Design and Manufacturing of Rotary Material Storage System

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Abstract - In industries, materials (which are available in raw material, finished parts, assembly parts etc.) are kept in a storeroom with stock and mix-up parts to each other which may be damage. So, secure tools, raw material, manufactured parts, and assembly parts of industry have stored in rotary storage system. This system is very useful for material storage in industrial application. Storage compartments rotate by using chain and sprocket mechanism. It is simple to operate with the employee to store the material in the system at the ground level. Each employee has a unique ID for store material in compartments and retrieved material from compartments.

Keywords- industry, storeroom, chain and sprocket mechanism, unique ID

I. INTRODUCTION

It is simple to operate with the employee storing material in the system at the ground level. Once the employee leaves the incorporated safety zone the compartment is automatically stored material by the system rotating to lift the stored material compartment away from the bottom central position. This leaves an empty compartment available at the ground level for the next material to be stored in. The stored materials are easily retrieved by pushing the button for the relevant position number of the compartment material stored in. This causes the required compartment to rotate down to ground level ready for the employee to enter the safety zone and receive material out of the system. Except all other systems use a large ground area. Rotary storage System is developed to utilize maximum vertical area in the available minimum ground area. It is quite successful when installed in minimum areas which are well established and are suffering with shortage of area for storing material in industry.

The Rotary Storage System for material such as material stored in storeroom, tools and equipment stored in cupboard etc. have been implemented on a huge scale. But these systems have a major disadvantage of large space consumption and worst management of organization which is successfully eliminated with the use of a rotary storage system. Moreover, the latter provides the added benefits of flexible operation without the need of an attendant and added security and least chances of materials damage. Since the model makes use of composite parts, it is easy to assemble and dismantle and is thus more convenient than the traditional material storing systems. The rotary model is specifically designed to accommodate material separately with less space. The materials are safely store and retrieve uniformly and unique shaped items.

The structure can accommodate eight compartments in the space and can even be customized to hold a greater number depending upon the requirements of the organization. Storage spaces cannot cope with the growth of the different type of the materials. The structure of the system is like a building. The basic structure of the rotary storage system can be described with the help of block diagram.

Now days in industry, materials (which are available in raw material, finished parts, assembly parts etc.) are kept in a storeroom with stock and mix-up parts to each other which may be damage. So, secure tools, raw material, manufactured parts, and assembly parts of industry have stored in rotary storage system. This system is very useful for material storage in industrial application. Storage compartments rotate by using chain and sprocket mechanism. It is simple to operate with the employee to store the material in the system at the ground level. Each employee has a unique ID for store material in compartments and retrieved material from compartments. Traditional systems have a major disadvantage of large space consumption and damaging material which is successfully eliminated with the use of a rotary storage system. Moreover, the latter provides the added benefits of flexible operation without the need of an attendant and added security and least chances of material damage. Since the model makes use of composite parts, it is easy to assemble and dismantle and is thus more convenient than the traditional storage systems. The idea is to storage and move material with no disturbance to the already stored material in rotary storage system. Once the employee leaves the incorporated safety zone the system rotating to lift the stored material compartment away from the bottom to central position. This leaves an empty compartment available at the ground level for the next material to be stored in. The stored material is easily retrieved by pushing the button for the relevant position number in which material is stored. This causes the required material compartment to rotate down to ground level ready for the employee of industry to enter the safety zone.

II. METHODOLOGY

Phase 1
a. Market survey
During this period detail market survey has been done to learn available material storing systems and their utility also their literatures of different types of storage systems and its difference between have been observed.
b. Problems in existing systems
The problems regarding the existing system have been found such as, Complicated programming, High budgets, Unfeasible design, high end robots, etc.
c. Conceptual Design.
Taking problem statement from above and studying the fundamental engineering concepts various concepts regarding modern storage system are prepared and amongst those best concepts design has been selected for further phases.
d. Modeling in SW
Putting the ideas on the modeling software for visualization of the prototype and making it more and more compatible so that there will be less complexity in designing.

