International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 8 Aug 2021, pp: 210-216www.ijaem.net ISSN: 2395-5252

Design and Fabrication of motorized automated Object liftingjack

Aatish hatkhambakar,Aniket pawar[1], Dhananjay shende[1],Prof.Priyanka wagh[1]
[1](ISB&M school of technology Nande, Tal. Mulshi, Dist. Pune)

Submitted: 01-08-2021 Revised: 07-08-2021 Accepted: 10-08-2021

ABSTRACT: - With the increasing levels of technology, the efforts are being put to produce any kind of work thathas been continuously decreasing. The efforts required in achieving the desired output can be effectively andeconomically be decreased by the implementation of better designs. Power screws are used to convert rotarymotion into reciprocating motion. An object lifting jack is an example of a power screw in which a small forceapplied ina horizontal plane isused to raise orlowera large load. Inthis fabricated model, an electric motorwillbeintegratedwiththeobjectliftingjackandtheelectricityneededfortheoperationwillbetakenfromthe d.cbatteryandtherebythemechanical advantage will be increased.

Keywords:-
Objectliftingjack,automation,limitswitch,lead screw

I. INTRODUCTION

Our research survey in this regard revealed that in several automobile garages , revealed the facts thatmostly some difficult methods were adopted in lifting the vehicles for reconditioning, repair and maintenance.This fabricated model has mainly concentrated on this difficulty, and hence a suitable device has been designed,such that the vehicle and heavy objects can be lifted from floor land without the application of impact force. Thefabrication part of it has been considered with almost case for its simplicity and economy, such that this can beaccommodated as one of its essential tools on automobile garages. The object lifting jack has been developed tocater to the needs of small and medium automobile garages, which are normally man powered with minimumskilled labour. In most of the garages the vehicles are lifted by using screw jack. This needs high man power andskilled labour. In order to avoid all such disadvantages, the automated motorized object lifting jack has beendesigned in such a way that it can be used to lift the vehicle very smoothly without any impact force. Theoperation is made simple so that even unskilled labour can use it with ease. The d.c motor is coupled with thelead screw by gear arrangement, the lead screw rotation depends upon the rotation of d.c motor. This is an era ofautomation where it is broadly defined as replacement of manual effort by mechanical power in all degrees ofautomation. The operation remains to be an essential part of the system although with changing demands onphysicalinput, thedegreeofmechanizationisincreased.

Needfor automation

- Toachievemass production.
- Toreducehumaneffort.
- Toincreasetheefficiencyofthejack.
- Toreducetheworkload.
- Toreducetheproduction cost.
- Toreducetheproductiontime.
- Toreducethematerialhandling.
- Toreducethefatigueofworkers.

Principleofoperation

The lead screw is considered as an inclined plane with inclination α. When the load is being raised orlowered,followingforcesactatapointonthisinclined plane.

Load(W): Italwaysactsinverticallydownwarddirection.

Normalreaction (N):Itactsperpendicular(normal)totheinclinedplane.

Frictional force (μN): It acts opposite to the motion. When the load is moving the inclined plane, frictionalforce acts along the inclined plane in downward direction and when the load is moving down the inclined plane,frictionalforceactsalongtheinclinedplaneinupwarddirection.

Effort(P): It acts in a direction perpendicular to the load (W). It may act towards right to overcome thefrictionandraisetheload.

