Middle-East Journal of Scientific Research 20 (6): 744-748, 2014
ISSN 1990-9233

DOI: 10.5829/idosi.mejsr.2014.20.06.11372

Design and Fabrication of Rack and Pinion Lift

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Abstract: A Rack and Pinion Lift is composed of two gears and a Rack and Pinion arrangement. The flat helical gear is the rack and the round helical gear is the pinion. The rack has teeth cut into it and they mesh the teeth of the pinion gear. Also a spur gear is connected to the shaft of the pinion. And this gear is connected to another gear by using a chain drive. One of the spur gear is connected to the shaft of the torque and transfer power by using a chair. The motor is running by use of 12 v battery. A rack and pinion is used to convert between rotary and linear motion. This rack and pinion lift is commonly used in many industrial applications. A rack and pinion lift consists of a rack and a pinion engaging also transfer motion to or from a special kind of spur gear called a rack consisting of series of teeth in a straight line on a flat surface. The invention relates to rack and pinion lifts, which include a lift car which is driven via toothed wheels by means of an electromotor along a rack carried by a lift mast, said car containing a control and maneuver unit for the electric motor with a control and maneuver button set including floor call buttons, landing based call button units being connected to said control and maneuver unit via a ground level unit from which also a power cable leads to the lift car. In association with the lift car a sensor device is arranged to indicate passage of teeth of the rack or the toothed wheel and produce corresponding position impulses, which represent the position of the lift car. A micro computer system is connected for receiving the position impulses and for collecting and storing call impulses from the call units and destination impulses from the button set of the control and maneuver unit and based upon the position of the lift car ordering travel direction, retardation and stop of the lift car. Said micro computer system includes on the one hand a programmable micro computer unit in the lift car with a register for position impulse numbers corresponding to the positionsof the landings, inputs for landings and outputs for controlling operation of the electric motor, on the other hand a micro computer unit scanning the call button units with respect to their state and associated with the ground level unit and communicating with the programmable micro computer unit in the lift car.

Key words: Rack and Pinion arrangement · Rack and pinion lift consists · Which represent the position

INTRODUCTION

A Rack and pinion gear system is composed of two gears. The normal helical gear is the pinion gear and the straight helical gear is the rack. The rack has teeth cut into it and they mesh the teeth of the pinion gear. Rack and pinion gear provides a greater feedback and steering sensation [1]. A well designed mechanism such as the rack and pinion gear save effort and time. The rack and pinion is used to convert between rotary and linear motion. Rack and pinion can convert from rotary to linear or from linear to rotary. The diameter of the gear determines the speed that the rack moves as the pinion turns. Rack and pinion are commonly used in the steering system of cars to convert the rotary motion to the steering wheel to the side to side motion in the wheel [2].

A rack and pinion consists of a pinion engaging and transferring motion to or from a special kind of spur gear, called a rack, consisting of a series of teeth in a straight line on a flat surface. The rack and pinion changes linear motion into rotary motion, or vice versa the rack and pinion is used to convert between rotary and linear motion. Rack and pinion can convert from rotary to linear or from linear to rotary. The diameter of the gear

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determines the speed that the rack moves as the pinion turns. Rack and pinion are commonly used in the steering system of cars to convert the rotary motion of to the steering wheel to the side to side motion in the wheel. A rack and pinion consists of a pinion engaging and transferring motion to or from a special kind of spur gear, called a rack, consisting of a series of teeth in a straight line on a flat surface [3]. The rack and pinion changes linear motion into rotary motion, or vice versa.

In a rack and pinion lift system, comprising a lift car, electro motor means for driving said car along a lift mast via rack and pinion means, a control unit in said car with a control buttons set including floor call buttons, call button units on landings along said mast, means connecting said call button units to said control unit via a ground level unit, the improvement comprising. The present invention relates to a rack and pinion lift system, comprising a lift car electro motor means for driving said car along a lift mast via rack and pinion means, a control unit in said car with a control button set including floor call buttons, call button units on landings along said mast, means connecting said call button units to said control unit via a ground level unit.

Micro computer controlled floor call systems are earlier known in connection with fixed wire rope hoist systems for indoor applications. To apply similar systems for automatic control of rack and pinion drive lifts in tough industrial environment, building sites, excavations and the similar, meet with a number of problems. Among these problems temperature and moisture conditions varying within wide limits should be mentioned, as well as corrosive atmosphere in some cases. power mains voltage variations often occur due to connection and disconnection of great loads and also the risk for voltage disappearance is greater than normal. The above mentioned problems can certainly in some cases be remedied by suitable choice of components, but at the same time they necessitate a far going simplification of the signal transmission and its organization in order to eliminate as many sources of error as possible because of environment [4].

Work Done: We have designed and fabricated Rack And Pinion Lift and further calculations are done. Rack and pinion mechanism are introduced in lifting mechanism.

The major operations done in design and fabrication of a rack and pinion lifts are as follows:

- Cutting
- Drilling
- Welding
- Grinding

Cutting: Cutting operations are done so as to make the materials in proper dimensions. The cutting operations are done by the various cutters available in the market just like dewalt, black deccor etc. hack saw are used for soft iron parts such as stainless steels [5].

Drilling: Drilling is a cutting process that uses a drill bit to cut or enlarge a hole in solid materials. The drill bit is a multipoint, end cutting tool. It cuts by applying pressure and rotation to the workpiece, which forms chips at the cutting edge [6].

Welding: Welding is a process for joining different materials.welding joins different metals or alloys with the help of a number of processes in which heat is supplied either electrically or by means of a gas torch.Heat and pressure are the important requirement in welding.

