kept within 0.0003 in. for the full length of the bearing, or within half the shaft tolerance, whichever is less.

4.3.14 Special, heavy-duty needle roller bearing -Cam followers

A cam follower is a special, heavy-duty needle roller bearing with a heavy outer race section. There are two basic types: one with an integral stud for cantilever mounting; the other, an integral inner race for yoke mounting. Both types, Figure 15, may have a crowned OD, which compensates for a reasonable amount of bearing misalignment with the track or cam to prevent corner loading of the outer race. This helps maintain more uniform stress distribution over the track or cam surface, and increases assembly life. Crowning also minimizes skidding of the cam follower on flat circular tracks or cams.

To select a cam follower, evaluate load, speed, alignment, track or cam design, and available lubrication. If operating speed is less than the maximum allowable speed, choose a bearing size from the given load and speed for a specific life requirement. For shock loads, consider a heavy stud cam follower or cam yoke roller.

To prevent galling between the follower OD and the track member, lubricate the track with grease of high enough consistency to adhere to the track during operation. For continuous rotation, provide continuous oil lubrication or frequent grease relubrication. Automatic lubrication devices are strongly recommended for intermittent lubrication.

4.3.15 Spherical roller bearings

The term spherical roller bearing generally refers to a single or double-row, internally self-aligning roller bearing. Self alignment is obtained by making one of the raceways a portion of a spherical surface. These bearings support high radial or combined radial-axial loads. The double-row type generally is not used for pure thrust load, but the single-row type can be used to support predominantly thrust load.

Probably the greatest advantage of spherical roller bearings is the ability to accommodate misalignment with no decrease in rating or life. They usually accept 1 or 2-deg misalignment.

As a rule, spherical roller bearings lubricated with grease are limited to a speed that produces a DN value no greater than 100,000. Oil-lubricated bearings generally operate up to 200,000 DN. Spherical roller bearings have operated successfully at 1 million DN.

4.3.16 Tapered roller bearings

Applications in a wide variety from appliances and aircraft wheels to machine tools, automotive transaxles, and industrial equipment of all types are served by tapered roller bearings.

In a tapered roller bearing, the rollers and races are built on a cone principle. Specifically, the apexes of the rollers and races meet at a common point on the bearing axis.

4.3.17 Load-carrying capability

Because of this geometry, tapered roller bearings are the only type of bearing that can carry heavy radial loads, or thrust loads, or any combination of the two.

When a tapered roller bearing is loaded, the external load is transformed into three load components: a radial component perpendicular to the bearing axis; a thrust component parallel to the axis; and a smaller roller-seating force. This seating force keeps the large end of each roller in contact with a rib on the large end of the cone, providing positive roller guidance that keeps rollers aligned. Because the tapers of the rollers, cup, and cone meet at a common apex on the bearing centerline, the rollers rotate with true rolling motion with no skidding of rollers over a raceway. Thus, tapered roller bearings perform well during the life of an application.

In addition, the race and roller angles can be matched to the loading situation - shallow angles for predominantly radial loads and steeper angles for greater thrust capacity.

4.3.17 Speed capability

Tapered roller bearings can handle applications from low-speed railway axles to high-speed turbine shafts. For very high-speed applications, it may be necessary to make special lubrication and design provisions.

4.3.18 Misalignment

Tapered roller bearings can be highly tolerant to misalignment and deflection for two basic reasons:

1. There is the ability to adjust internal clearance within a tapered roller bearing during installation.
2. Mounting arrangement can significantly increase stiffness of an assembly.

4.3.19 Preload and end play control

A special characteristic of tapered roller bearings is that their internal clearance - or setting - is adjustable. It can be optimized for a given application without re machining shafts or housings, to provide the best performance and life in any given application. Tapered roller bearings can be manually set, supplied as a preset assembly, or set by using one of several automated setting techniques.

4.3.20 Precision

Tapered roller bearings in the "precision" class are produced with maximum radial runout (out-of-roundness) of 75 millionths of an inch. "Super-precision" bearings for the highest-accuracy applications such as machine-tool spindles, have maximum radial runout of just 40 millionths of an inch: 1/60th diameter of a human hair.

