



Open access Journal

International Journal of Emerging Trends in Science and Technology

Impact Factor: 2.838

DOI: <http://dx.doi.org/10.18535/ijetst/v3i05.09>

Design and Development of Twelve-Spindle Charkha by Converting Two Six-Spindle Charkha

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ABSTRACT

The Khadi industry is one of the largest employment generation initiatives in the country. This sector employed about 14.79 lakh people both full time and part time in khadi spinning during 1994. However today, the employment generation has come down to 7 lakh, in 2004. Hence a research has been undertaken to help the khadi spinner to earn a better wage in his rural home itself by redesigning the spinning wheel and adding some more spindles without unduly enlarging the size of the spinning machine.

The objectives of the study are clearly defined in the working. The methods to increase the speed of spindle and production rates in the charkha spinning machine have been discussed. Here the researcher has conceived idea of redesigning the charkha on the lines of the spinning machines that are working in large textile mills. As the ring frame is built on 6 Spindles per staff length, the researcher has taken 12 spindles so that commercially available parts are cheaper and could be easily fixed on to the machine frame such as fluted rollers, rings, spindles and top arms. The spinning angle and train of wheels to drive the machine have all been modified. Addition of spindles also contributes to increased production.

Knowing the Khadi cost chart rate we could easily calculate the wage earnings per day of the spinner. There is a 105 - 118 percentage increase in both production and wage earnings to the spinner on the improved 12 spindle charkha machine. The yarns that were spun on different charkhas which are available commercially and compared to the performance of 12 Spindle Charkha for yarn quality. By the present research work, millions of rural women who are in khadi industry can be retained in charkha spinning without any drudgery and earn a reasonable wage of Rs 174 per day for 8 hours working in improved 12 Spindle Charkha spinning. The yarn produced from the narrow width spinning charkha with 12 spindles is quite comparable with SITRA norms and could be used for making bed spreads with optimum returns to the weaver also.

Elongation percentage of yarn and Hairiness Index, in all these parameters studied, the 12 spindle machine gave good results which were comparable to SITRA (South Indian Textile Research Association) norms for yarn quality.

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HIGHLIGHTS

- 1] Collaborating Agencies with Mahatma Gandhi Institute Of Rural Industrialization (MGIRI), Wardha & Magansangrahalay, Wardha.
- 2] Purpose: There are thousands of charkhas of six spindle under Maharashtra Khadi Village Industries are lying idle in various centers all over Maharashtra. This is mainly because of introduction of eight and 12 spindle charkhas provide more productivity.
- 3] Need: Revival of this idle six spindle charkhas to be converted into twelve spindle charkhas. An opportunity is provided to generate employment and further conversion of solar operation. This will provide rural employment. No of charkha artisans in khadi sector are alarmingly decreasing. It is needed to revival in khadi sector to bring back the pride of khadi.
- 4] Trials: Charkhas converted are in operation at Magansangrahalay Seva Samiti Wardha
- 5] Outcome:
 - a] 6-Spindle Charkhas were successfully converted into 12-Spindle keeping the function of charkha are in normal operation.
 - b] Productivity of charkhas has increased obviously and also found out from the trials without involvement of much drudgery.
 - c] Yarn quality will remain same.
 - d] Cost: Huge cost benefit. Since, they are made out of scrap.

CHAPTER 1

INTRODUCTION

The cotton industry in India is known as one of the important manufacturing institution of the world. The term Khadi or Khaddar is commonly used in north and central part of India in order to define the coarse cotton clothes woven by hand spun yarn through the charkha. The khadi clothes are also considered as Gandhian Khadi as it was initiated by Mahatma Gandhi in the year 1918 (*Joshi, 2002*). In the 20th century, the cotton was locally grown and hand spun by local women. The hand weaving of the clothes is carried out by “Bunkar” (Weaver) caste people. Charkha is a small spinning machine which can be manually operated. Since India lives in its villages, the economic development of the country should be started from the rural areas. We should aim at “Production by masses instead of mass production”. If the earnings of the villagers will improve, standards of living, health and family planning will automatically follow. The Khadi and village Industries Commission (KVIC) was thus started in the year 1957. The objectives KVIC are social objective of providing employment, economic objective of producing the saleable goods and a wider objective of creating self-reliance among the rural people.

The box charkha has emerged into multi spindle charkha starting from 2 spindle wooden charkha, 4 spindle wooden charkha, 6 spindle wooden charkha and ultimately to 8 spindle all metal charkha which is the new model Rajkot charkha. This charkha is used commercially and gives a production of 30 hanks in 8 hours of work by the spinner. But the wage rate earned at this production is not sufficient to maintain a family and hence the charkha spinner migrates to other areas of work as cited by many researchers. A spinner migrates to the cities in search of employment and thus adds to the problems of infrastructure in the already crowded cities. With a view to increase the wage earnings, improve the yarn quality and ultimately to improve the sale rate of the yarn, the researcher has proposed to develop a narrow width and improved high speed spinning charkha machine that could spin most counts of yarn in Khadi sector. Hence by joining the two six spindle wastage spinning machine we convert it into a twelve spindle useful spinning machine to increase the product and wage in same time. Khadi is hand-spun and hand-woven fabric made largely out of natural fibers like wool, cotton and silk.

The charkha is designed to produce yarn by the process known as spinning. The charkha performs three basic operations. The word charkha means wheel and it is being used for spinning the rowing cotton into thread. Charkhas are available in 1, 2, 4, 6 and 8 spindle models. These charkhas are manually operated and unable to give enough income for the artisans due to less production and drudgery. In 2008-09, Rural Energy and Infrastructure department of MGIRI decided to convert the manual operated 8 spindle charkha into solar operation to increase the yarn production and improve the yarn quality. MGIRI is a national level autonomous institute comes under MSME and involved in research and development activities.



Figure1.1:12-Spindle Charkha

The departments of MGIRI work on their research and provide the solution on problems arises in the small scale industries. RE&I (Rural energy and infrastructure department of MGIRI act as a technical agency to support various small scale industries. Charkha plays a crucial role in the manufacturing of Khadi clothes in most of the clusters which are financed and technically supported by Khadi and village industries commission (KVIC) in India. KVIC provides the funds for development of clusters through various schemes and income generated from the clusters is used for wages of the workers and further development in the clusters. These clusters are also act as CFC (common facility centre) where artisans can use the available technology for spinning their own rowing cotton into thread and sell to the small scale weaving industries.

The Khadi textile industries come under KVIC which is a main body of the ministry of Micro, Small and Medium Enterprises (MSME). MSME is government body who can provide financial support to various research organization and small scale industries to create employment opportunities. The KVIC was formed in 1956 to meet the dreams of Mahatma.

! Drafting of the feed material (i.e. roving or sliver) until the required fineness is achieved;

! Twisting of the drafted fibre strand to impart strength; and

! Winding the resulting yarn in a form of suitable package.

Chapter 2 Consist of literature survey which includes previous studies and research done by the scientists about various types of charkhas, such as solar operated charkha, pedal operated charkha etc. Chapter 3 Consist of objectives of the charkha which includes design parameters, capacity, production rate and other factors. Chapter 4 Consist of Technical Specification of Charkha like there actual dimensions, Serial no. of top arm , spindle diameter etc. Chapter 5 Consist of Modified part list, the part which are replaced and the parts which are modified are included in it. And each part is elaborated with the actual figure shown in it.

Each and every part is briefly describe. Chapter 6 Consist of Construction and Working of 12 Spindle Charkha with its actual figure. Also the features of charkha are included in it. parameters like Drafting, Drafting operations, Twisting, Package formation etc are included. Chapter 7 Consist of Design of parts it includes their figure as well as their calculations. Chapter 8 Consist of Fabrication the process is describe in it. like from obtaining the charkha and converting the charkha into 12 spindle charkha, and the finished product we get. Chapter 9 Consist of Definitions of Concepts it includes the terms which are define in the report. Chapter 10 Consist of Advantages and Disadvantages of the 12 Spindle Charkha. Chapter 11 Consist of Conclusion of the study of 12 Spindle Charkha. Chapter 12 Future scope of this project is included in this chapter.

CHAPTER 2

LITERATURE SURVEY

Kriplani J.B. - in his edited book "Gandhian Thought", Gandhi smaraknidhi, Rajghat, published by Orient long man, New Delhi, has discussed issues and strategies on rural Industries, HumanResources Employed in Village Industries, Social aspects of Rural Industries & Economic policy in Rural India and the role of Village Industries ^[1].

Dr Meenakshi Sundram N. and ~ Dr. See Rangarajan .R - In their book "Developmental strategies for Small Enterprises - GRI, " have discussed selected Khadi& Village Industries and suggested strategies for growth of cottage Industries. They have clearly illustrated the Flow Process Chart from cotton fibers to yarn spinning and how khadi yarns can be efficiently spun in the cottage Industry. Mr. Soundrapandiyan.M in his book "Rural Industries In India " has selected all the papers, which basically deal with issues and strategies of Rural Industries, Human resources management in Rural Industries, social problems in Rural Industries and Economic Policy in India, and role of KVIC in Rural Industrialization ^[2].

