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Smart inventory storage system

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ABSTRACT

In most of the industries, material handling and storage is done by industrial stackers. So industries have to pay for rack manufacturing and purchasing of stacker or turret. This goes costlier and more space, effort consuming. Many of the small-scale industries can't even afford it. The paper will describe one model called Smart Inventory Storage System (SISS) for material handling and storage which will save cost, effort, and space of the industry. After analyzing the successful operation of the small prototype of SISS, it is predicted that it will be a good solution to many of the small-scale industries for material handling and storage.

Keywords: *Material Handling, Storage, Inventory, Stacker, Turret.*

1. INTRODUCTION

When we use stackers for material handling purpose, it needs operational space between two racks in which material is to be stored. It also takes more effort of the operator to move stacker in the given space. To save space and effort turrets are the best options but they are very costly. They are recommended to use for handling of large inventory. Generally, small scale industries have not many inventories to install a rack- turret setup. So they go to the option of the stacker for material handling though it is quiet costly, space and effort consuming. The model developed named Smart Inventory Storage System (SISS) not only reduces cost but also space and effort for its operation. It has carriers on which material is to be stored and the system rotates so that carrier which we want comes in front of us. Hence the only operation we need to do is place the material in the carrier which is at our front and then rotates the system to repeat the operation with other carriers.

2. VARIOUS PARTS OF SMART INVENTORY STORAGE SYSTEM

2.1 Sprocket

Sprockets are used for motion and torque transfer. Basically, it acts as a mediator between motor and chain. The sprockets suitable for the design of SSIS is centre fewer sprockets due to its capacity of sustaining higher loads and high higher torque transmitting capacities.

Fig -1: Sprocket designed in CAD

2.2 Chain

The mountings which are to be attached to a chain should not generate stresses in dynamic conditions. So center less chain is best suitable for the application which has a greater pitch than normal chains as well as more load carrying capacity. Pitch of the chain can be defined as the distance between centers of two rollers of the chain.

2.3 Electric Geared Motor

This type of motor contains induction motor along with gear box as a unique body. Use of this motor type makes structure compact.

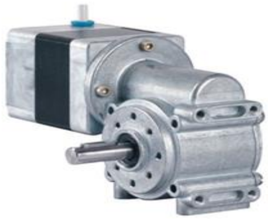

Fig – 2: Electric geared motor

2.4 Brackets

Brackets are the supporting members for carriers. They have one end fixed on chain side and another end fitted with carriers. They act like a cantilever beam.

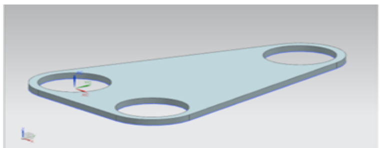

Fig – 3: Brackets designed in CAD

2.5 Carriers

Carriers are the load carrying members which move along the guided path i.e. Ellipse. Carriers are designed such that, it has the highest possible load carrying capacity with minimum self-weight**.**

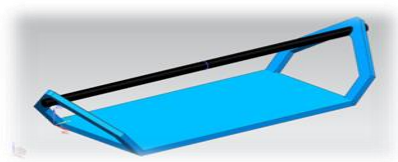

Fig -4: Carriers

3. ASSEMBLY IN CAD

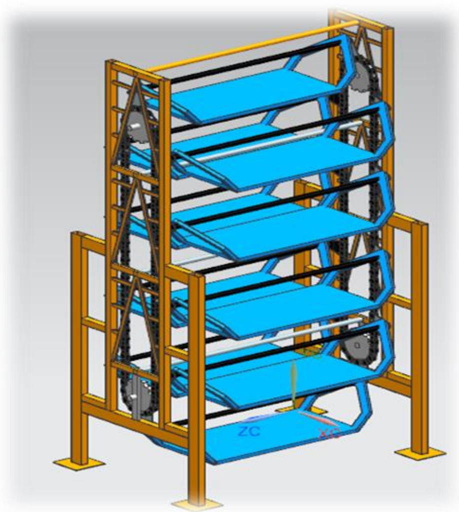

Fig – 5: Assembly in UGNX

4. WORKING PRINCIPLE

Working on this design is similar to Mary Go Round except for travel path which is an ellipse. The carriers are moved by rotating members such as chain-sprocket assembly which are mediators for torque & motion transmission between electric geared motor & carriers. The various carriers are given numbers for identification. It facilitates us to identify material placed in the respective carrier. This makes material handling and storage is simple for operator and store keeper. The whole setup can be set into motion by simply pushing one button which enables rotation of the motor and a carrier stop moving immediately after releasing button.

