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Conveyor Belt System with 3 Degrees of Freedom

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Abstract: ***A conveyor system is a common piece of mechanical handling equipment that moves materials from one location to another. Conveyors are especially useful in applications involving the transportation of heavy or bulky materials. Conveyor systems allow quick and efficient transportation for a wide variety of materials, which make them very popular in the material handling and packaging industries. Many kinds of conveying systems are available and are used according to the various needs of different industries. The objective of this project is to make a conveyr belt system that has 3 degrees of freedom. i.e. rotation along x-axis, changing the angle of y-axis and changing the length along y-axis.***

I. INTRODUTION

Belt Conveyors are used in self-unloading bulk freighters and in live bottom trucks. Conveyor technology is also used in conveyor transport such as moving sidewalks or, escalators as well as on many manufacturing assembly lines. Stores often have conveyor belts at the check-out counter to move shopping items. Ski areas also use conveyor belts to transport skiers up the hill. A wide variety of related conveying machines are available, different as regards principle of operation, means and direction of conveyance, including vibrating screw conveyors, pneumatic conveyors, the moving floor system, which uses reciprocating slats to move cargo, and roller conveyor system, which uses a series of powered rollers to convey boxes or pallets. Conveyors are used as components in automated distribution and warehousing. In combination with computer controlled pallet handling equipment this allows for more efficient retail, wholesale, and manufacturing distribution. It is considered a labor saving system that allows large volumes to move rapidly through a process, allowing companies to ship or receive higher volumes with smaller storage space and with less labor expense. Rubber Conveyor Belts are commonly used to convey items with irregular bottom surfaces, small items that would fall in between rollers (e.g. a sushi conveyor bar), or bags of product that would sag between rollers. Belt conveyors are generally fairly similar in construction consisting of a metal frame with rollers at either end of a flat metal bed. The rollers allow weight to be conveyed as they reduce the amount of friction generated from the heavier loading on the belting. Belt conveyors can now be manufactured with curved sections which use tapered rollers and curved belting to convey products around a corner. These conveyor systems are commonly used in postal sorting offices and airport baggage handling systems. Belt conveyors are the most commonly used powered conveyors because they are the most versatile and the least expensive. Product is conveyed directly on the belts both regular and irregular shaped objects, large or small, light and heavy, can be transported successfully. These conveyors should use only the height quality premium belting products, which reduce the belt scratch. Belt conveyors can be used to transport product in a straight-line or through changes in elevation or direction. In certain applications they can also be used for static accumulation or cartons.

II. LITERATURE SURVEY

The history of conveyor belts begins in the latter half of the 17th century. Since then, conveyor belts have been an inevitable part of material transportation. But it was in 1795 that conveyor belts became a popular means for conveying bulk materials. In the beginning, conveyor belts were used only for moving grain sacks to short distances.

Primitive conveyor belts were used since the 19th century. In 1892, Thomas Robins began a series of inventions which led to the development of a conveyor belt used for carrying coal, ores and other products. In 1901, Sandvik invented and started the production of steel conveyor belts. In 1905 Richard Sutcliffe invented the first conveyor belts for use in coal mines which revolutionized the mining industry.

The conveyor belt system and working were quite simple in the early days. The conveyor belt system had a flat wooden bed and a belt that travelled over the wooden bed. Earlier, conveyor belts were made of leather, canvas or rubber. This primitive conveyor belt system was very popular for conveying bulky items from one place to another. In the beginning of the 20th century, the applications of conveyor belts became wider.

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Hymle Goddard of Logan Company was the first to receive the patent for the roller conveyor in 1908. The roller conveyor business did not prosper. A few years later, in 1919, powered and free conveyors were used in automotive production. Thus, conveyor belts became popular tools for conveying heavy and large goods within factories.

During the 1920s, conveyor belts were common, and also underwent tremendous changes. Conveyor belts were used in coal mines to handle runs of coal for more than 8kms, and were made using layers of cotton and rubber covers. The longest conveyor belt now in use is 60 miles long, in the phosphate mines of Western Sahara.

One of the turning points in the history of conveyor belts was the introduction of synthetic conveyor belts. It was introduced during the Second World War, mainly because of the scarcity of natural materials such as cotton, rubber and canvas. Since then, synthetic conveyor belts have become popular in various fields.

With the increasing demand in the market, many synthetic polymers and fabrics began to be used in the manufacture of conveyor belts. Today, cotton, canvas, EPDM, leather, neoprene, nylon, polyester, polyurethane, urethane, PVC, rubber, silicone and steel are commonly used in conveyor belts. Nowadays, the material used for making a conveyor belt is determined by its application. Primitive conveyor belts were used since the 19th century. In 1892, Thomas Robins began a series of inventions which led to the development of a conveyor belt used for carrying coal, ores and other products. In 1901, Sandvik invented and started the production of steel conveyor belts. In 1905 Richard Sutcliffe invented the first conveyor belts for use in coal mines which revolutionized the mining industry. In 1913, Henry Ford introduced conveyor-belt assembly lines at Ford Motor Company's Highland Park, Michigan factory. In 1972, the French society REI created in New Caledonia the longest straight-belt conveyor in the world; at a length of 13.8 km. Hyacynthe Marcel Bocchetti was the concept designer. In 1957, the B. F. Goodrich Company patented a conveyor belt that it went on to produce as the Turnover Conveyor Belt System. Incorporating a half-twist, it had the advantage over conventional belts of a longer life because it could expose all of its surface area to wear and tear. Möbius strip belts are no longer manufactured because untwisted modern belts can be made more durable by constructing them from several layers of different materials. In 1970, Intralox, a Louisiana-based company, registered the first patent for all plastic, modular belting