Whenloadisraised,

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 8 Aug 2021, pp: 210-216www.ijaem.net ISSN: 2395-5252

For an equilibrium of horizontal forces, P = μN cos α + N sin α….(1)For an equilibrium of vertical forces,W = N cos α - μN sin α….(2)Dividingequation(1)by(2)weget,
P = W (μ cosα + sin α)….(3)cosα-μsinα
The coefficient of friction μ is expressed as μ= tan θ….(4)Substitutingequation(4)in(3)weget,
P=Wtan(θ+α) ….(5)
ThetorqueTrequiredtoraisetheloadisgivenby,T=tan(θ+α)….(6)

Whenload islowered,
For an equilibrium of horizontal forces, P = μN cos α - N sin α….(7)For an equilibrium of vertical forces,W = N cos α + μN sin α….(8)Dividingequation(7)by(8)weget,
P = W (μ cosα - sin α)….(9)cosα+μsinα
Substituting equation (4) in (9) we get,P =Wtan(θ-α)….(10)
ThetorqueTrequiredtoraisetheloadisgivenby,T=tan(θ-α) ….(11)

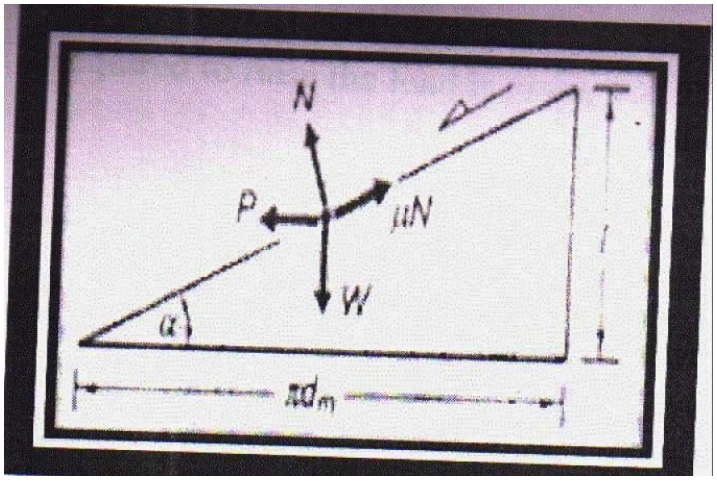

Fig 1:Forces actinginan inclinedplane

Componentsoffabricatedmodel
Themain partsoftheautomatedmotorized objectliftingjack areasfollows:

D.Cmotor

An electric motor is a machine which converts electrical energy into mechanical energy. Its action isbased on the principle that when a current carrying conductor is placed on a magnetic field, it experiences amagnetic force whose direction is given by Fleming's left hand rule. When a motor is in operation, it developstorque. This torque can produce mechanical rotation. D.C motors are also like generators classified into shuntwoundorserieswoundorcompoundwoundmotors.

LeadScrew

A lead screw is a portable device consisting of s screw mechanism used to raise or lower the load. Thelead screw can be short, tall, fat or thin depending on the amount of pressure they will be under and space thatthey need to fit into. It is made of various types of metals but the screw itself is made of lead.A large amount ofheat is generated init and long lifts cancause serious overheating. To retain the efficiency, it must be usedunder ambient temperatures, otherwise lubricants must be applied. These are oil lubricants intended to enhancethe equipment's capabilities. Apart from proper maintenance, to optimize the capability and usefulness of leadscrewitisimperativetoemployitaccordingtoitsdesignandconstruction.

Batteries

Inisolated systems away from the grid, batteries are used forstorage of excess solarenergy whichcanbe converted into electrical energy. In fact for small units with output less than one kilowatt, batteries seem to beless the only technically and economically available storage means. Since both the photovoltaic system andbatteries are high in capital costs , it is necessary that the overall system be optimized with respect to availableenergyandlocaldemandpattern.

Ballbearing

This is a type of rolling element bearing that uses balls to maintain the separation between the bearingraces. The purpose of a ball bearing is to reduce rotational friction and support and radial and axial loads. Itachievesthisbyusingatleasttworacestocontaintheballsandtransmittheloadsthroughtheballs.