4.3.21 Profile control

The contact geometry between the large roller end and the cone rib is closely controlled to enhance lubrication. Special attention is paid to the roller body and cup and cone raceway profiles to ensure full-line contact for maximum load capacity. For very high loads or misalignment, or both, the contact profiles can be modified to minimize stress concentrations and maximize performance.

4.3.22 Materials

Cups, cones, and rollers of most tapered roller bearings are case carburized. The case carburization process produces hard, long-lasting contact surfaces that can carry heavy loads without distress and the tough, ductile core can endure heavy shock loads.

4.3.23 Types

Tapered roller bearings come in a wide variety of types. The basic single-row bearing is available in many angles and roller lengths to provide a wide range of radial and thrust ratings. For more capacity, two-row bearings are used. For exceptionally rigorous service such as rolling mills, four-row bearings are used. Also available are a variety of thrust bearings, and packaged bearings with seals, lubrication, and preset adjustment.

4.4 BELTS

Belts are used to transmit power from one shaft to another by means of pulleys which rotate at the same or different speeds. The amount of power transmitted depends on the following factors:

1. The velocity of the belt.
2. The tension under which the belt is placed on the pulleys.
3. The arc of contact between the belt and the smaller pulley.
4. The conditions under which the belt is used.

4.4.1 Selection of a belt drive

The various important factors upon which the selection of a belt drive depends are as follows

1. Speed of the driving and driven shafts
2. Speed reduction ratio
3. Power to be transmitted
4. Centre distance between shafts
5. Positive drive requirements
6. Shafts layout
7. Space available
8. Service condition

4.4.2 Multiple V-Ribbed Belts

Multiple V-Ribbed Belts combine the high flexibility of flat belts with the high power transmission capacity of V-belts. Multiple V-Ribbed Belts allow low cost design, even with difficult drive system requirements such as high transmission ratios, high belt speeds, small pulley diameters and reverse-tensioning idlers. They are particularly suitable for serpentine drives and provide a reliable and highly efficient element of friction transmission, compact drives.

Multiple V-Ribbed Belts are made of first class materials and consists of the following three components:

1. base construction
2. tension member
3. cover

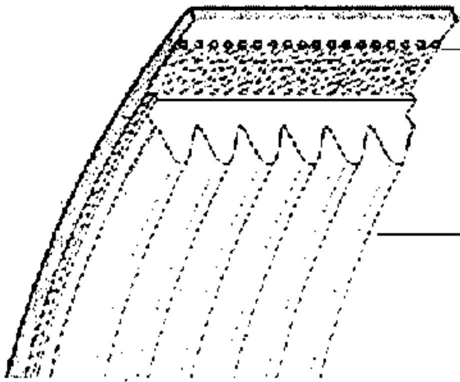


FIG 4.14 MULTI RIBBED BELT

4.4.2.1 Base construction

The base construction is made up of parallel V-shaped ribs in the direction of the belt travel. These ribs guarantee a good frictional engagement and ensure an even load distribution throughout the entire width of the belt. The polychloroprene base elastomer is reinforced by transversely aligned fibers. It is hard wearing and not affected by ambient in influences.

4.4.2.2 Tension member

The tension member consists of high-strength low-stretch polyester cords, which are continuously wound across the whole belt width, and kept enclosed in a special compound which is firmly bonded to the base construction.

4.4.2.3 Cover

The durable, flexible cover provides lasting protection of the tension member and permits the use of reverse-tensioning idlers.