Phase 2
a. Analysis of Design
This phase includes the analysis of design using analytical software and make experimental validation.
b. Material Selection and Procurement
In this phase material selection is done and also its procurement as per need the dimensions are taken from SW model.
c. Fabrication
This phase includes fabrication of model in the workshop from the procured material and preparing the model from the software model.
d. Assembly & Testing
This phase include Assembly of all the sub parts, also the arrangement of the motor and its wiring is done, all finishing operations like grinding, trimming, painting is done here. Testing phase includes testing of the model under real environment.

III. DESIGN

1. Chain and Sprocket
A sprocket is a toothed wheel that fits onto a shaft. It is prevented from rotating on the shaft by a key that fits into keyways in the sprocket and shaft. A chain is used to connect two sprockets. Chains that are used to transmit motion and force from one sprocket to another are called power transmission chains. An advantage of chain drives over most belt drives is that the chain cannot slip on the sprocket, so the chain and sprocket provides a positive, non-slip drive, i.e. the chain cannot slip on the sprocket because the sprocket teeth prevent the chain from slipping.
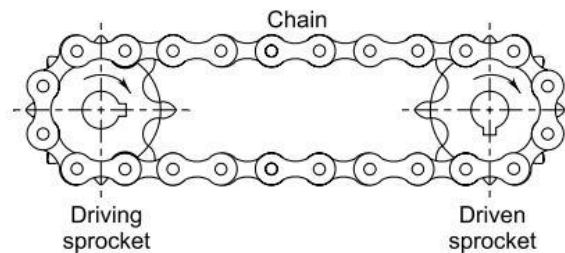

Fig 1. Chain Drive

2. Shaft
Ordinary transmission shaft is made of medium carbon steels with a carbon content from 0.15 %to 0.40% such as 30C8 or 40C8. These steels are commonly called machinery steels. Where greater strength is required, high carbon steel such as 45C8 or 50C8 or alloy steels are employed. Alloy steel includes Nickel, Nickel Chromium and molybdenum steels. Common grades of alloy steels used for making transmission shaft are 16Mn5Cr4, 40cr4Mo2, 16Ni3Cr2, 35Ni5Cr2, 40Ni6Cr4Mo2 and 40Ni10Cr3Mo6. Alloy steels are costly compared with plain carbon steels. However, Alloy steels are high strength, hardness and toughness. Also, high values of hardness and strength can be achieved for components with large section diameters. Alloy steels posse's higher resistance to corrosion compared with plain carbon steels. Therefore, in some applications, these advantages justify the higher cost of the alloy steel.

       Commercial shaft is made of low carbon steel. They are produced by hot-rolling and finished to size either by cold-drawing produces as stronger shaft then a hot-rolling. However, cold-drawn shaft has certain disadvantages. The tolerance on their diameters and straightness and are not very close compared with shafts finished by turning and grinding process. Also, cold-drawing produces residual stresses at and near the surface of the shaft.The straightening of distorted and twisted shaft is difficult and expensive operation. Therefore, most of the transmission shafts after being hot rolled is turned and ground. They are further hardened by oil-quenching to achieve the required strength and hardness. Commercial shafts, used for structural and general engineering purposes, are available in standard sizes.

Specification:
Material of shaft is **Mild steel**
Material properties of mild steel

Yield strength	Syt	247MPa
Ultimate tensile strength	Sut	841 MPa
Factor of safety	FS	2
Poisons ratio	μ	.303
θ		180°

Table: Properties of Mild steel

3. Key

Rectangular key is selected for shaft transmission.
From Machine Design Book by Khurmi Gupta.
The Width of Key,
　　　　　　w = d/4 (where d = diameter of shaft)
The Thickness of Key,
　　　　　　t = d/6 (where d= diameter of shaft)

4. Bearing

A bearing is a machine element which support another moving machine element (known as journal). It permits a relative motion between the contact surfaces of the members, while carrying the load. A little consideration will show that due to the relative motion between the contact surfaces, a certain amount of power is wasted in overcoming frictional resistance and if the rubbing surfaces are in direct contact, there will be rapid wear. In order to reduce frictional resistance and wear and in some cases to carry away the heat generated, a layer of fluid (known as lubricant) maybe provided. The lubricant used to separate the journal and bearing is usually a mineral oil refined from petroleum, but vegetable oils, silicon oils, greases etc., may be used.