Grosberg P. &lype C. in their Book "Yarn Production" published by Textile Institute, Manchester 2000 have dealt at great length on the theoretical affects of yarn spinning, general principles of yarn manufacture and the forecasting on the Fibers and Yarns. The magnitude of Electro Static forces acting on the fibers and friction on the Fibers & Yarns. The Balloon theory has been discussed in great detail and the tension changes occurring due to Ballooning has been established.

Pattabiram.T.K has edited "Essentials of Practical Cotton Spinning". The Book gives the formulas for calculating the speeds and production rates for different counts on spinning machines ^[4].

Gandhi M.K. In the article "Khadi, Why & How", Indian National Congress Convention, Bombay 1947, has explained the need to produce the khadi yarns and khadi cloth in rural houses, provide employment to rural masses and fight the evils of poverty and un employment ^[5].

Cost Chart, KVIC Publication (1979); describes the C (New Model Charkha Act), Production rates in hanks and wage rates to be paid for different counts are given in a tabular column ^[6].

Rural industrialization; why and How, KVIC Publication (1987)the report states that India lives in its villages. If the villages start rural industries it not only promotes employment and wage earnings but also prevents migration of the skilled work force to cities. It ensures peace and harmony in the country besides eco-friendly industries are promoted. K&VI provide employment to nearly 60-lakh people directly ^[7].

Radhakrishnan.S (2000) in his studies on KVIC on "Rural Industrialization" analyzed the performance of Khadi & village industries growth of production, sales into current and constant price in Khadi & Village Industries products, analyzing capital cost peremployment for capital consumption of Khadi and Village Industries all over India for a period of ten years. Their major findings are low/negative growth rate of production, sales, employment are due to many reasons like utilization of capacity, stiff competition from organized sector, low level technology and accumulation of stocks due to low sales. Increased allocation of

funds, use of modern technology, change of consumption pattern of people may in future increase the growth of Khadi and village Industries activities ^[8].

Bhartiya L.K. in his KVIC publications, (1990); "Towards rural Industrialization has described progress in rural Industrialization. He has made a mention to the development of 12-spindle hand operated charkha. The production rates and speeds achieved ^[9] .

"WARDHA LOOM", KVIC publication (1991) describes the Wardha Loom in some details. The flexibility of the loom in producing fabrics from cotton, silk and linen yarns. These looms made of wood are popular even today and used in large numbers in the districts of Dhule, Paithain , Aurangabad, Nanded, Wardha, Nagpur and Sholapur in Maharashtra state ^[10] .

Planning Commission. GOVERNMENT OF INDIA Report of the working group on Khadi & Village Industry (1980) has discussed strategies for improving the working of the khadi and village industries. The different products that are produced area wise and the people engaged in these trades are discussed at length. Targets are fixed for the plan periods. Ministry of Industry, Government of India ^[11].

CHAPTER 3

OBJECTIVES

The Objectives Identified which also define the scope of the work is as given below:

- 1] To design narrow width, high speed spinning machine to suit rural homes.
- 2] To introduce more number of spindles without enlarging the size of the machine unduly.
- 3] To optimize the speed and other processing parameters in charkha spinning to get higher production from the present level.
- 4] To increase the yarn production rate from the present low level to the optimum level.
- 5] To increase the wage earning capacity of unemployed youth and contribute to increase in the growth rate of rural and urban employment.
- 6] To generate employment opportunities in rural as well as urban areas of the country through setting up of new self-employment ventures / projects / micro enterprises.
- 7] Reduction of drudgery in spinning and to attract more number of people to take up charkha spinning as an avenue of self employment and thus to reduce the problem of unemployment in villages.
- 8] Decentralization of power spinning from mill spinning to power driven charkha spinning at homes.
- 9] To study the economics of course count khadi spinning and weaving with the use of improved charkha.

CHAPTER 4

TECHNICAL SPECIFICATION

Technical Specifications Of 12 Spindle Improved Charkha

Application	: Staple fiber spinning up to 60mm
Max number of spindles	: 12
Counts Spun	: 4s to 140s Ne

MACHINE DATA

Machine Length	: 890mm (35")
Machine width	: 380mm (15")
Machine height	: 1372mm (54")
Spindle gauge	: 70mm
Spindle Lift	: 180(7")
Ring diameter	: 42mm (or) 15/8"
Range of twist	: 250 - 2550 turns/meter

Tin roller diameter	: 190mm
Spindle wharvediameter	: 13mm
Front roller diameter	: 25.4mm
Top arm type	: SKF PK 225
Drive	: Hand driven

CHAPTER 5

MODIFIED PART LIST

In this chapter the modified component list is discussed. The modified components are :

- 1) Handle Shaft ,
- 2) Cam Shaft ,
- 3) Pulley Shaft ,
- 4) Ball Bearings ,
- 5) Muff Couplings ,
- 6) Spur Gears.

5.1: Handle Shaft

A shaft is a rotating element which is used to transmit power from one place to another. The power delivered to the shaft by some tangential force and the resultant torque set up within the shaft permits the power to be transferred to various machines linked up to the shaft in order to transfer the power from one shaft to another. In other words, we may say that a shaft is used for the transmission of torque and bending moment. The various members are mounted on the shaft by means of keys or splines.

Types of Shafts:-

1. Transmission Shafts:- These shafts transmits power the source and the machines absorbing power. The counter shaft, overhead shaft and all factory shafts are transmission shafts Since these shafts carry machine parts such as pulleys, gears etc.

2. Machines Shafts:- These shafts form an integral part of the machine itself. The crank shaft is an example of machine shaft.



Figure5.1: Handle Shaft

5.2: Cam Shaft

A cam is a rotating machine element which gives reciprocating or oscillating motion to another element known as follower. The cam and follower have a line contact and constitute a higher pair. The cams are usually rotated at uniform speed by a shaft, but the follower motion is predetermined and will be according to the shape of the cam. The cam and follower is one of the simplest as well as one of the most important mechanisms found in modern machinery today. The shaft which is connected to the cam is called cam shaft.

Types of cam:-

1. Radial or disc cam:- In radial cams, the follower reciprocates or oscillates in a direction perpendicular to the cam axis.

2.Cylindrical cam:- In cylindrical cams the follower reciprocates or oscillates in a direction parallel to the cam axis.



Figure5.2: Cam Shaft

5.3: Pulley Shaft

A pulley shaft is a rotating machine element which consists of number of pulleys on the shaft, which is driven by input shaft (i.e Handle shaft) with the help of various gear train. The pulleys on the pulley shaft is used to rotate the spindles which is mounted in front face of charkha with the help of belt.

As we have reduced 12 pulleys to 6 pulleys on pulley shaft. Now, the pulley shaft consists of six pulleys on the shaft, and each pulley drives two spindles. Due to which the weight is reduced. Hence drudgery is reduced.

We have also tried to attached a motor to a pulley shaft which can generate enough power which can used to run appliances such as LED light, mini FAN, and it can also charge mobile phones.



Figure5.3: Pulley Shaft

5.4: Bearing

A bearing is a machine element which supports another moving machine element. It permits a relative motion between the contact surfaces of the members, while carrying the load.

Types of Bearing:-

1. Ball Bearing
2. Cylindrical roller bearings
3. Taper roller bearings.
4. Spherical roller bearings.
5. Needle roller bearings.

Therefore, Ball bearings tend to have lower load capacity for their size than other kinds of rolling element bearings due to the smaller contact area between the balls and races so ball bearing is preferred in spinning machine.



Figure 5.4: Ball bearing

5.5 :Coupling

Coupling is a device used to connect two shafts together at their ends for the purpose of transmitting power.

Types of Coupling:-

1. Sleeve or muff coupling
2. Clamp or split muff coupling
3. Flange coupling

Therefore, Muff coupling is used because there is simplicity of construction. Very few components easy for assembly and dismantling. Simplicity of construction. Very few components easy for assembly & dismantling. Simple / Easy maintenance. Their high torque capabilities make them suitable for higher rpm power transmission applications. No lubrication, due to rigid connecting. Low operational cost as no lubrication is required & maintenance is minimal, Operational cost is very low. Smooth & quiet operation.