III. OBJECTIVES

A. Now in industries only fixed type belt conveyor is available

B. But we will make the conveyor belt such that it can be rotate 360° and up-down mechanism and with varying length with proto type model.

IV. METHODOLOGY

A. In this system one motor is connected with the shaft of the belt which will rotate the conveyor belt.

B. Secondly two motors and two actuator will be use for making the up-down mechanism.

C. Here two motor are connected with the actuator and when the motor will rotate the actuator will move in the up-down position.

D. Another motor is being housed at bottom of the base and the shaft will be connect to the clamp which is connected with the motor shaft with the help of brass coupling.

E. So by enhancing this method we can rotate the conveyor belt at 360°.

F. Design

Shaft

Design of shaft:

Area of shaft A= $\frac{\pi d^2}{4}$

Diameter of shaft d=20mm

$$A=\frac{\pi (20)^2}{4}$$

$$A=314.159mm^2$$

Torque transmitted by shaft:-

$$T=\frac{995\times10^4\times KW}{N}\ \text{N-mm}$$

Power =150W

$$T=\frac{995\times10^4\times0.150}{60}$$

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T=23875 N-mm

Maximum shear stress in a circular shaft

$$\tau = \frac{16\times T}{\pi\times d^3}\ \text{N/}mm^2$$

$$\tau = \frac{16 \times 23875}{\pi \times 20^3}$$

$$\tau = 15.20\ \text{N/}mm^2$$

Belt
Design of belt:-
Width of the belt b=250mm
Thickness of belt t=5mm
Area of belt material A=b× t

A=250× 5
A=1250 mm^2

velocity of the belt $V=\frac{\pi\times D\times N}{60}$

Diameter of pulley D=60mm

$$V=\frac{\pi\times 60\times 60}{60}$$
V=188.49mm/sec

Assuming safe stress, σ =3 N/mm^2
maximum tension in belt T=σ.A

=σ.b.t
=3×1250
T=3750 N

For low speed neglecting centrifugal tension (mv^2)
Tension in tight side of belt T=T_1 =3750N

We have $\frac{T_1}{T_2}=e^{f\times\theta}$

$(e^{f\times\theta}=e^{0.35\times 180\times\frac{\pi}{180}}=3.00)$

f=coefficient of friction, for dry leather f=0.35

θ=angle of lap =180°

Tension in slack side of belt:-

$$T_2=\frac{T_1}{e^{f\theta}}$$
$$=\frac{3750}{3.00}$$

T_2=1250 N
f. Power transmitted by a belt:-

P= (T_1-T_2)×V
= (3750-1250)× 188.49× 10^{-3}
P=0.471KW

Gear

1. $\frac{N1}{N2}=\frac{D2}{D1}=\frac{Z2}{Z1}$

Where,
N1= RPM of driver gear
N2 = RPM of driven gear

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Z1= no. of teeth of driver gear
Z2= no. of teeth of driven gear
D1= Dia. Of driver gear
D2= Dia. Of driven gear

G. Motor

1) Selection Of Motor

a) Determine the drive mechanism component
b) Confirm the required specifications
c) Calculate the speed and load
d) Select motor type
e) Check the selected motor

H. Electric Motor

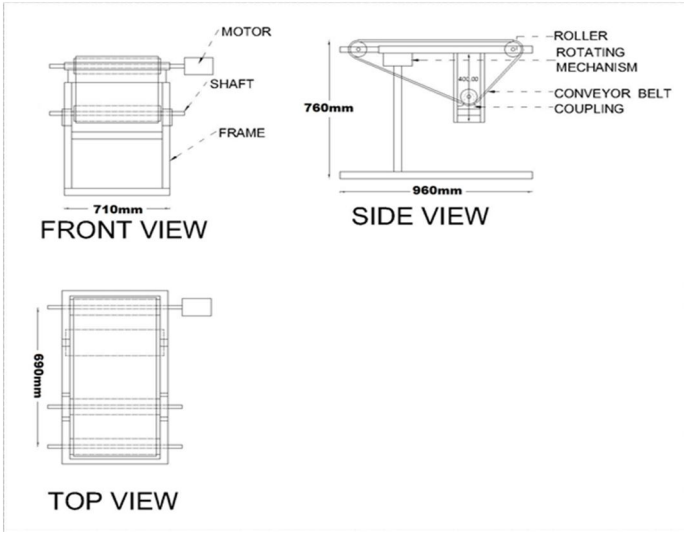
1) Type: DC gear motor
2) Brake Horse Power: 0.13HP = 102.73 Watts
3) Voltage range: 4V to 12V
4) Speed : 10 rpm at 12V
5) Shaft diameter : 8mm
6) Shaft length: 25mm
7) Gear assembly: spur
8) Brush type: carbon
9) Motor weight : 0.52 kg

I. Working Principle

Since in multidirectional conveyors often rotation manually becomes ridiculous hence in order to overcome this DC motors are used for automatic direction change. When DC motor is switched on shaft rotates, it carries a round plate on which the whole assembly is mounted. hence when shaft rotates it causes the while body to rotate automatically.