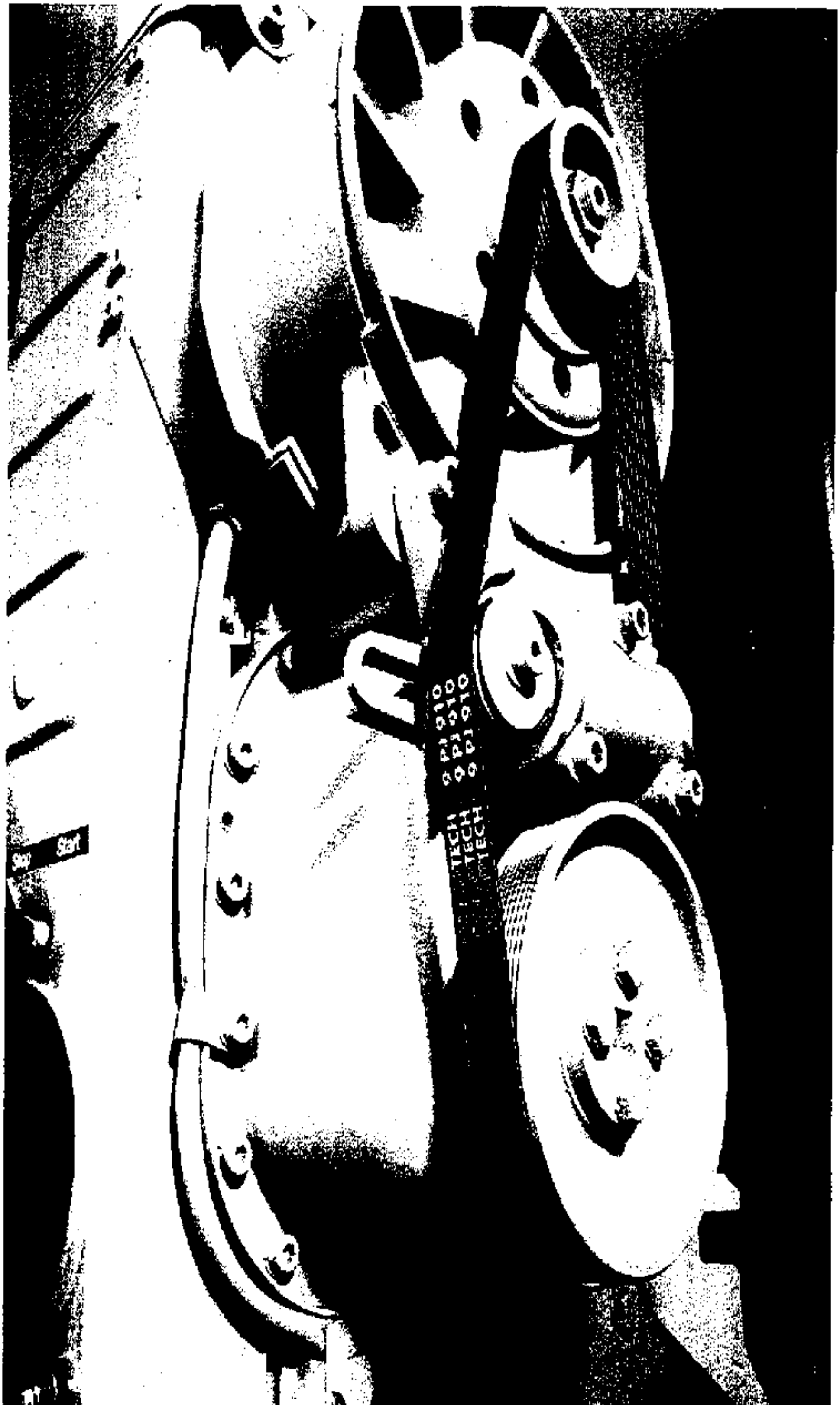


FIG 4.15 MULTI RIBBED BELT

4.4.3 Properties

4.4.3.1 High transmission ratio

The belt's construction ensures extremely high flexibility and consequently transmission ratios of up to 1: 40 using pulleys of extremely small diameter.

4.4.3.2 High belt speed

Construction and materials allow high-speed drives with belt speeds with speed up to 60 m/s.

4.4.3.3 Compact drives

The outstanding flexibility permits a high reverse bending capacity at a belt flex frequency of up to 120 per second. This means that extremely small diameter pulleys can be used and also allows counter flexing. Limitations like Short centre distances and restricted spaces can be overcome by using reverse-tensioning idlers and serpentine drives.

4.4.3.4 High power transmission

Excellent frictional engagement and even load distribution across the entire belt width contribute to ensure an efficiency of 98%. For high power transmissions, Multiple V-Ribbed Belts of the ZAR type which have several aramid tension members can be employed. For lower power transmissions and high speed changes, Multiple V-Ribbed Belts can be used as V- flat drives.