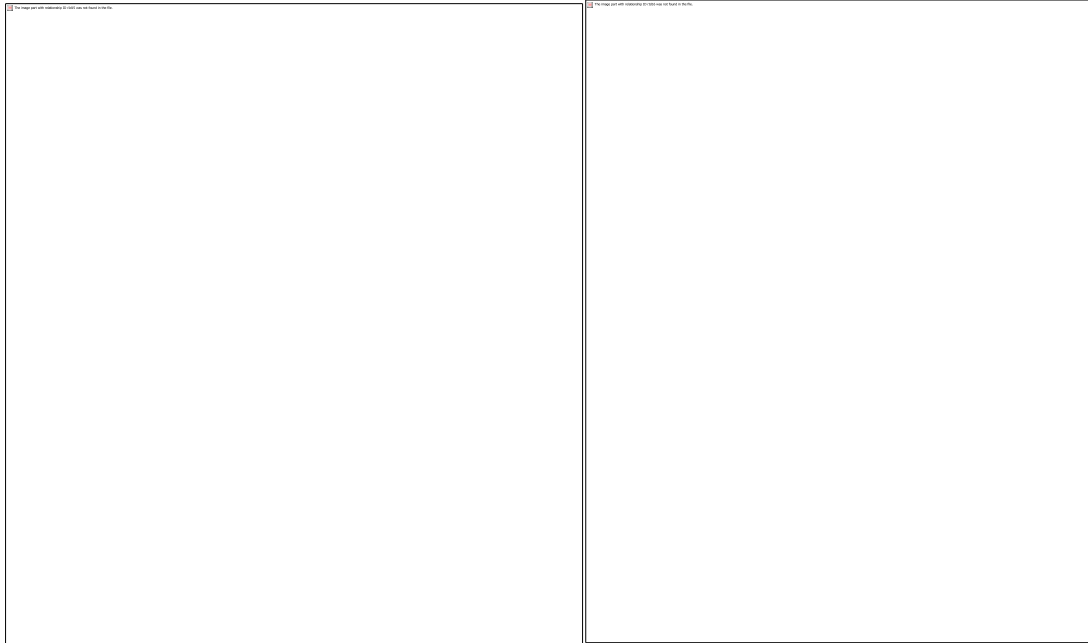


Figure 5.5:Muff Coupling

5.6:Gears

Gears are toothed members which transmit power/motion between two shafts by meshing without any slip. In any pair of gears, the smaller one is called pinion and the larger one is called gear immaterial of which is driving the other.

Types of gears :-

1. Spur gear
2. Double helical gear
3. Rack and pinion
4. Worm gear
5. Helical gear
6. Internal gear
7. Bevel gear
8. Spiral gear

Therefore, spur gears have their teeth parallel to the axis and are used for transmitting power between two parallel shafts. They are simple in construction, easy to manufacture and cost less. They have highest efficiency and excellent precision rating. They are used in high speed and high load application in all types of trains and a wide range of velocity ratios. Hence they are used in spinning machines.



Figure 5.6: Spur Gear

CHAPTER 6

CONSTRUCTION & WORKING

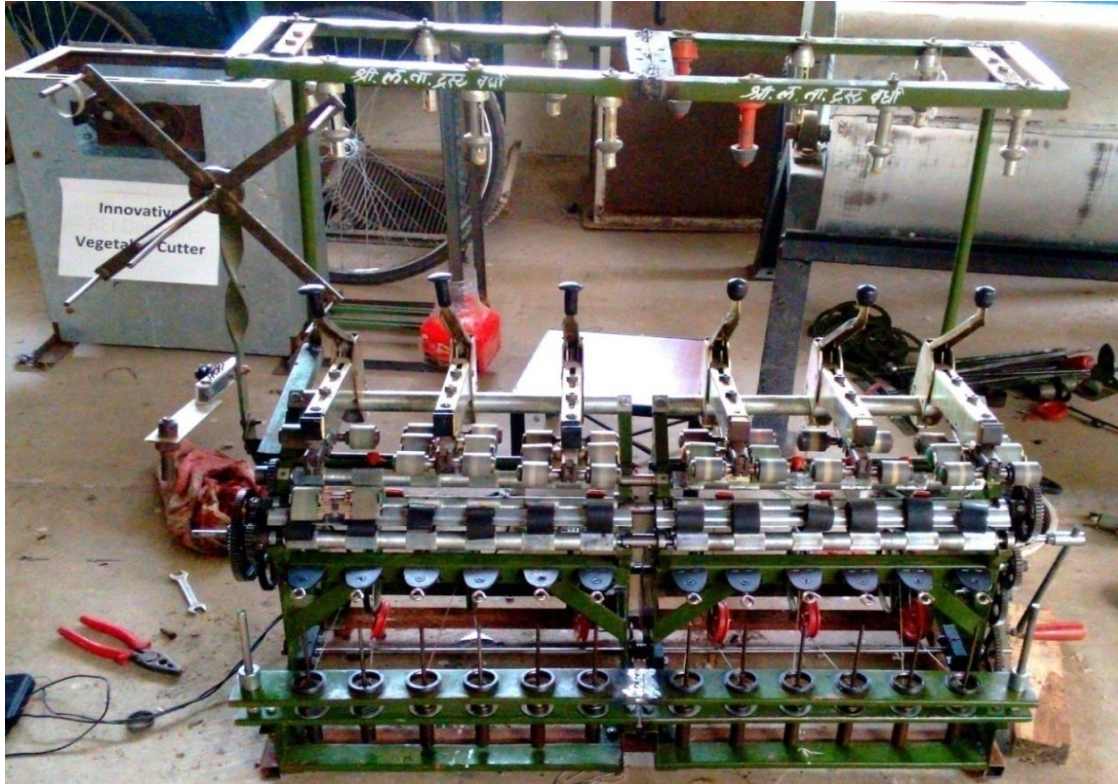


Figure6.1:12-Spindle Charkha

Construction of the twelve spindle charkha is as shown in above Figure. As the charkha is in existing we have coupled two six spindle charkhas to convert it into twelve spindle charkha. These two charkhas are coupled together with the help of muff coupling as well as welding. For the mounting of two charkhas a rectangular frame is made of suitable size, so that both the charkhas can be mounted over it. As the charkha consists of gearing system on both the sides say left side and right of each charkha for transmission of power. But by joining the two charkhas the left side gearing system of one charkha and right side gearing system of another charkha has been removed and for the coupling of cam shaft, pulley shaft and knurling shafts muff coupling is used.

6.1 Features of charkha

- 1.Reduction in drudgery of spinners.
- 2.Enhancement in productivity.
- 3.Improvement in yarn quality.
- 4.Overall reduction in yarn price.
- 5.Low yarn breakages.
- 6.Facility for manual operation also.

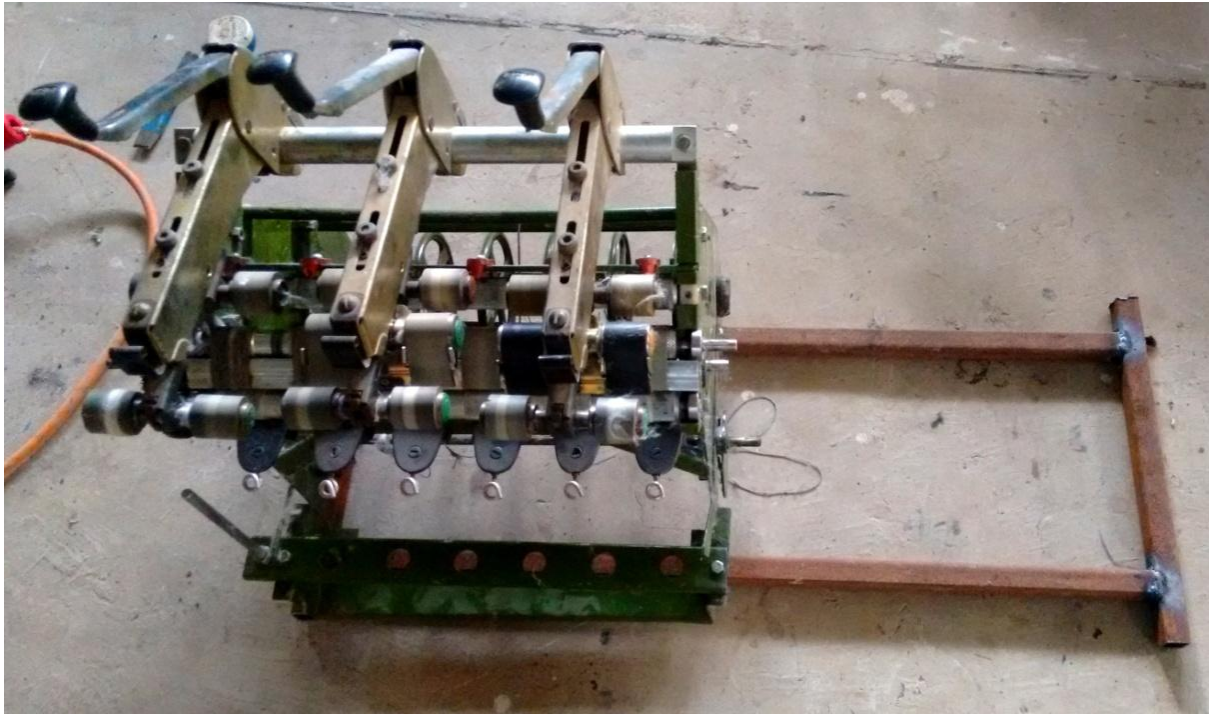


Figure 6.2: Frame Base

As in case of six spindle charkha a single spindle can be run by using a single pulley but in case of twelve spindle charkha two spindle can be run by using a single pulley. The charkha is hand driven, there might be variations in the speed as it is driven by humans so for this purpose the handle shaft, cam shaft and pulley shaft are replaced and through shafts are used to prevent certain losses.



Figure 6.3: Two 6 spindle Charkha

6.2 Working Principle

The input material to the charkha is roving/sliver which contains large number of fibres in its cross section. The numbers must be reduced to about 100 in the yarn cross section. The reduction of fibers in the cross section is effected through drafting. In charkha 3-line single-apron drafting system is used (Figure 1).