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 8 Aug 2021, pp: 210-216www.ijaem.net ISSN: 2395-5252

Spur gears

These are designed to transmit motion and power between parallel shafts which are the most economicalgearsinthepowertransmissionindustry.T wotypes areusedinthismodel:

Internalspur gear

These spur gears are turned inside out. In other words, the teeth are cut into the inside diameter while theoutside diameter is kept smooth. This design allows for the driving pinion to rotate internal to the gear, which, inturn, allows for clean operation. Intended for light duty applications, these are gears always available only inbrass. When choosing a mating spur gear always remember that the difference in the number of teeth betweentheinternalgearandpinionshouldnotbeless than12or15.

1.3.5.2Externalspurgear

Perhaps the most often used and simplest gear system, external spur gears are cylindrical gears withstraight teeth parallel to the axis. They are used to transmit rotary motion between parallel shafts and the shaftsthat rotate in opposite directions. They tend to be noisy at high speeds as the two gear surfaces come into contactatonce.

LimitSwitch

It is a switch operated by the motion of a machine part or presence of an object. It is used for control of amachine, as safety interlocks, or to count objects passing a point. It is a electromechanical device that consists ofan actuator mechanically linked to a set of contacts. When an object comes into contact with the actuator, thedevice operates the contacts to make or break an electrical connection. It is used in a variety of applications andenvironments because of their ruggedness, ease of installation, and reliability of operation. It can determine thepresence or absence, passing, positioning and end of travel of an object. It was first used to define the limit oftravelofanobject,hencethename‘limitswitch.’

Controlswitch

It is used in order to start or stop the entire operation of the object lifting jack. The type of switch that isused is knownas a toggle switch. The toggle switchis a class of electrical switches that are manually actuatedby a mechanical lever, handle, or rocking mechanism..This is designed to provide the simultaneous actuation ofmultiplesets ofelectricalcontacts,orthecontroloflargeamounts ofelectriccurrentormainsvoltages.

Controlcables

Theseareusedinordertoconnectthebatterytothemotor andtheswitch.

Baseand Frame

A base for the entire set-up has also been made. The motor is mounted on an inverted U shaped supportframe.Ballrollersareattachedtofourends ofthebaseformovementandareelectricallycontrolled byswitch.

Specificationofparts

D.Cmotor

Torque	10Kgcm
Speed	150rpm
Voltage supply	12V
Type	D.C

1.4.3LargerGear

1.4.2LeadScrew

Outerdiameter(d_o)	13.7mm
Innerdiameter (d_i)	11mm
Mean diameter(d)	12.7mm
Pitch	2mm

SmallerGear

Addendumcirclediameter	73.45mm
Dedendumcirclediameter	61.80mm
Largerwidthoftooth	5.46mm
Smallerwidthoftooth	1.44mm
Depth ofcut	6.45mm
Thickness	12.95mm

Addendumcirclediameter	44.95mm
Dedendumcirclediameter	32.52mm
Largerwidthoftooth	4.76mm
Smallerwidthoftooth	1.14mm
Thickness	13.06mm

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 8 Aug 2021, pp: 210-216www.ijaem.net ISSN: 2395-5252

Roller

Torque	5 Kg cm
Speed	150rpm
Voltage supply	12V
Type	D.C
Number	2

1.4.7Limit Switch

1.4.6 Base

Length	72.5mm
Breadth	42.5mm
Thickness	2cm
Materialused	Plywood

Number	2
Type	Rollertype
Twowayvoltage supply	12V

ControlSwitch

Type	DPCO(DoublePoleControl Off)