5. Linear Control System

The linear control system controls the relay which directly has control on the motor. The compartment movement of storing is dependent on the movement of the motor shaft. This motion can be clockwise as well as anticlockwise in both the directions according to the users' requirement. Not only the relay operation but also the Radio Frequency Identification (RFID) controls the users' details and sensors i.e. Infra-Red Sensors are used for getting the details of the compartments i.e., whether it is occupied or not. All these systems are controlled by the microcontroller.

[A] Infra-Red (IR) Sensor: The infrared sensor allows detecting an object's distance.
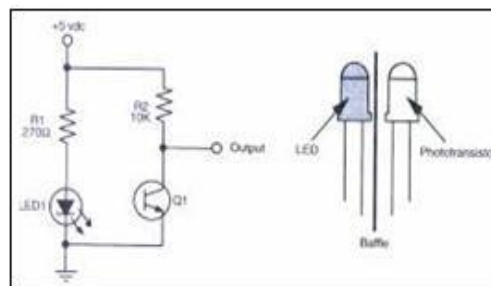

Fig.2. Infrared Sensor

Every compartment is fitted with a Light Emitting Diode (LED) and an IR sensor at the opposite ends on the inner side. This combination is used to check the status of the compartment.

[B] RFID Tag/Reader: RFID is an abbreviation for Radio Frequency Identification. Thesesystem consists of two parts i.e. a reader, and one or more tags. RFID systems have evolved from barcode labels as a means to automatically identify and track products as well as people. In the rotary storage system, the user is assigned a unique ID corresponding to the specific compartment. This helps in quick identification and movement of the same.

[**C] Microcontroller:** The IC AT89S51is a low-power, high-performance CMOS 8- bit microcontroller and has 4K bytes of in-system programmable flash memory. This chip is manufactured using Atmel's high-density non-volatile memory technology. The on-chip flash memory allows the program memory to be reprogrammed in-system or by a conventional non-volatile memory programmer.

IV.CALCULATIONS

- **Chain & Sprocket -**
  For Load (w)   = 10 kg
  Torque acting on the motor is T   = 98.07 N.m
  Speed   = 100rpm
  Number of teeth, Z1   = 20 (sprocket)
  For driving sprocket, D1   = 85 mm
  For driven sprocket, D2   = 85 mm
  No of chain links   = 83
  Centre Distance, a   = 400 mm
- **Shaft -**
  Diameter of Shaft, D   = 16 mm
  Shaft Length, L   = 394 mm
- **Key-**
  Length of Key, l   = 46 mm
  Width of Key, w   = 4 mm
  Thickness of Key, t   = 2.67 mm
- **Bearing-**
  Bore Diameter, d   = 17 mm
  Outer Diameter, D   = 40 mm
  Width, b   = 12 mm

V. WORKING MODEL OF ROTARY MATERIAL STORAGE SYSTEM

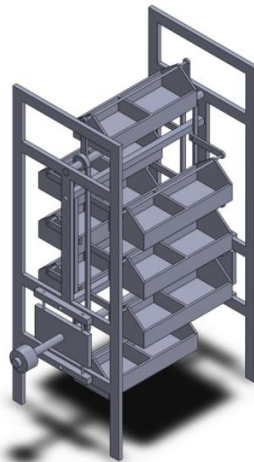

Fig 3. Rotary material storage system

VI. FUTURE SCOPE

The rotary material storage system can be manufactured as per various industries requirements. It is used to store raw material, assembly parts, finished parts, tools and equipment separately in system compartment. This system should be less time consuming, expensive and better management in inventory for organization. Rotary storage System is developed to utilize maximum vertical area in the available minimum ground area. During work study it is observed that there are many more areas where chances of improvement available like increasing load carrying capacity by changing design consideration. In advance, we can modify the system for storage of more valuable materials. For this, we can use touch sensor for security of system. We can use Load cell as a sensor which not only sense the presence of object but also measure the amount of that object.

CONCLUSION

Rotary Material Storage System is very good substitute for traditional material storage system. Design is efficient one because compared to other existing design, it can handle more material in limited space. Space required for this storage system is less due to it uses vertical area rasther than horizontal area.Keep tools, parts and equipment from being lost or damaged. By using RFID tag & IR sensor, the human efforts considerably less. It increases Organizational efficiency and Productivity. This system has better storage flexibility.

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