4.4.3.5 Smooth running

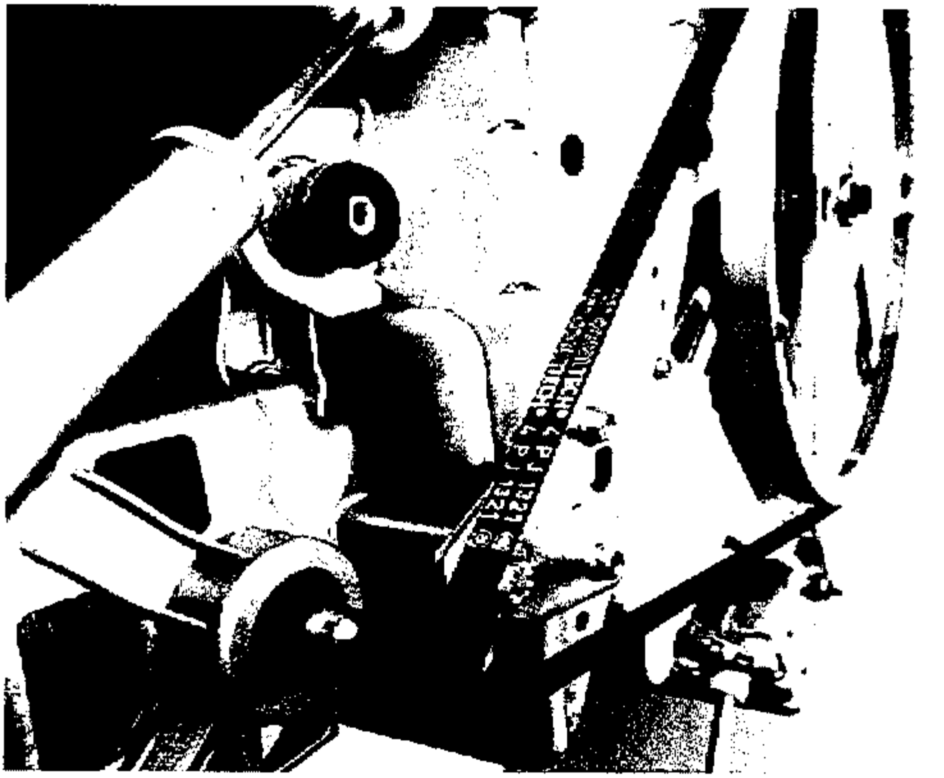
No twisting in the pulley grooves due to the single belt design characteristics. This ensures low vibration and quiet operation.

4.4.3.6 Long service life

The tough abrasion resistant materials can withstand high loading and dynamic Stress. This assures long belt life and economical drives.

All standard Multiple V-Ribbed Belts are:

- designed for temperatures ranging from 80 C to 30 C
- resistant to certain oils
- unaffected by weathering
- resistant to effects of ozone
- suited to use in tropical climates



- electrically conductive

FIG 4.16 MULTI RIBBED BELT

4.4.4 Designation

Multiple V-Ribbed Belts are fully specified by a coding system based on DIN 7867/ISO 9982 and showing the following data:

- number of ribs
- belt section
- effective length
- type

Examples

Multiple V-Ribbed Belts 6 PJ 1321/520 J 6

DIN/ISO designation

6	-----------------	Number of ribs
PJ	-----------------	belt section
321	-----------------	Effective length in mm
UK designation 520	-----------------	effective length in 1/10 inch
J	-----------------	Belt section
6	-----------------	Number of ribs

4.4.5 Multi ribbed belts

The performance of a Multiple V-Ribbed Belt drive is affected to a large extent by the multi-grooved pulleys contained in the drive. Pulleys should be manufactured to DIN 7867/ISO 9982 specifications.

Multi-grooved pulleys are made of materials widely used in mechanical engineering, such as St 37 and steel of higher strength ratings, grey cast iron (e.g. GG 20) with no signs of bubbles or other surface irregularities, as well as aluminum alloys with coated surface.

4.4.6 Selection

4.4.6.1 Only use recommended pulley diameters

In general, the effective diameters should be selected according to the R-20 series.