During drafting the fibres are firmly nipped between the bottom steel fluted roller and the weighted top pressure roller. The pressure is applied by spring weighting system. The roller pairs rotate at an incremental speed resulting stretch (i.e. draft) in the material nipped between the rollers. The controlled two stage stretching operations (i.e. drafting) elongate the feed roving and bring it to the required yarn dimension from the point of view of mass per unit length.

Once the drafted product emerges from the nip of the front pair of roller, it is to be twisted to impart strength to the fibre matrix. Twist is imparted by the combination of ring and traveller. The traveller is a small loop of wire loosely mounted on the ring and hence free to move on the circular ring. The spindle which holds the package (bobbin) causes the traveller to rotate on a ring. The yarn loop between the front roller to the bobbin via the traveller, causes required force to be imparted on the traveller by the spindle. Every revolution of traveller causes the yarn to be twisted around its own axis.

The twisted yarn is simultaneously wound on the package. The ring rests on a platform which is made to oscillate from bottom to top of the package at a certain frequency. As the ring moves up and down, the traveller also follows the same and hence the yarn is guided from bottom to top of the bobbin for laying.

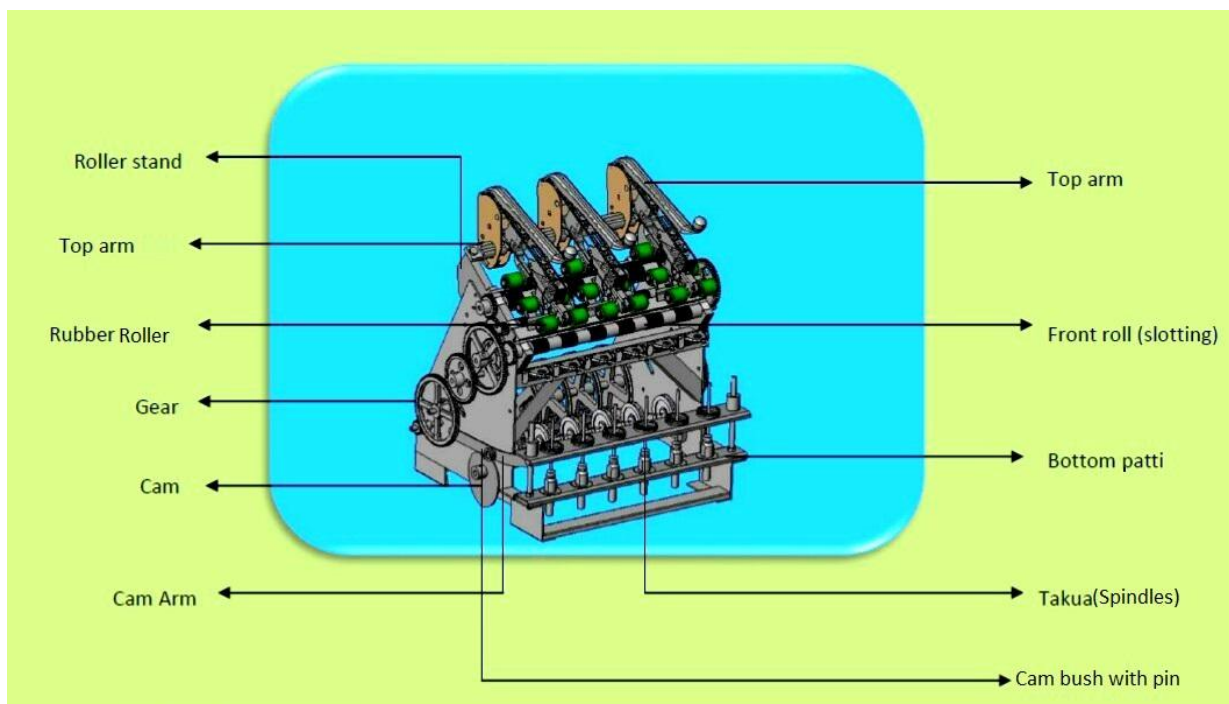


Figure 6.4: Nomenclature of Charkha

6.3 Drafting

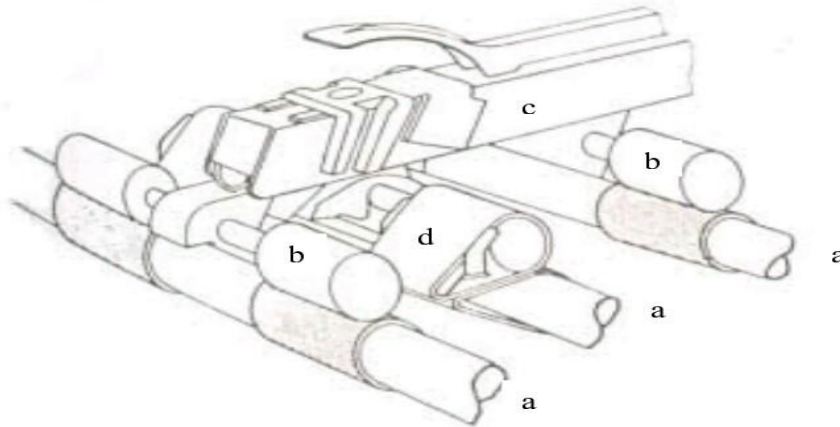
The bottom drafting rollers made of steel are mounted on an inclined roller stand having fixed brackets. The top rubber covered rollers are mounted in a pendulum lever arm which is pivoted in the machine frame. The lever can be swung to lift all the rollers together. The top rollers are pressed against the bottom steel rollers by spring pressure. The bottom rollers are positively driven and top rollers are surface driven.

Certain flexibility in fixing the values of draft is required to be able to spin yarns of different fineness from the same feed material and hence while designing drive to the rollers change gears needs to be incorporated.

6.4 Drafting Operations

Draft is the result of differential velocity imparted to the three sets of rollers viz. back middle and front. The respective draft can be worked out from the drive. Since the source of drive to all the rollers is same and all

being of same diameter, the draft would be the ratio of number of revolution of the concerned rollers in a drafting zone assuming one of them turned by one revolution.



a: Bottom fluted roller, b: Top roller, c: Pendulum lever arm, d: Apron

Figure 6.5: Drafting arrangement of Charkha

A change in break draft and total draft is a technological necessity in order to produce a yarn of different fineness from same feed material i.e. sliver or roving. However in the existing design it is fixed and cannot be changed. However this flexibility can be brought about by making changes in gearing.

6.5 Twisting

Twist is imparted to the yarn by the rotating traveller (Figure 2). Each revolution of the traveller imparts one turn of twist to the strand. The traveller rotates on the surface of the ring. The traveller does not have its own drive. It is dragged by the yarn that passes through it on to the bobbin surface which is mounted on the spindle. The yarn is pulled by the rotating spindle.

The strength of yarn is manipulated by varying twist. Strength generally increases with twist. However too high twist make the yarn hard and also reduces productivity as twist is usually increased by reducing delivery. In order to change twist the delivery by front drafting rollers is changed.

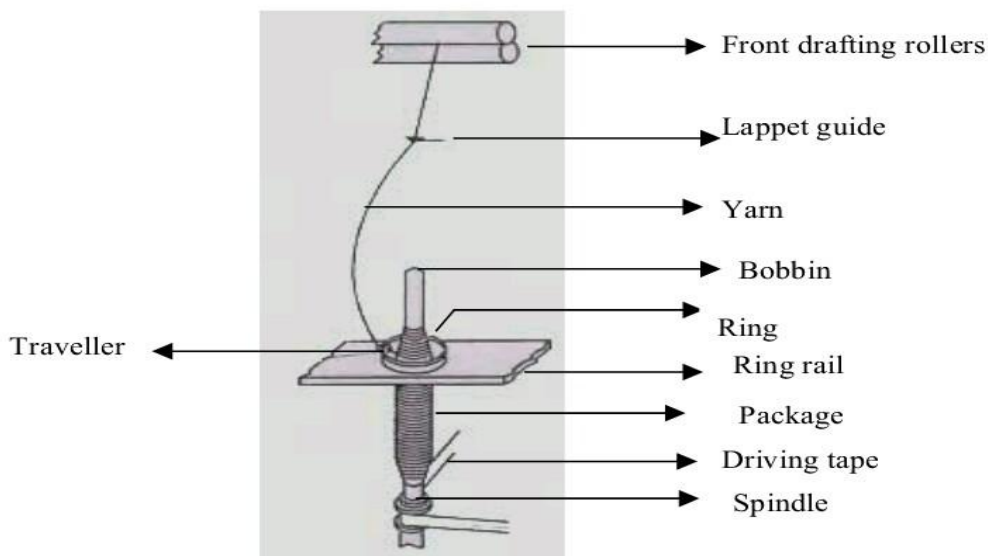


Figure 6.6: The passage of yarn in the charkha

6.6 Package Formation

For package formation the yarn needs to be wound around the package and laid uniformly across the entire length of it. As the traveller and spindle rotate in the same direction, the difference in the peripheral speeds of the traveller and the spindle causes the yarn to be wound on to the package.