5. CALCULATIONS

We know that power is constant throughout the transmission system. But this not similar in the case of torque. Power equals the product of torque and speed.[1]

Power in = Power out

$H = T_i W_i = T_0 W_0$ ....(equation- 1)

For the calculations of SISS model, it is assumed that a number of carriers are 10 and each has the maximum load carrying capacity of 600 kg. With a constant power, a gear ratio to decrease the angular velocity will simultaneously increase torque.

The gear ratio, or train value, for the gear train is

$e = \omega_0/\omega_i = T_i/T_0$ ....(equation- 2)

$w = \frac{2\pi N}{60}$ as $w \alpha N$, Where w= angular speed in rad/ sec & N= Revolution per minute. ...(equation- 3)

According to our assumption we have,

N_i=735 rpm, N_0=12 rpm, T_0= 17658 Nm

$Ti = \frac{N0}{Ni} \times T_0 = 288.3$ Nm ....(equation- 4)

Based on above torque requirements and gear reduction (60:1), motor suitable for the application is 25 HP 3 phase induction motor.[3]

Let's try to calculate output torque by designing a compound gear train [2],

Reduction $E = \frac{Wo}{Wi} = 1{:}\,61.25$

e = 1/61.25

(For smallest package size)

Let both stages be the same reduction. Also by making 2 stages identical, the in-line condition on the input & output shaft will automatically be satisfied.

$$\frac{N2}{N3} = \frac{N4}{N5} = \frac{1}{\sqrt{61.25}} = 0.127$$

For this ratio, the min. number of teeth

$N_p = \frac{2k}{(1+2m)sin^2\Phi}(m + \sqrt{m^2 + (1+2m)sin^2\Phi})$ ....(equation- 4)

Where k=1 for full depth teeth, 0.8 for stub teeth & Φ =Pressure angle (20°) with k=1

Here mating gear has more teeth than the pinion,

$m_c = \frac{Nc}{Np} = m$

The smallest number of teeth on a spur pinion and gear, one to one gear ratio, which can exist without interference is N_p.

$N_p = \frac{2K}{3sin^2\emptyset}(1 + \sqrt{1 + 3sin^2\emptyset})$ ....(equation- 4)

$N_2 = N_4 = 12$ teeth

$N_3 = N_5 = \frac{N2}{0.127} = 93$

check if W_5 is within limit.

$W_5 = \frac{12}{93} * \frac{12}{93} * 735 \ = 12.24$rpm

In this situation, 12.24 rpm is acceptable with gear ratio 1:60.

$N_2 = N_4 = 12$ teeth

$N_3 = N_5 = 93$ teeth.

$e = \frac{12}{93}\frac{12}{93.} = 0.0163$

$W_5 = 12.24$ rpm

$W_3 = W_4 = \frac{12}{93} * 735 = 94.83$ rpm

To determine the torques, return to the power relationship. We are using the motor 25 HP.

$H = T_2W_2 = T_5W_5$

$T_2 = H/W_2 = 243.07$ N-m

$T_5 = 19855.84$ Nm.

We require 17658 Nm torque output and we get 19855.84 N-m torque. Hence we can use 25 HP 3 phase induction motor.

Chains and sprockets and other transmission elements can be selected according to load carrying capacities. They are available in standard sizes.

6. PROTOTYPE OF SISS

Fig -6: Working Model of SISS

7. IMPORTANCE AND USEFULNESS OR SCOPE

The smart inventory storage system has minimum work volume. The benefit of this concept is it does not require any additional costly material handling equipment such as stacker. As far as small-scale industries are concerned everyone will prefer to invest nearly 3 lakhs for this concept rather than paying nearly 6 lakhs for designing stacker & rack separately. The concept can be preferred because of its less cost, satisfactory capacity & ease of handling. If operational space stacker is neglected, SISS takes only 17% more space than simple racks of same capacity which is worth to invest in it.

8. DISADVANTAGES

- It is suitable only for small-scale industries which have less or moderate material handling and storage.

- Balancing is mandatory for safe operation.
- For small weight capacity, the motor power requirement is comparatively more.

9. CONCLUSION

Material handling and storage is one of the important concerns of any industry. Everyone tries to minimize its inventory as inventory carrying and storage cost are much higher. All industries try to make inventory storage and material handling with as less space as possible. The attempt is also given to make all these operations easy in terms of effort, time, and safety. So our design fulfill all those requirements.

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