LoadPanel

Diameter	9.8cm
Thickness	5mm

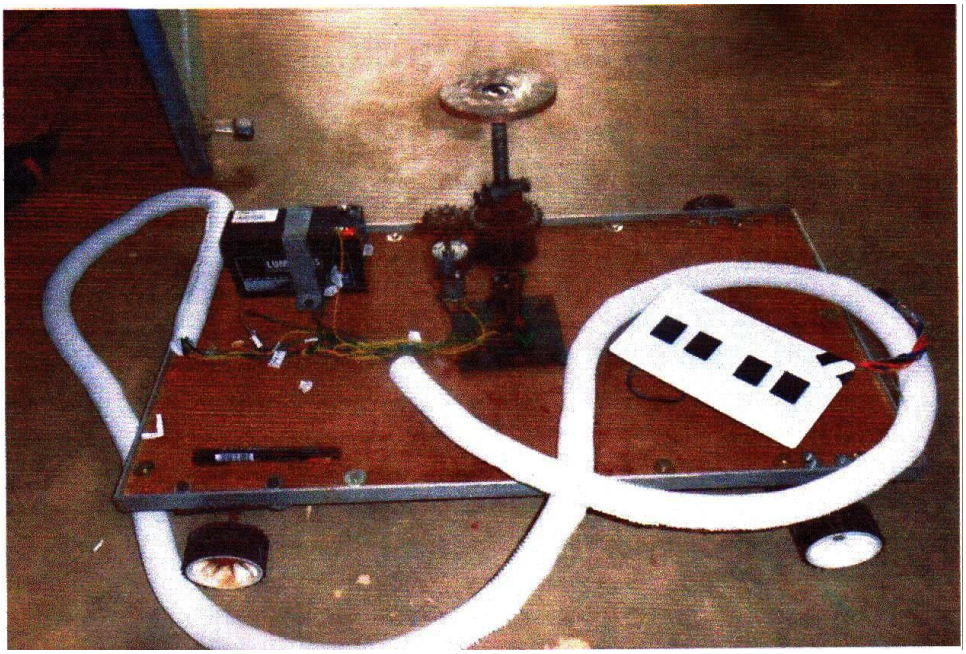

Fig2:FabricatedmodelofObjectliftingjack

II. DESIGNCONSIDERATIONS

The load on the screw is the load which is to be lifted W, twisting moment M, between the screwthreads and force F at the handle to rotate the screw. The load W is compressive in nature and induces thecompressive stress in the screw. It may also lead the screw to buckle. The load F produces bending and it ismaximum, when the screw is at its

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 8 Aug 2021, pp: 210-216www.ijaem.net ISSN: 2395-5252

maximum lift. The screw also experiences twisting moment due to F, theshearstressisalsoinducedinthescrewduetothetwisting momentbetweenthethreadsofscrewandnut.

StepIProblemSpecification

It is required to design an object lifting jack for supporting the machine parts during their repair andmaintenance. It should be a general purpose jack with a load carrying capacity of 50 KN and a maximum liftingheightof0.3m.Thejackissooperatedbymeansof aD.Cmotor.

StepIISelectionofMaterials

(i) The frame of the object lifting jack has complex shape. It is subjected to compressive stress. Grey cast iron isselected as the material for the frame. Cast iron is cheap and it can be given any complex shape withoutinvolvingcostlymachiningoperations.Castironhashighercompressivestrengthcompared withsteel.Therefore,itistechnicallyandeconomically advantageous tousecastironfortheframe.

(ii) Thescrew issubjectedto torsionalmoment,compressiveforceandbending moment.Fromstrengthconsideration,EN8isselectedasmaterialforscrew.

(iii) There is a relative motion between the screw and the nut, which results in friction. The friction causes wearat the contacting surfaces. When the same material is used for these two components, the surfaces of bothcomponents get worn out, requiring replacement. This is undesirable. The size and shape of the screw make itcostlycomparedwiththenut. Thematerialusedforthenutisstainlesssteel.

StepIIIDesignofobjectliftingjack

Theobjectliftingjackisanintermittentlyused eviceandwearofthreadsisnotanimportantconsideration. Therefore, instead of trapezoidal threads, the screw is provided with square threads. Squarethreads have higher efficiency and provision can be made for self-locking arrangement. When the condition ofself-locking is fulfilled, the load itself will not turn the screw and descend down, unless an effort in the reversedirectionisapplied.