The speed difference is due to the lagging of the traveller relative to the spindle due to continuous delivery of yarn from front roller and traveller ring frictional drag. Since the traveller also acts as a guide for the yarn it is oscillated back and forth across the entire length of the package for laying the yarn uniformly. This oscillating movement is imparted to the ring rail which holds the ring on which the traveller runs.

6.7 Technological Requirements

Charkha has some technical shortcomings. It is not flexible in terms of adjustment of draft, twist, roller settings and the top roller pressure. This is required for producing different yarn counts in the same charkha. Finer yarn requires higher draft and twist as compared to coarse yarn. There should be provision on the charkha for varying this. Finer yarn is produced from finer fibre of longer length. So the distance between the rollers should be adjustable according to the fibre length. Also there should be provision for changing the top roller pressure.

The charkha is designed to be operated by sitting in the floor. This leads to physical strain after a few hours of operation. Also there are some technical shortcomings which lead to drudgery after running for the charkha for hours.

6.8 Kinematical Analysis of Drive

The charkha is operated by turning a handle usually. Pedal operated charkhas are also available. The prime mover is the main shaft which is turned by hand or pedal. As this shaft turns, the motion gets transmitted through a series of gears and pulleys to different rotating parts of the machine. A plan view of the drive is shown in Figure.

The motion transmission from the main shaft to the spindle is through a set of gears and pulleys. Since the pulley shaft is located a bit away from the main shaft, four gears had to be used to transmit motion. This increase load on the operator since more power will be required to turn all of them. A driving belt arrangement between main shaft and pulley shaft can reduce the load on the operator. Some of the gears can also be made from ebonite instead of mild steel to reduce their weights.

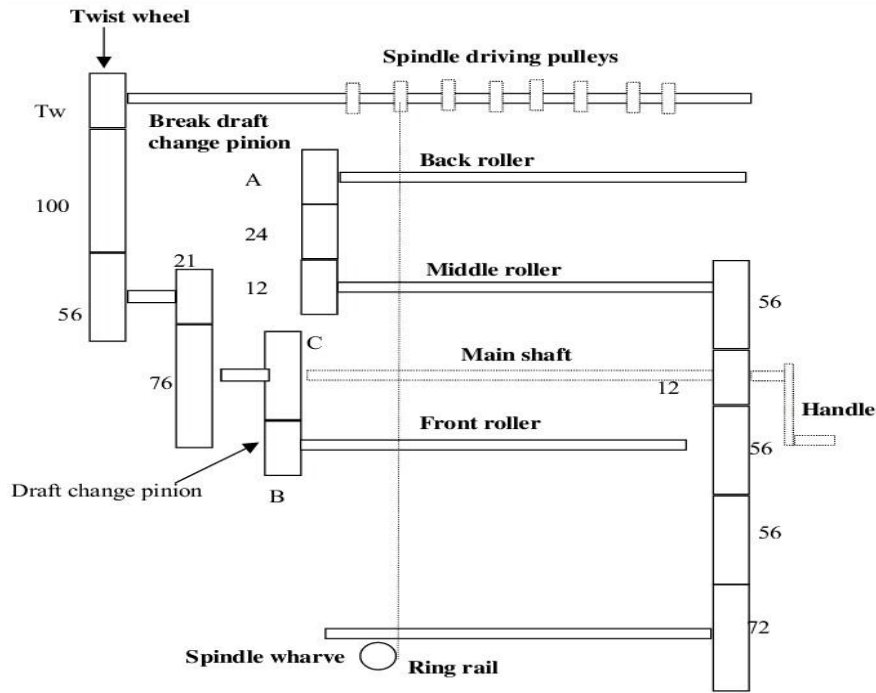


Figure6.7: Gearing diagram of charkha

6.9 Ergonomic Considerations

The charkhas are generally floor mounted. As a result the operator has to sit on the ground with folded legs to run it by hand. A table mounted charkha where the operator can sit on a chair of appropriate height can reduce his/her drudgery. Pedal operated charkha can serve the same purpose. In fact the hands can be made free since the feet will be engaged to run the machine. Improved bearings in the driving rollers can cause them to roll easily necessitating less power.

A pedal operated charkha with a provision to run it by hand can be better alternative as it will offer flexibility to the operator to use either hand or feet . Since through feet more power can be applied, bigger package with same number of spindle can be made by employing bigger diameter ring with appropriate spindle and bobbin. This will reduce the frequency of package doffing and may improve productivity.

CHAPTER 7

DESIGN OF PARTS

In this chapter design of the used parts is presented.

7.1:Design of Handle Shaft

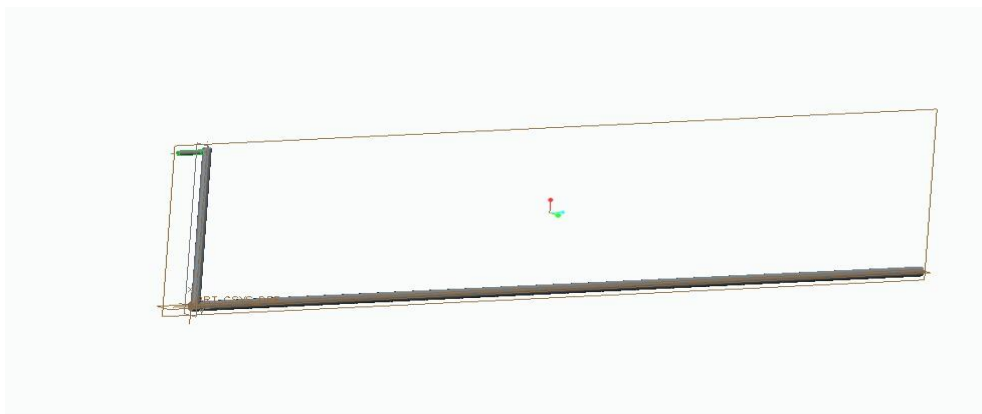


Figure 7.1: Design of Handle Shaft

Givendata:-

$$\text{Torque (T)} = 784.8 \text{ Nm}$$

$$N = 20 \text{ rpm}$$

$$P = \frac{2\pi * N * T}{60}$$

$$= \frac{2\pi * 20 * 784.8}{60}$$

$$= 1643.68 \text{ Nm}$$

$$= 1.64 \text{ watt}$$

Assuming that the torque at A,B,C are same , therefore the tangential force on gear A acting horizontally towards left is given by,

$$F_{ta} = \frac{T}{R_a} \text{ where, } D_a = 190\text{mm, } R_a = 95\text{mm}$$

$$= \frac{784.8}{95}$$

$$= 8.26 \text{ N}$$

Tangentially force on gear B acting horizontally towards left is given by,

$$F_{tb} = \frac{T}{R_b} \text{ where, } D_b = 120\text{mm, } R_b = 60\text{mm}$$

