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# Design and Fabrication of Vertical Drawer System

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***Abstract:*** *Vertical drawer system is a setup of 10 drawers adjusted vertically such that the adjacent drawer comes below and above the drawer. The mechanism used to operate this drawer is chain-sprocket drive mechanism i.e. compact as well as vertical marry-go-round system. It utilizes the ceiling height in order to save horizontal space which further reduces the problem of storage. It operates on rechargeable automobile battery so it doesn't require heavy 3-phase or single phase power supply and hence it can also be operated during power cut. Also it consumes the ceiling height of that space it can be considered as compact*

***Keyword:*** *Vertical drawers, chain drive operated, rotating drawer, shaft and chain-sprocket design, space availability.*

## I. INTRODUCTION

Vertical drawer system is a system which utilizes the ceiling height of the building or that particular area so as to reduce the problem of storage. It operates on the principle of chain sprocket mechanism and hence can be referred as a mini setup of vertical marry-go-round system. As it operates on rechargeable automobile battery so it doesn't requires heavy 3 phase or single phase power supply and hence it can also be operated during the power cut. It reduces the material handling problem and hence it is time saving. It is mostly preferable for light weight application. Also it doesn't require any type of fossil fuel and hence it is eco-friendly. No skilled labours required for operating this system.

It consists of chain-sprocket mechanism which works on following principle;

Chain drive is the commonly used way of transmitting motion and power from one place to another by use of shaft and gears/sprocket drive .It is mostly used to transmit power to the wheels of a vehicle, especially bicycles and motor-cycles. It is also used in wide varieties of machines besides vehicle. Most commonly used chain is the roller chain, also known as the drive chain or transmission chain. [7]

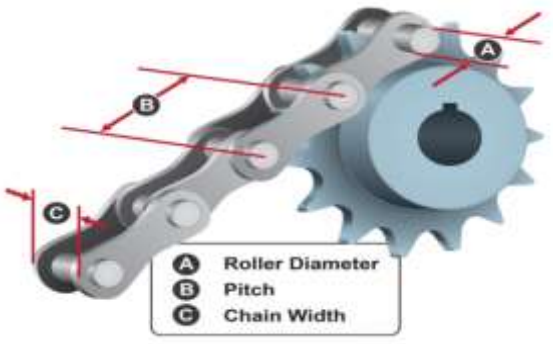


Fig.1. Chain Sprocket mechanism

Previously the industries used to have a store room for storage of raw material, finished goods, equipment's, material handling etc. which consumes more horizontal space which leads in the problem of storage so. The objective the invention[1] was to produce a drawer adapted for a vertical ' system of filling cabinets in which the above objections and

faults are minimized and in which the file contents are at all times held inconvenient usually vertical reference position so that the records may be quickly referred in the file from where either singly or in groups and with or without their index cards, which will result in saving the time, labour as well as money as compared to that in the use of former drawers/cabinet for that purpose.

The modular drawer system of the present invention [2] is designed and manufactured to meet the requirements such as ease in operation, less effort etc. In one aspect, the present project provides a modular drawer system comprising a frame, with a substantially rectangular base and at-least four corner column deduced pieces, each begin slide-able connected to one of the four support column at the top, which is attached to a frame.

## II. MATERIALS AND METHODOLOGY

Materials used in vertical drawer system were selected keeping in mind various loading parameter, the materials for frame, shaft, chain, sprocket and drawers are respectively M.S, bright material, hardened M.S, M.S with gun metal teeth and aluminium/galvanized iron.

**Design details**

**Design of shaft:**

Shaft is a rotating machine element which is used for transmission of power and motion from one place to another. They are usually manufactured by hot rolling process and finished by turning and grinding process.[4][5]

The following stress may be induced in shaft.

i. Shear stress due to torque transmission.
ii. Bending stress due to force acting on it.
iii. Stresses due to combine effect of torsion and bending load

When the shaft is subjected to twisting moment only then,

$$T = \pi/16 * \tau * d^3$$

Where, T = twisting moment

$\tau$ = torsional shear stress

d = diameter of solid shaft.