Welding is classified into;

- Gas welding
- Arc welding
- Resistance welding
- Solid state welding
- Gas welding

Gas Welding: It is a fusion welding process.it joins metals using the heat of combustion of and oxygen/air and fuel gas mixture. The intense heat thus produced melts and fuses together the edges of the parts to be welded,generally with the addition of a filler me [7].

Grinding: For material removal, the method used in grinding is called abrasion. In other words, in grinding, an abrasive material rubs against the metal part and clears or removes tiny pieces of material. The process implies that instead of cutting like a lathe bit, the material is slowly and steadily worn away. This is because compared to the material being ground, the abrasive is harder. The grinding wheel actually acts like many hundreds of very small lathe bit, each cutting off some metal. The abrasive must be strong enough to bear any kind of forces acting upon it while grinding. Usually some sort of

impact shock occurs when the abrasive comes in contact with the material. Grinding abrades material in a way similar to sanding. The grinding operation is performed on a several machines like the lathe and the mill, with the appropriate add-on accessories, the most important of which is the spindle.

Design Calculations:
Design of Rack:

- Rack-Cast iron
- Pinion-Cast iron
- σu<390 N/mm²
- σb =30 N/ mm²

Calculation of Centre Distance
Corresponding Number of Starts:

- Z= 3
- Z= iZ
- 24×3=72

Check Whether Z Lies Between 25 and 85

- Choose q=11
- Assume(σc) =159 N/mm²
- Assume initially kkd=1

Wheel torque= power × 60÷2π × rpm of the pinion

=50×60÷2π×(50÷24)
= 229 Nm

[Mt] =ko.kd.Mt

=1×1×229×10³
=229×10³ Nmm
a =[(z÷q)+]³v[(540÷(z÷q)[σc]]².[Mt]÷10
=[(72÷11)+1]³v[540÷(72÷11)×159.[229×10³÷10]
=7.56³v(0.518867)²×(229×10³)÷10
=7.56×18.336
=139mm

Calculation of Axial Module

Mx=2a÷(q+z)
=2×139÷(11+72)
=3.3mm

Take mx=5mm (standard)

REVISE a and OBTAIN d1

a =0.5 mx (q+z)
a =0.5×5(11+72)
=207mm

Pitch circle diameter of rack=d1=qmx

=11×5
=55mm

5.Vs=V1÷cosγ tanγ=z÷q

=0.14÷cos15.25° =3÷11
=0.145m/s lead
angle γ= 15.25°

V1=pitch line velocity of rack

=πd1n1÷(60×1000)
=π×55×50÷(60×1000)
=0.1439m/s

SINCE Vs < 4m/s, the [σc] is correct
REVISE k,kd and [Mt] for the actual pitch line velocity of the pinion

V2=rack speed(rpm)×lead÷(60×1000)

= 50×(2π mx)or zpa÷(60×1000)
=50×3×π×5÷(60×1000)
=0.03m/s

Since V2=0.03m/s<3m/s, kd=1

[Mt]=k.kd.Mt
=1×1×229×10³
=229×10³

Determination of Induced Stress:

σc=540÷(z÷q)v[((z÷q)+1)÷a]³.[Mt]÷10
=540÷v[(72÷11)+1)÷207]³.229×10³
=82.5×1.03512
=86.9N/mm²<[σc]=159N/mm²
σb=1.9[Mt]÷m³xqzyv
=1.9×229×10³÷(5³×11×72×0.499)
=8.80N/mm²<[σb]=30N/mm² Zeq=z÷cos³γ
=72÷cos³15.25°
=80
yv =0.499(for 80 teeth)

Basic Dimensions:
Rack:

L =(12.5+0.09 Z)MX
=(12.5+(0.09×72)15
=284mm

L1=L+35(grinding allowance)

=284+38
=319

Number of Threads on Rack

=L1÷πmx
=319÷(π×5)
=21

Actual Length of Rack

=21×π×5
=330mm

Pitch diameter of the rack=55mm

Tip diameter da=d1+2mx

=55+(2×5=65

Root diameter df1=d1-2mx-2c

=55-(2×5)-2×(0.3×5)
=42

Design of Pinion
Face Width of the Pinion

b =0.75 d1
=0.75×55
=42

Pitch circle diameter of pinion,d2=zmx

=72×5
=360mm

Tip diameter of the wheel,da2=(z+2)mx

=(72+2)×5
=370mm

Maximum pinion diameter de2=da2+1.5mx

=370+(1.5×5)
=378mm

Root diameter of the pinion
df2=(z-2)mx-2c

=(72-2)5-(2×0.3×5)
=347mm

Specification of Rack:

- Material- Cast iron
- Module=1.5mm
- Cross section=58×25mm
- Teeth on the rack is adjusted for
- 86mm

Specification of Pinion:

- Material-Cast iron
- Outside diameter=58mm
- Pitch circle diameter=55mm
- Circular pitch=4.7mm
- Module=1.5mm
- Pressure angle=21°
- Addendum=1.5mm
- Dedendum=1.8m
- Circular tooth thickness=2.35mm
- Fillet radius=0.45mm
- Clearance=0.375

Expected Load Can Handle:

P=mgh÷t

The power getting in pinion after all reduction

=38.4
M=?
t =5sec(assumed)
g =9.8
h =45cm(assumed)
m =P×t ÷gh
=(38.4×5)÷(9.81×0.45)
=43.49kg(including rack weight)

CONCLUSION

Therefore to conclude, we have designed and fabricated Rack And Pinion Lift and further calculations are done. Rack and pinion mechanism are introduced in

lifting mechanism.Thus we came in to a contradiction that the installation of a lift is not an easy task and high installation cost.

As compared with the other lifting mechanism, rack and pinion lift mechanism does not need any separate machine rooms. Well designed Rack and pinion lifts are more compact and saves effort and time.

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