$$= \frac{784.8}{60}$$

$$= 13.08 \text{ N}$$

Tangentially force on gear C acting horizontally towards left is given by,

$$F_{tc} = \frac{T}{R_c} \text{ where, } D_c = 30\text{mm, } R_c = 15\text{mm}$$

$$= \frac{784.8}{15} = 52.32$$

Vertical and horizontal loading:-

Now let us find the vertical loading,

$$R_{AV}, R_{BV} \text{ \& } R_{CV} = 0$$

Now let us find the horizontal loading,

$$R_{xh} + R_{yh} = 8.26 + 13.08 + 52.32$$

$$= 73.66$$

Taking moment about Y,

$$-R_{xh} * 800 + 52.32 * 830 = 0$$

$$R_{xh} = 1.10 \text{ N}$$

$$R_{yh} = 73.66 - 1.10$$

$$R_{yh} = 72.56 \text{ N}$$

We know , B.M at X & Y

$$\text{Consider, } M_{xh} = M_{yh} = 0$$

Therefore Now,

B.M at A

$$M_{Ah} = R_{xh} * 45 - 13.08 * 25$$

$$= 1.10 * 45 - 13.08 * 25$$

$$M_{Ah} = 277.5 \text{ N-mm}$$

$$M_{Bh} = R_{yh} * 20$$

$$= 52.32 * 20$$

$$M_{Bh} = 22 \text{ N-mm}$$

$$M_{Ch} = R_{yh} * 10$$

$$= 52.32 * 10$$

$$M_{Ch} = 523.2 \text{ N-mm}$$

Take Resultant Bending moment of A,B& C

$$M_A = \sqrt{(MA_v)^2 + (MA_h)^2} = \sqrt{(0)^2 + (277.5)^2}$$

$$M_A = 277.5 \text{ N-mm}$$

$$M_B = \sqrt{(MB_v)^2 + (MB_h)^2} = \sqrt{(0)^2 + (22)^2}$$

$$M_B = 22 \text{ N-mm}$$

$$M_C = \sqrt{(MC_v)^2 + (MC_h)^2} = \sqrt{(0)^2 + (523.2)^2}$$

$$M_C = 523.2 \text{ N-mm}$$

Therefore, maximum bending moment

$$M = M_C$$

The equivalent twisting moment is given by,

$$T_e = \sqrt{(M)^2 + (T)^2}$$

$$= \sqrt{(523.2)^2 + (784.8)^2}$$

$$= 943.2 \text{ N-mm}$$

$$= 0.9432 \text{ N-m}$$

Therefore,

$$T_e = \frac{\pi}{16} * \tau * d^3$$

Where, d= diameter of shaft

$$d = 12.5 \text{ mm}$$

$$943.2 = \frac{\pi}{16} * \tau * (12.5)^3$$

$$\tau = 2.45 \text{ N/mm}^2 \text{ or mpa}$$

7.2: Design of Pulley Shaft

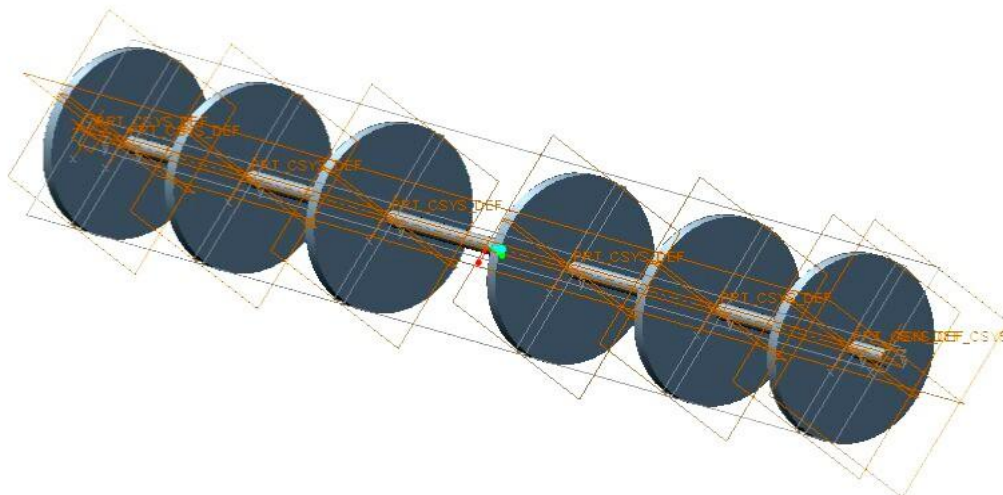


Figure 7.2: Design of Pulley Shaft

Given data :-

Torque = 784.8 N-mm

N = 100 rpm

Diameter of shaft = 10mm

Diameter of gear = 50mm

Consider, $\theta = 180^\circ = \pi \text{ rad}$, $\mu = 0.3$

Assume, $T_1 = 1\text{N}$

$$2.3 \log \left(\frac{T_1}{T_2} \right) = \mu \theta$$

$$2.3 \log \left(\frac{1}{T_2} \right) = 0.3 * 180$$

$$T_2 = 0.38 \text{ N}$$

$T_1 = \text{Tight side} = 1\text{N}$

$T_2 = \text{Slack side} = 0.38 \text{ N}$

Assuming that the torque at A,B,C,D,E,F & G are equal , therefore the tangential force acting on gear A is ,

$$F_{ta} = \frac{T}{R_a}$$

$$= \frac{784.8}{25}$$

$$= 31.39 \text{ N}$$

Horizontal load acting on shaft at B,C,D,E,F& G

$$W_{BH} = T_1 + T_2$$

$$= 1 + 0.38$$

$$W_{BH} = 1.38 \text{ N}$$

No, vertical load on gear and pulleys therefore vertical load are zero

Now, Let us find the maximum bending moment for horizontal loading,

$$R_{xh} + R_{yh} = 31.39 + (1.38 * 6)$$

$$= 39.67$$

Taking moment about Y,

$$R_{xh} * 800 - 31.39 * 885 - 1.38 * 685 - 1.38 * 560 - 1.38 * 435$$

$$- 1.38 * 310 - 1.38 * 185 - 1.38 * 60 = 0$$

$$R_{xh} = 38.58 \text{ N}$$

$$R_{yh} = 1.09 \text{ N}$$

Now,

Consider, B.M at x&y

$$M_{xh} = M_{yh} = 0$$

Therefore Now,

B.M at A,

$$M_{Ah} = R_{xh} * 70 = 38.58 * 70$$

$$= 2700.6 \text{ N-mm}$$

B.M at B,

$$M_{Bh} = R_{xh} * 115$$

$$= 38.58 * 115$$

$$M_{Bh} = 4436.7 \text{ N-mm}$$

B.M at C,

$$M_{Ch} = R_{xh} * 240 - 1.38 * 1.25$$

$$= 38.58 * 240 - 1.38 * 1.25$$

$$M_{Ch} = 9086.7 \text{ N-mm}$$

B.M at D,

$$M_{Dh} = R_{xh} * 365 - 1.38 * 250 - 1.38 * 125$$

$$= 38.58 * 365 - 1.38 * 250 - 1.38 * 125$$

$$= 13564.2 \text{ N-mm}$$

B.M at E,

$$M_{Eh} = R_{xh} * 490 - 1.38 * 375 - 1.38 * 250 - 1.38 * 125$$

$$= 17869.2 \text{ N-mm}$$

B.M at F,

$$M_{Fh} = 38.58 * 615 - 1.38 * 500 - 1.38 * 375$$

$$- 1.38 * 250 - 1.38 * 125$$

$$= 22001.7 \text{ N-m}$$

B.M at G,

$$M_{Gh} = 38.58 * 740 - 1.38 * 625 - 1.38 * 500 - 1.38$$

$$* 375 - 1.38 * 250 - 1.38 * 125$$

$$M_{Gh} = 25961.7 \text{ N-m}$$

Take maximum B.M,

$$M_{Gh} = M$$

Twisting moment is given by,

$$T_e = \sqrt{(M)^2 + (T)^2}$$

$$= \sqrt{(25961.7)^2 + (784.8)^2}$$

$$= 25973.55 \text{ N-mm}$$

Equivalent twisting moment is given by,

$$T_e = \frac{\pi}{16} * \tau * (d)^3$$

Where, d= diameter of shaft

$$d = 10 \text{ mm}$$

$$25973.55 = \frac{\pi}{16} * \tau * (10)^3$$

$$\tau = 132.28 \text{ N - mm}^2$$

7.3: Design of Cam Shaft

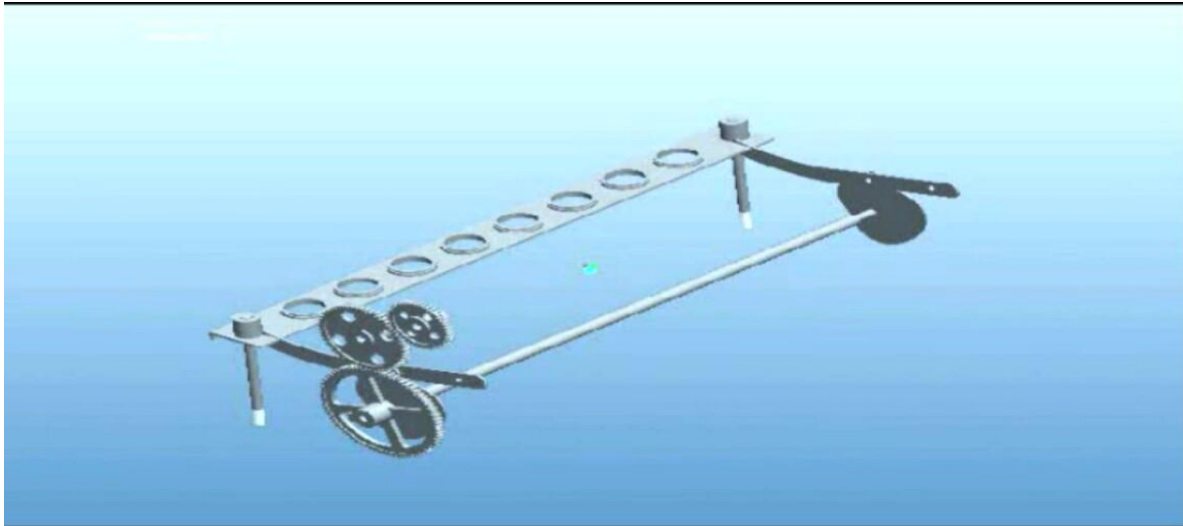


Figure 7.3: Design of Cam Shaft

Given data:-

$$T = 784.8 \text{ N-m}$$

$$N = 770$$

$$P = \frac{2 * \pi * N * T}{60} = 63281.72 \text{ KW} = 63.28 \text{ watt}$$

Assuming that the torque at C & D are same , therefore the tangential force on gear D acting horizontally towards left is given by

$$F_{ta} = \frac{T}{R_a} \text{ where, } D_a = 190\text{mm, } R_a = 95\text{mm}$$

$$= \frac{784.8}{95} = 8.26 \text{ N}$$

Assume,

Tangential force on cam C is 10 N.