When the shaft is subjected to bending moment only then,

$$M = \pi/32 * \sigma_b * d^3$$

Where, $\sigma_b$ = bending stress

When the shaft is subjected to combine stress of torsion and bending moment; then the two theory come into light:

i. Maximum shear stress theory or Guest's theory.
ii. Maximum normal stress theory or Rankin's theory.

According to guest's theory,

$$\tau_{max} = ½ * [\sqrt{(\sigma_b)^2 + (4 * \tau^2)}]$$

$$=16/ (\pi * d^3) * [\sqrt{(M^2 + T^2)}]$$

Where, $[\sqrt{(M^2 + T^2)}]$ = Equivalent twisting moment.

According to Rankin's theory,

$$\sigma_{bmax} = ½ * \sigma_b + ½ [\sqrt{(\sigma_b)^2 + (4 * \tau)}]$$

$$= 32/ (\pi * d^3) * [½ \{M + \sqrt{(M^2 + T^2)}\}]$$

The expression [½ {M + √ ($M^2$ + $T^2$)}] is known as equivalent bending moment.

**Design of chain & sprocket**

Chain is regarded in between of gears and belt drive made of metals and requires less space. Main advantage of using chain drive is no slip and reduced load on shaft. The wheel over which the chain runs is known sprocket.

Let the chain be wrapped around the sprocket in form of pitch polygon,

Let, T = Number of Teeth on Sprocket.

Φ = Angle subtended by chord of link at centre of sprocket.

r = Radius of pitch circle.

Then,

$$P = 2r * \sin(\Phi/2)$$

$$=2r * \sin[½ (360^o/T)]$$

$$=2r * \sin[(180^o/T)]$$

Therefore,

$$r = P/ [2*\sin(180^o/T)]$$

$$= P/2 * \text{cosec}(180^o/T)$$

Let R and r be radii of pitch circle between two sprockets having T and t number of teeth. Also,

L = Length of chain

C = Centre distance between sprockets

P = Pitch of chain

Therefore,

$$L = \pi * (R + r) + (R – r)^2 / C + 2C$$

But,

$$R = P/2 * \text{cosec}(180^o/T) \text{ and } r = P/2 * \text{cosec}(180^o/t)$$

Therefore,

$$L = (PT + Pt)/2 + [P/2 * \text{cosec}(180^o/T) - P/2 * \text{cosec}(180^o/t)]^2 / C + 2C$$

Therefore,

$$L = P[(T + t)/2 + (\text{cosec}(180^o/T) - \text{cosec}(180^o/t)]^2 / 4C + 2C$$

## III. RESULT OF CALCULATION AND MODEL DESIGN

Table.1. dimensional details

| Sr. No. | Parts name | Specification (Approx.) In mm |
|---|---|---|
| 1. | Frame | 508*508*1524 |
| 2. | MS angle | 35*5 |
| 3 | Shaft | Length : 635<br>Dia.: 20 |
| 4. | Chain | 4000 |
| 5. | Sprocket | OD.: 127<br>ID.: 20<br>Pitch: 0.5 |
| 6. | Drawers | 431*203*50 |

**Model design:** The model of vertical drawer system is designed such a way that it utilizes maximum ceiling height and minimum floor space so as to overcome the problem of storage and material handling. The design is as shown in figure 2.