As in some cases the material is to be conveyed at certain higher and lower position the whole body is tilted at required angle and is locked at that position using locking nut and when the motor is switched on the driving pulley rotates causing driven pulley to rotate, the materials are transmitted to required height. The frame inside the body is pulled out to required length and is locked after the required length is obtained using idler pulleys this is done when materials are to be transmitted to different distances. When the frame is shorten for short distance the belt is adjusted using idler roller.

V. BLOCK DAIGRAM



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VI. APPLICATIONS

A. Used in automobile industries.
B. In airport.
C. Used in coal industries.
D. In stone crushing factory.
E. In food packing processes.
F. Sugar industry
G. Used in stores

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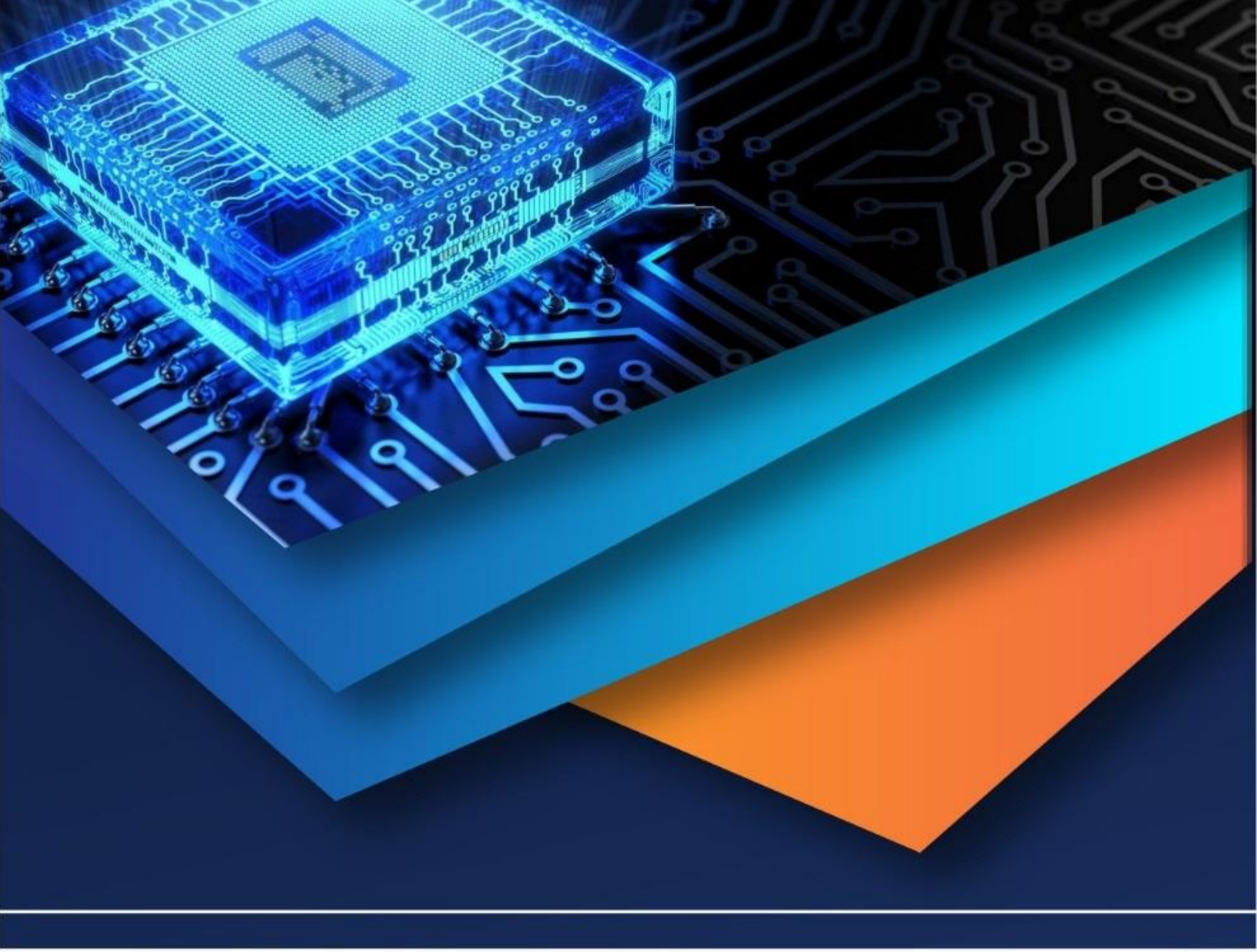

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