Vertical and horizontal loading:-

Now let us find the vertical loading,

$$R_{Dv} \& R_{Cv} = 0$$

Now let us find the horizontal loading,

$$R_{Ah} + R_{Bh} = 8.26 + 10$$

$$= 18.26$$

Taking moment about B,

$$-10 * 810 + R_{Ah} * 800 = 0$$

$$R_{Ah} = 10.125$$

$$R_{Bh} = 8.13$$

We know , B.M at X & Y

Consider, $M_{Ah} = M_{Bh} = 0$

Therefore Now,

B.M at C,

$$M_{Ch} = R_{Ah} * 10$$

$$= 10.125 * 10 = 101.25 \text{ N-mm}$$

B.M at D,

$$M_{Dh} = R_{Bh} * 20 = 8.13 * 20$$

$$M_{Dh} = 162.6 \text{ N-m m}$$

Resultant Bending moment of C& D,

$$M_C = \sqrt{(M_{cv})^2 + (M_{ch})^2} = \sqrt{(0)^2 + (101.25)^2}$$

$$M_C = 101.25 \text{ N-mm}$$

$$M_D = \sqrt{(M_{Dv})^2 + (M_{Dh})^2} = \sqrt{(0)^2 + (162.6)^2}$$

$$M_D = 162.6 \text{ N-mm}$$

Therefore, maximum bending moment

$$M = M_D$$

The equivalent twisting moment is given by,

$$T_e = \sqrt{(M)^2 + (T)^2}$$

$$= \sqrt{(162.6)^2 + (784.8)^2}$$

$$= 801.46 \text{ N-mm}$$

Therefore,

$$T_e = \frac{\pi}{16} * \tau * d^3$$

Where, d= diameter of shaft

$$d = 10\text{mm}$$

$$801.46 = \frac{\pi}{16} * \tau * (10)^3$$

$$\tau = 4.08 \text{ N/mm}^2 \text{ or mpa}$$

7.4: Design of Muff Coupling

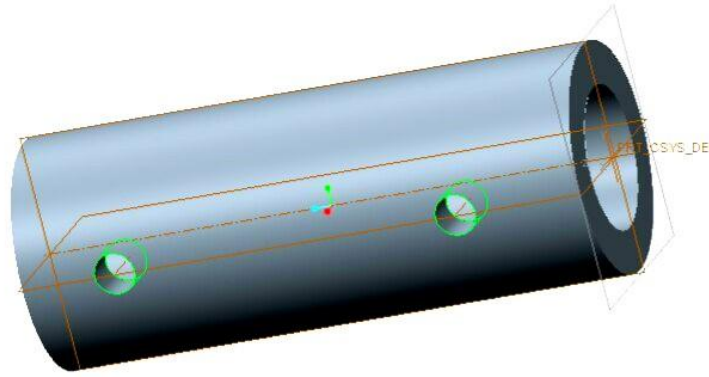


Figure 7.4: Design of Muff Coupling

Given data:-

$$L = 40 \text{ mm}$$

$$d = 10 \text{ mm (internal dia)}$$

$$D = 16 \text{ mm (external dia)}$$

$$T = 0.7848$$

Let τ_c be the induced stress in the muff which is made of cast iron. Since the muff is considered to be a hollow shaft,

Therefore the torque transmitted (T)

$$T = \frac{\pi}{16} * \tau_c * \left[\frac{D^4 - d^4}{D} \right]$$

$$0.7848 * 10^3 = \frac{\pi}{16} * \tau_c * \left[\frac{16^4 - 10^4}{16} \right] \tau_c = 1.51 \text{ N/mm}^2$$

7.5 Design of Bearing

6000 Z- Metric extra light single shield single row deep Groove Ball Bearing.

Limiting speed - 40000 r/min (rpm)

$$\text{Output torque on shaft} = \frac{\pi}{16} * T * D^3$$

known, D - 12.5mm

$$T - 340 \text{ N/mm}$$

$$T_{\text{output}} = 21.731 \text{ Nm}$$

$$\text{Radial load on shaft } K_r = F_r = \frac{T_{\text{output}} * K_s * 2000}{D_p}$$

$$= \frac{21.731 * 1.50 * 2000}{0.14}$$

$$= 465664.2 \text{ N}$$

Where, K_s = service factor = 1.50

$$D_p = \text{Dia of pulley} = 140 \text{ mm} = 0.14 \text{ m}$$

$$\text{Radial load on Bearing} = F_{x_b} = \frac{L_1}{L - a_1} * K_r$$

L = 890mm - Distance between centres of two Bearing.

L₁ = 430mm - Distance between centres of Bearing position and point of action of force.

$a_1 = 15\text{mm}$ - Distance between Geo. centres of match bearing and point of action of Radial load F_{r_b} .

$$F_{r_b} = 228840 \text{ N.}$$

$$\text{Axial load } F_a = 20\%F_{r_b} = 45768 \text{ N}$$

$$\frac{F_a}{F_{r_b}} = 0.2 < X=1 \text{ and } Y=0$$

Dynamic Equivalent Radial load W

$$W = X.F_{r_b} + Y.F_a$$

$$W = 228840 \text{ N}$$

Life of Bearing =>

$$\text{Life of Bearing in Hrs} = L_H = 5*300*10$$

Assuming 5 years at 10hrs /day for 300 working days/year.

$$L_H = 15,000 \text{ hrs.}$$

Life of Bearing in revolutions,

$$L = 60 N * L_H$$

$$= 60 * 40000 * 15000$$

$$= 36000 * 10^6 \text{ revolution}$$

Dynamic Load rating,

$$C = W \left(\frac{L}{10^6} \right)^{\frac{1}{K}}$$

$$C = 228840 \left(\frac{36000 * 10^6}{10^6} \right)^{\frac{1}{3}}$$

$$C = 75 * 10^3 \text{ KN}$$

CHAPTER 8

FABRICATION

The two six spindle charkhas were provided by Magansangrahalay in Wardha. The provided charkhas were not in good condition they were brought to MGIRI Wardha, then the charkhas were disassemble and the required cleaning were done, the disassembled parts are as shown in Figure.

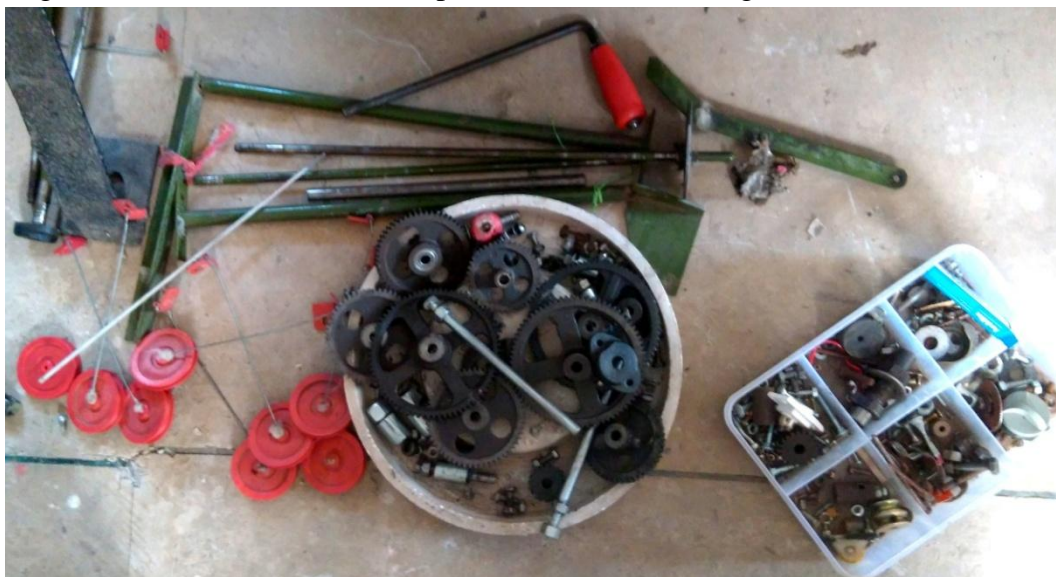




Figure 8.1: Disassembled parts of Charkha

After the disassembly a frame base is made to place both the charkha on it according to the required dimensions of the charkha. Machining operations are performed such as Welding Machine, Drilling Machine & Cutting Machine. Both the disassemble charkhas were placed on the frame base to check whether they are as per the dimension, frame and charkhas are bolded and a required frame of 12 spindle charkha is made. Before the assembly all the parts were checked.the base frame of 12 spindle charkha is shown in Figure