4.4.6.2 Never use below minimum pulley diameters

Pulley diameters smaller than those recommended will shorten the belt's life and hence impair the economical and reliable operation of the drive.

4.4.6.3 Select relatively large pulley diameters.

Large pulley diameters have a positive impact on the service life of the belt. However, care should be taken to ensure that the maximum belt speed is not exceeded. Drive economy factors should also be taken into consideration for each individual case.

4.4.7 Modifications made in the Belt drive

In the existing setup all the belts used in the gear end to transmit power were V belts. In the existing setup the power was transmitted to the drum shaft from each motor (5 hp) by a single V belt. Since there is only one motor (7.5 hp) to drive the drum shafts now, it is necessary to redesign the belt drives. To transmit the power from motor to the main shaft a multi ribbed belt is used. From the main shaft to the drum shafts the power is transmitted with the help of timing belts. By using timing belts the exact rpm required can be obtained, since there is no slip. Also it has been established that there will be a power saving of 3% by using ribbed belts.

4.4.8 Modifications made in the gear end- Drawings

In the few coming pages, the changes that have been made in the existing setup to accommodate the proposals made are depicted in drawings.

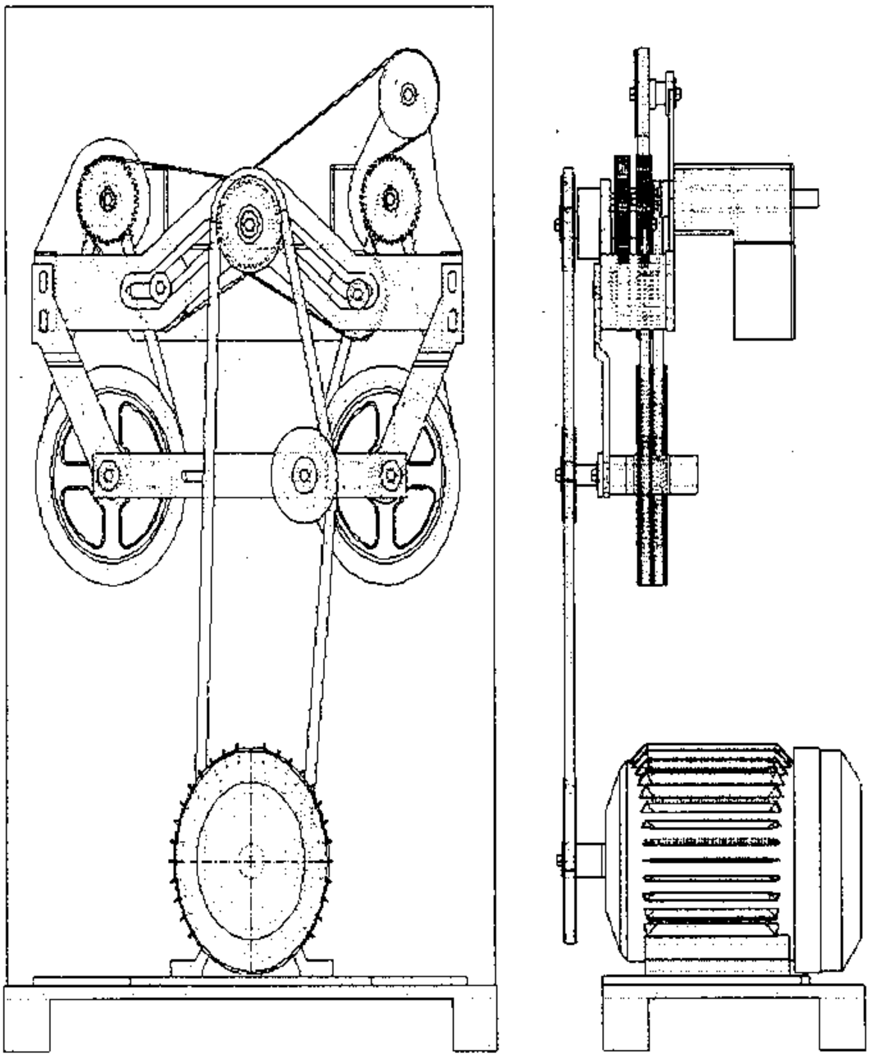
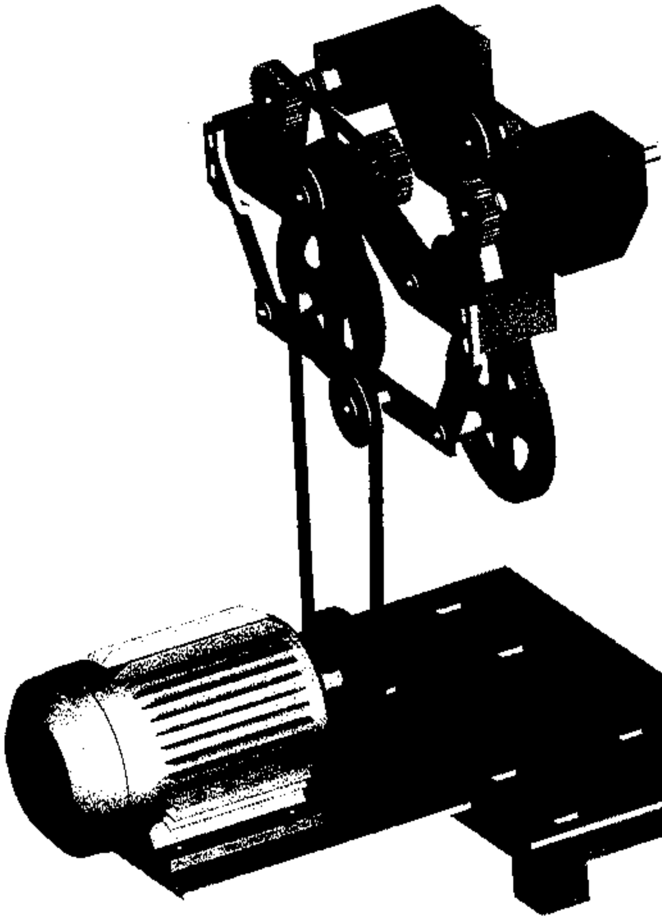