III. CALCULATIONS

Observed data:

Nominal diameter of screw, d = 13.7 mmCore diameter of screw, d_c = 11 mmPitchofscrewthread, p=2mm
LoadW=20kg
Coefficientoffriction, μ=0.15
Mean diameter of screw, d_m = 12.7 mmHelixangleofscrew,$\alpha=2.68^0$

Tangentialforcerequiredatthecircumferenceofthescrewtoraisetheload$\mu=\tan\phi=0.15$ $p=W\times \frac{\tan\alpha+\tan\phi}{1-\tan\alpha.\tan\phi}=40.2N$
Torquerequiredtooperatethe screw= $p\times\frac{d}{2}+\mu r_m$
=40.2×(12.7/2)+ (0.15×200×18)
=825.27Nmm=0.8257Nm=8.5Kgcm
Efficiencyofthe screw=T_0/T_1
$=\frac{200\times(12.7/2)}{0.15\times200\times18+200\times(12.7/2)}=27\%$
Forloweringload(P)=Wtan(α+ø)
$=W\times\frac{\tan\alpha+\tan\phi}{1-\tan\alpha.\tan\phi}=19.826N$
Torque= $p\times\frac{d}{2}+\mu r_m W= 0.662N$
Shear stress due to torque T_1, $\tau=16T_1/\pi(d_c)^3 = 825.27\ N/mm^2 = 3.15\ N/mm^2$Compressivestressduetoaxialload(σ_c)=W/A=2.10N/mm
$\sqrt{\sigma_c^2+4\tau^2}$

Shear stress due to torque (σ_{cmax}) = 0.5 [σ_c +Maximum shear stress = 3.32 N/mm^2< 40 N/mm^2So,designissafe.

Spur Gear,
Gear Ratio = $1.75T_p$= 16 T_g=28
Velocityratio=$0.571N_p$=150 N_g=85.714

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 8 Aug 2021, pp: 210-216www.ijaem.net ISSN: 2395-5252

A_p=44.95 A_g=73.45
D_p=32.96 D_g=61.80

Y= 0.175- 0.841/no.ofteeth
=$\pi \times m \times T_p \times N_p$=40πm160
TakingC_s= 1
W_t=$P \times C_s$=15.40×1= 122.55V 0.12566
=4.5N/mm^2<50N/mm^2

C_v=3 = 3 = 0.959
3+v 3+0.12566
Y_p=0.175–0.84=0.1224
16
Y_g=0.1449
W_t=$\sigma_{wp} \times b \times \pi \times m \times Y_p$

15.40= 60×6×π×0.097× 3
0.1256 3+0.12566

46.2+1.93424=96.4521m^3

m = 2.5 standardAddendum = 3.45 mmDedendum=8.2mm
Centre distance between the shaft = 55 mmWeartoothload(W_w)=$D_p \times b \times Q \times K$
=40×12.5× (14/11)× 1.57
=1000N
DynamicLoad(W_d)=$W_t + W_t$
=21v(b_c+W_t) = 43.3 N21v+
V = 0.341 m/sb=12.5mm $\sqrt{b_c + W_t}$
C= K_e. = 1063.41+1
E_p $E_g W_d$ =825.4N
SinceW_d<W_w.Designistrue.

$W_s = \sigma_c \times b \times P_c \times y\sigma_c$=80N/$mm^2$
b = 12.5 mmP=πm
Y=0.1224
W_s = 958.185W_s>W_D
Itis true.

IV. WORKINGMECHANISM

STEP 1 The lead acid battery is used to drive the d.c motor. The d.c motor shaft is connected to the spur gear.If power is driven to the d.c motor, it will run so that the spur gear also runs to slow down the speed of the d.cmotor. The object moving jack moves the lead screw upwards, so that the vehicle lifts from the ground. Thevehicle is lifted by using the lifting platform at the top of the jack. The motor draws power supply from thebattery.Theliftinganduplitingisdonebychangingt he batterysupplytothe motor.