Figure 8.2:Frame



Figure 8.3: Base of 12 spindle Charkha

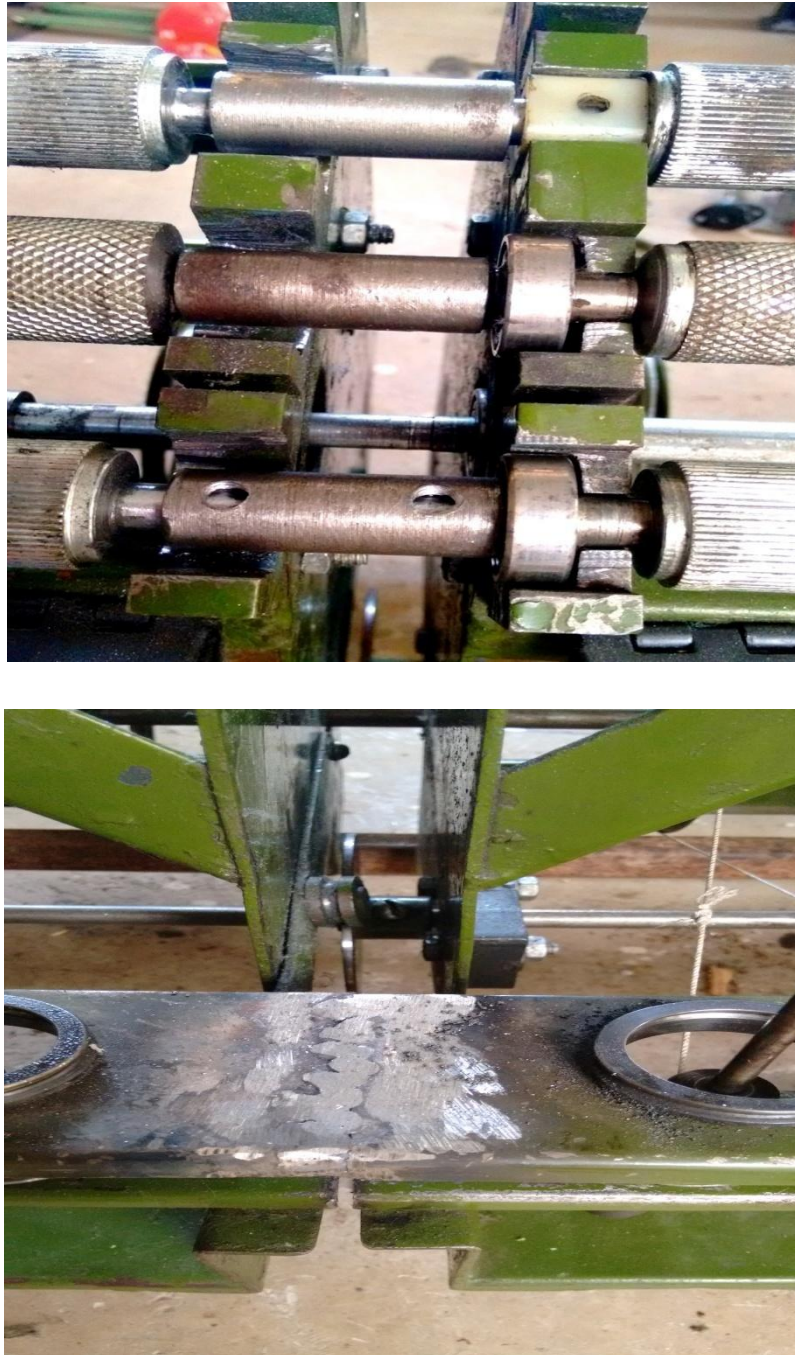


Figure 8.4: Coupling & Welding Joint

All the remaining parts of the charkha were assembled and the shafts were coupled together by muff coupling, there were 12 pulleys which then removed and 6 pulleys are kept instead of them, one pulley is attached to 2 spindles also 6 Adlerpulleys are kept instead of 12. The shafts are modified as well as required changes are made in the gear mechanism of charkha.

The Charkha is now ready to operate, A thread is produce out of roving by spinning on a charkha, A yarn is produce which is a product of substantial length and relatively small cross section consisting of fibers and or filament with or without twist. Yarn is a finished product as shown in Figure, which is then supplied to the market as per their demand or requirement for further processing.



Figure 8.5: Finished Product

CHAPTER 9

DEFINITIONS OF CONCEPTS

Khadi: Khadi means any cloth woven on hand looms in India from yams made of cotton, wool or silk or a mixture of these yarns, which are hand spun.

Charkha: It is domestic equipment made of either wood or steel and used to spin yarn. Charkha machine is operated by hand. Hand spun yarn on Charkha is called khadi yarn

Wages: Payment made to employee of a business for his or her labour by hour, week or month.

Roving : A strand of fibers attenuated to the size of a pencil lead.

Khadi yarn: A thread produced out of roving by spinning on a charkha.

Twist per Inch: The number of turns given to the thread in one inch during the charkha spinning operation.

Hairiness: The protruding fibers from central axis of the thread.

Hairiness Index: It is a measure of yarn Hairiness. It is calculated as number of the protruding hairs on the fiber axis.

End Breakage rate: The thread breaks on the spindle during spinning operation. Generally the number of thread breakages per spindle per hour is a measure.

Yarn: A product of substantial length and relatively small cross section consisting of fibers and or filament with or without twist.

Spinning machine: The narrow width, high-speed machine with 12 spindles arranged in a row and driven by a hand. It does the operation of drafting, twisting and winding of the threads into the bobbins.

Rings: It is a double-flanged steel ring, looks like a bangle with very smooth surface. The traveller rotates on the crown of the ring flange to insert twist.

Spindles: An aluminium blade of 6", 7" or more with three special buttons on top to hold the bobbin to fix ring cop having a taper of 1:64.

Traveller: A 'C' shaped steel bit fixed on to the ring flange. It goes round and round the ring and guides the yarn in to the bobbin. It helps in twisting and winding the yarn on the bobbin.

Creel: The stand to keep the supply material like roving bobbins. It is fixed on top of the spinning machine.

Spindle speed: The rpm of the rotating spindles. Higher the spindle speed greater is the machine productivity.

Lappet: A hook fixed above the spindle center to control the yarn tension.

Cots: Rubber covered roller mounted on steel arbours. They form the three sets of rollers in the drafting system mounted.

Aprons: There are endless synthetic aprons fitted over steel cradles. The aprons control the drafting of the short fibres. There are top and bottom cradles.

CHAPTER 10

ADVANTAGES & DISADVANTAGES

10.1 ADVANTAGES:

- 1] To enhance the earnings of the khadi spinners through better prices and evolving methods to popularize charkha spinning in rural houses.
- 2] To increase the yarn production rate from the present low level to the optimum level.

10.2 DISADVANTAGES:

- 1] Both the 8 spindle as well as the 12 spindle charkhas available now use foot power or hand power for rotating the spindles through a train of gear wheels and ropes. The spinner has to use both his legs (or) hands for operating the machine, which consumes a lot of energy.
- 2] For doing the spinning, the spinner has to use his legs or hands for a period of 8 hours in a day, continuous use of hand power causes greater strain to the hand and hence the speed of the spindles get reduced at a diminishing rate. Due to fatigue, monotony, drudgery and low wages, the spinner absents himself from work frequently. This causes shortage of khadi yarn for handlooms.

CHAPTER 11

CONCLUSION & FUTURE SCOPE

11.1 CONCLUSION

1. Charkha is the major tool which can increase the rate of employment generation and improve the quality of output products. Charkha has direct impact on the life of women and on the household.
2. It is possible to convert all 1 million 6 spindle charkha into 12 spindle charkha. It will help to engage 1 million women to work on 12 spindle charkha. MGIRI is trying to approach Indian government to sanction the funds for conversion of these 6 spindle charkhas.
3. Divorced and widowed women are still facing social problems in the Indian society. They can happily survive their life with the income generated from 12 spindle charkha.
4. The detail study of 12 spindle charkha has been done in this research study. It is possible to convert all the 6 spindle charkhas into 12 spindle charkha.
5. The minimum energy consumption and affordable costing were the main criteria behind the invention of 12 spindle charkha. This charkha can be easily operated by hand power. The total cost of 12 spindle solar charkha without subsidy is Rs.20,000 which is affordable as an initial investment for middle class people.

11.2 FUTURE SCOPE:

1. The 12 spindle charkha can be easily converted into solar operated charkha.

2. Most of the women are hesitating to work on hand operated 12 spindle charkha due to its continuous hand operation which causes pain in elbow and joints. These problems have been solved with the solar application in 12 spindle charkha.

ACKNOWLEDGEMENT

It is a matter of great pleasure by getting the opportunity of highlighting a fraction of knowledge, we acquired during our technical education through this project.

This project would not have been successful without enlightened ideas, timely suggestions and useful advice of our respected Guide Prof. Kishore H. Watane without his best guidance this would have been an impossible task to complete.

We also express our sincere thanks to Mr. Ravi Kumar (Deputy Director, REI), Mr. Deep Varma (Principal Scientific Officer, REI) & Mr. Sachin Raut (Senior Scientific Officer, REI) MGIRI, Wardha for their valuable suggestion and encouragement. Being on the same line we all express our deep sense of gratitude to our Head of Department Prof. A. P. Pathre for his most valuable guidance. We would like to thank Dr. P. V. Ingole, Principal of our institution and Dr. P. B. Kale (Director, MGIRI Wardha) for providing necessary facilities during the period of working on this project work.

Last but not the least, we would like to express our thankfulness to teaching and non-teaching staff, our friends and all our well-wishers.

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APPENDIX I

COST ESTIMATION

Table AI.1: Cost Estimation

Sr. No.	EXPENDITURE	QUANTITY	AMOUNT (Rs)
1	Cam Shaft	1	450
2	Cam Pulley	1	80
3	Pulley Shaft	1	370
4	Coupling	3	400
5	Bearing	8	480
6	Handle Shaft	1	250
7	Machine	2	24000
8	Grub Screws	10	30
	Total cost		26060