FIG 4.17 ASSEMBLY OF MODIFIED SET UP



4.18 3-D ASSEMBLY OF PRESENT SETUP

The above drawings depict the changes made in the existing setup to incorporate the proposed changes.

CHAPTER 5
POWER SAVING

5.1 POWER SAVING

In the present setup two 5 hp motors are used. Each one is used to drive a drum shaft separately. From the energy meters installed in the present machine a few observations have been made. They are explained as follows:

In the present setup there are two 5 hp motors (one for each drum shaft). The full load rated current of one 5 hp motor is about 7.5amps. Also, it has been observed that when the supply to the motor is about to be cut-off, one motor draws about 4.5 amps and the other one about 3.9 amps. When the supply id restored, one motor draws about 5.5 amps and the other one about 6.1 amps. Thus on an average each motor draws around 5 amps. When the supply is cut-off the rpm falls down to 1950 from 2150.

The full load rated current of 5 hp motor is 7.5 amps. But the motor draws an average of just 5 amps. It means that the motor loading is about 66.67%. It would be enough for the motors to draw 8-9 amps to take the load. At that condition, the loading would fall below 60%. It has been established that maximum efficiency of the motor occurs at about 75% of the dull load current. So power losses can be avoided to a major extent provided the motors are loaded suitably.

5.2 EFFICIENCY OF A MOTOR

Electric motor efficiency is the measure of the ability of an electric motor to convert electrical energy into mechanical energy i.e. kilowatts of electric power are supplied at its electric terminals and the horse power of mechanical energy is taken out of the motor at rotating shaft. Therefore, the power absorbed by the electric motor is the only loss incurred in making the conversion from electrical to mechanical energy. Thus the motor efficiency can be expressed as,

Efficiency = (Mechanical energy i/p / Electrical energy i/p) * 100

The various losses occurring in a motor are

1. Power losses (55%)
2. Magnetic core losses (20%)
3. Friction and windage losses (9%)
4. Stray load losses (16%)

5.3 FORMULAE:

1. Efficiency = (Mechanical energy o/p / Electrical energy i/p) * 100

2. I/P Electric power = (rated hp * 746)/ efficiency

3. Power factor = (O/P hp * 746) / (voltage*√3*efficiency*I)

   I= Stator current in amps.