STEP 2After pressing the DPCO switch, the circuit is completed and from battery power is transferred to themotor that is connected to the roller. Now the roller starts moving. Now controlling the two number of DPCOswitch which is connected to the two motors at the base the whole set-up is adjusted below the body which isbeinglifted.

STEP 3 Now pressing the DPCO switch to the circuit which is connected to the motor that is coupled to theleadscrew,thecircuitiscompletedandvoltagefromt hebatteryispasstothemotor.Whentappingtheswitchto the positive pole, positive voltage is supplied to the d.c motor moves in clockwise direction and lead screwmoves indownwarddirection.

STEP 4When tapping the switch to the negative pole, negative voltage is supplied to the d.c motor moves inanticlockwisedirectionandleadscrewmovesinupw arddirection.

STEP 5 Now when the lead screw moves to the maximum limit, the limit switch at the upper end getsactivated and the circuit gets cut-off. When the lead screw moves to the minimum limit, the limit

switch at thebottomendgetsactivatedandthecircuitgetscut-off.

V. CONCLUSION

Object lifting jacks are the ideal product to push, pull, lift, lower and position loads of anything from acoupleof kilograms to hundreds of tonnes. The need has long existed for animproved portable jack forautomotive vehicles. it is highly desirable that a jack become available that can be operated alternatively frominside the vehicle or from a location of safety off the road on which the vehicle is located. Such a jack should belight enough and be compact enough so that it can be stored in an automobile trunk, can be lifted up and carriedby most adults to its position of use, and yet be capable of lifting a wheel of a 4000-5000 pound vehicle off theground. Further, it should be stable and easily controllable by a switch so that jacking can be done from aposition of safety. It should be easily movable either to a position underneath the axle of the vehicle or someother reinforced support surface designed to be engaged by a jack. Thus, the product has been developedconsidering all the above requirements. This particular design of motorized automated object lifting jack willprovetobebeneficialinliftingandloweringofheavyloads.

REFERENCES

[1] M.M. Noor, K. Kadirgama and M.M. Rahman, Analysis Of Auto Car Jack, National Conference inMechanical Engineering Research and Postgraduate Students, FKM Conference Hall, UMP, Kuantan,Pahang,Malaysia,26-27May2010, 198-203.

[2] Mohd Abuzaid, Mohd Hasnain, Shabaj Alam, Sohail Khan and Surendra Agarwal, Inbuilt Hydraulic jackinAutomobilevehicles,InternationalJournalofInnovationsinEngineeringandTechnology,2(2),2013,76-84.

[3] Tarachand G. Lokhande, Ashwin S. Chatpalliwar and Amar A. Bhoyar, Optimizing Efficiency of SquareThreaded Mechanical Screw Jack by Varying Helix Angle, International Journal of Modern EngineeringResearch,.2(1),2012, 504-508.

[4] P.S.Rana,P.H.Belge,N.A.Nagrare,C.A.Padwad,P.R.Daga,K.B.Deshbhratarand N.K.Mandavgade,EuropeanJournalofAppliedEngineering andScientificResearch,1(4),2012,167-172.

[5] PrashantKumarSrivastav,VipinKumarPandey,ShaileshKumarMaurya,AjitTiwari,JawedRafiqandS.K.Dwivedi,HighlyEfficientMotorizedScrewJack,InternationalJournalofComputationalEngineeringResearch, 3(5), 2013, 35-41.

[6] A. S. Akinwonmi and A. Mohammed, Modification of the Existing Design of a Car Jack, Journal ofEmergingTrendsinEngineeringandApplied Sciences, 3(4),2012, 581-588.

[7] J.J. Ferreira, M.G. Boocock and M.I. Gray, Review of the risks associated with pushing and pulling heavyloads (HealthandSafetyLaboratoryBroadLaneSheffieldS37HQ,2004).