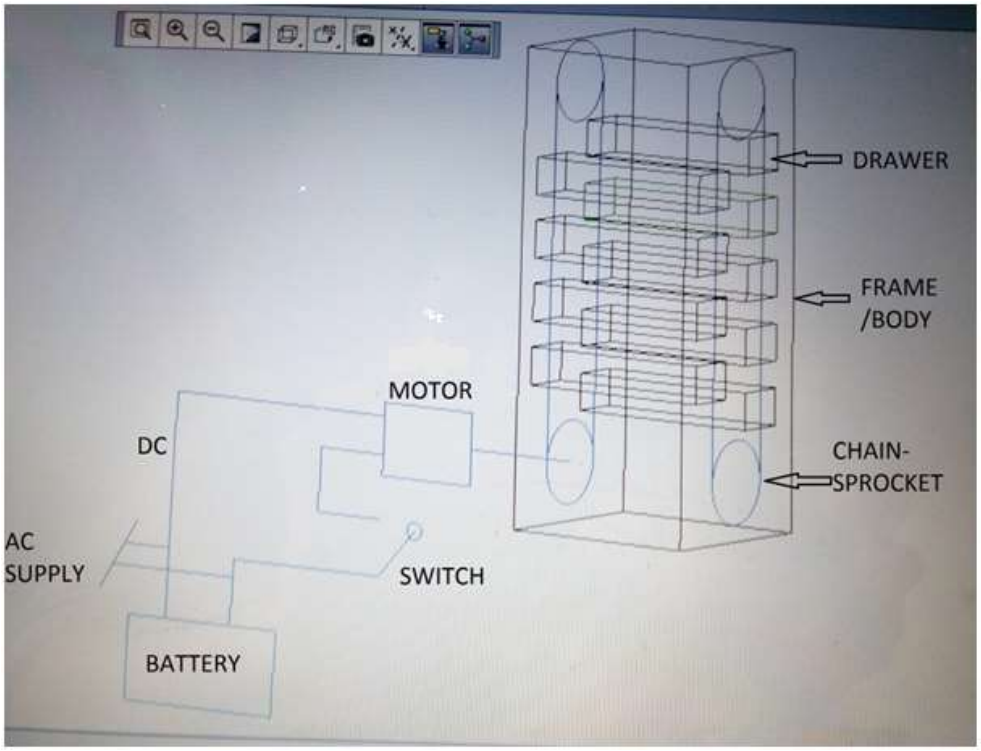


Fig.2. Model design

Fig.3. Model of Vertical Drawer System

## IV. RESULT AND DISCUSSION

By performing various repetitions of cycles on our model we concluded the following result as follows:

Table no. 3: Result for Forward Revolution

| Sr. No. | Loading | Approx. Time (Sec.) |
|---|---|---|
| 1. | Empty | 12 |
| 2. | 1Kg in 1 Box | 14 |
| 3. | 1Kg in all Box | 15 |
| 4. | Alternate Loading | 13 |
| 5. | Random Loading (22Kg) | 15 |
| 6. | Random Loading (26Kg) | 16 |

Table no. 4: Result for Reverse Revolution

| Sr. No. | Loading | Approx. Time (Sec.) |
|---|---|---|
| 1. | Empty | 12 |
| 2. | 1Kg in 1 Box | 14 |
| 3. | 1Kg in all Box | 15 |
| 4. | Alternate Loading | 13 |
| 5. | Random Loading (22Kg) | 15 |
| 6. | Random Loading (26Kg) | 16 |

## V. CONCLUSION

The problem of handling spare parts, inventories, integrated circuits and medicines can be solved by using the vertical storage and retrieval system. As a result of implementing this vertical system of storage and retrieval of goods/inventory/I.Cs/medicine can be made possible, which leads in better space utilization and saves time by sorting out and without any damage to the products.

As it only takes 12 seconds for 1 revolution of empty boxes and 16 seconds for total load of 26 Kg so the problem of time can be neglected and it also consumes less floor area so horizontal space can be saved.

This system reduces manual work and can easily be controlled by any common man or worker or employee. It can also be referred as a good way to make storage secure and reliable. It also allows quick storage of goods. Many industrial sectors prefer vertical storage and retrieval system as it is beneficial in number of ways.

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