4. Stator Current, I = I/P watts / (voltage*√3* Power factor)

5. Power consumed = $\sqrt{3}\ V\ I_d \cos\theta$ * Loading factor

   I_d = Current drawn

6. Loading factor = Current drawn / Rated full load current

5.4 CALCULATIONS FOR EXISTING SETUP:

Current drawn (for both motors on average) = 10 A

Rated load current (for both motors) = 15 A

Voltage = 415 Volts

Loading factor = Current drawn / Rated full load current

= 10/15

Loading factor = **0.667**

Efficiency = (Mechanical energy o/p / Electrical energy i/p) * 100

= (7460/9160) * 100

= **81.4%**

Power factor = (O/P hp * 746) / (voltage*√3*efficiency*I)

I= Stator current in amps.

PF = (10*746)/ (415*√3*15*0.814)

PF = 0.85

Power consumed = √3 V I_d Cos θ * Loading factor

I_d = Current drawn

Power Consumed = √3*415*10*0.667

= **4.794 Kw hr**

→ Power Consumed (per day) = 4.794 * 24 = **115 Kw hr**

5.5 CALCULATIONS FOR MODIFIED SETUP:

Current drawn (on an average) = 7.8 A

Rated load current = 11.2 A

Voltage = 415 Volts

Loading factor = Current drawn / Rated full load current

= 7.8/11.2

Loading factor= **0.696**

Efficiency = (Mechanical energy o/p / Electrical energy i/p) * 100

= (5595/6590) * 100

= **84.9%**

Power factor = (O/P hp * 746) / (voltage*√3*efficiency*I)

I= Stator current in amps.

PF = (7.5*746)/ (415*√3*11.2*0.849)

PF = 0.82

Power consumed = $\sqrt{3}$ V I_d Cos θ * Loading factor

I_d = Current drawn

Power Consumed = $\sqrt{3}$*415*7.8*0.696

= 3.902 Kw hr

➔ Power Consumed (per day) = 3.902 * 24 = **94 Kw hr (approx)**

Voltage = 415 volts (for both set-ups)

5.1 VARIOUS PARAMETERS COMPARED FOR BOTH SET-UPS

1	Loading factor	**0.667**	**0.696**
2	Efficiency	**81.4%**	**84.9%**
3	Power factor	**0.85**	**0.82**
4	Current drawn	**10**	**7.8**
5	Rated load current	**15**	**11.2**
6	Power Consumed	**4.794 Kw hr**	**3.902 Kw hr**
7	Power Consumed (per day)	**115 Kw hr**	**94 Kw hr**

Remark: For the existing setup, all calculations are made for both the motors together.

5.6 SAVINGS & RETURNS ON INVESTMENT

Savings in terms of Power = (Power consumption of existing setup-
Power consumption of existing setup)

= 4.794- 3.902

Savings in terms of Power = **0.892 Kw hr**.

Savings in terms of Power = 0.892 * 24
(per day) = **22 Kw hr** (approx)

1 Kw hr (1 unit) of power costs Rs. 4.60 to the concern.

→ Savings per day = 22 * 4.60 = Rs. 101.20

→ Savings per month = 101.20 * 30 = Rs. 3036

→ Saving per year = 3036 * 12 = Rs. 36,432

→ % power saving = (21/115) * 100 = 19%

TABLE 5.2 ADDITIONAL INVESTMENTS MADE

S. No.	Item Name	Quantity	Cost Incurred Rs
1	**7.5 hp motor**	1	11,500
2	**Inverter setup**	1	25,000
3	**Ribbed Belt**	1	2000
4	**Timing Belt**	2	1500
5	**Aluminium Pulleys, Idlers, Bearings**	-	5500
6	TOTAL		45,500

5.7 BREAK EVEN POINT

Break even point is described as the point at which there is no loss or no profit. The additional investment made can be recovered in **45,500/3036** months i.e. the additional investment of Rs. 60,000 made towards modifying the existing machine will be recovered in **15 months.**

Break even point = **15 months** from the day of Installation.

5.8 AREAS FOR FURTHER DEVELOPMENT

In the existing machines, Ball bearings are used on the drum shaft. It is well known that ball bearings are best suited for axial loads. But the drum shafts in the present machine are mainly subjected to radial loads. Cylindrical roller or Needle bearings are best suited for such radial loads. Ball bearings cost not more than Rs.300 whereas cylindrical roller bearings or Needle Bearings cost between Rs.2500 to Rs.2800. And there are totally 86 bearings in the machine that are to be replaced. This will increase the cost of machine by Rs.1, 89,200 which is too high for an investment to be made. But this is one area where, in the future, efficiency of the machine can be improved.

TABLE 5.3 SCOPE OF THE FUTURE MACHINE

S. no.	Parameter	Existing setup cost in Rs.	Future setup cost in rs.
1	Motor	18000	11500
2	Ribbon Breakers	12000	25000
3	Belt	900	3500
4	Pulleys, Idlers, Bearings	1000	6000
5	TOTAL	31,900	45,500

Extra investment in the new machine= 45,500 – 31,900

= 13,600 .

An extra investment of Rs.13,600 is made in the new machine. But the power saving in the new machine is Rs.3036 every month. This extra investment made can be recovered in (13600/3036) months i.e. **4 months and 9 days.**

CHAPTER 6

CONCLUSION

CONCLUSION

In the past few decades there had been a notable shift in the market from being a manufacturer oriented one to customer oriented one. Moreover the competition has increased tremendously. So manufacturers have to produce the machine in a cost efficient manner and provide lucrative value additions to make profits.

Through the project, it has been identified that the present set up has over sized motors and a high current drawing ribbon breaking mechanism. To overcome these drawbacks, the present two 5 HP motors were replaced by a single 7.5 HP motor. By doing this it had been possible to reduce the current drawn and also avoid the overheating of the motor.

The savings are about **Rs. 3036** for the company and **660 units** for our country, per month. This accounts for about **20% power saving** and reduction in the total power consumption of the machine. And also the machine incorporating the modifications has a pay back period of just **1 year and 3 months**. A new machine will have a payback period of just **4 months and 9 days**.

The project which was just a "Vision" yesterday has now become a "Mission Accomplished" today. We are happy that our suggestions are going to help the concern to rise itself to a position, which the competitors can only dream of. Above all we feel proud & privileged to be one among the torch bearers running towards the goal of **OPTIMIZATION OF POWER CONSUMPTION**.

REFERENCES

1. Alexander.S.Langdorf, (1988), *Theory of Alternating Current Machinery,* Pearson Education.

2. Athre.K (1992), *Paper on Selection of Bearing Types And Application of Anti Friction Bearings.*

3. Bernard.P.Corbman, (1982), *Textiles-Fibre to Fabrics*, Tata Mc Graw Hill Publications.

4. Deshmukh.S.G , (1998), *Paper on Recent Developments in Motors and Drives.*

5. *Kalayanaraman .A.R .(1994), SITRA Journal, Article on Energy Saving Belts And Spindles.*

6. Nagrath.I.J, (1991), *Electrical Machines- 2,* Jain Publications.

7. Northern India Textile Research Association, Ghaziabad, (1978), *Proceedings of Workshop on Conservation of Electrical Energy in Textile Mills.*

8. Northern India Textile Research Association, Ghaziabad, (1992), *Workshop Series- Proceedings of Workshop on Integrated Cost Reduction Approach through Energy Conservation.*

9. Northern India Textile Research Association, Ghaziabad, (1976), *Seminar Series- Proceedings of Workshop on Energy Conservation in Textile Mills.*

10. Rai.V.S. (1993),National Productivity Council,Ahmedabad, Paper on Scope of Reduction in Power Bills in Textile mills. *Proceedings of Workshop on Cost Reduction in Textile Mills.*

11. Ramachandran.K.P, (1987),*Winding*, Peacock Publications.

12. Ratnam.T.V, (1982), *Cost Control and Costing in Spinning Mills*, Jain Publications.