Technical Research on Design and Modification of Pedal Hacksaw Cutter Machine

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Abstract- *the main aim to make this research paper is to design, development and construction of pedal (manual) Power hacksaw cutter machine by using crank and slider mechanism like i.c. engine crank and piston arrangement And to diminish the much effort of manual conventional hand hacksaw Cutting. Here, the slider is replaced by hacksaw blade as cutter. This machine specially made for remote area where electricity is not easily available and it can be used for small Industrial purpose like cutting metal and acrylic blocks and bars as well as in domestic application such as cutting of wooden block, pvc pipes and other materials like plastics. Construction of this model includes distinct operation like cutting, drilling joining(welding) and machining.Secondly,this machine is easy to utilize compared to traditional hard working hand hacksaw method.*

Keywords- cuttingblades,crank and slider mechanism, pedal-gear arrangement,workpiece holder, model frames.

I. INTRODUCTION

In engineering, mechanism is a device in which all parts are working together accordingly their construction, input forces and movement and giving output motion and forces such as gearing, chain transmission, belt drive, friction less drive, cam and follower and others. Here, we have used single slider crank mechanism.It also known as simple four single chain drive mechanism.It contain rotary motion of shaft into liner motion of hacksaw cutter.

Necessity of hacksaw machine

In today scenario, Augmenting productivity is very essential part of any type of manufacturing industry by improving the production rate or declining the manufacturing time.Previous hand hacksaw was time consuming to cut the material but pedal hacksaw overcome this problem.Also,we kept the bearing slider mechanism to prevent damaging of hacksaw blade after cutting the work piece.**David Gordon Wilson, (1986),**According to the author**, a person can generate four timer more power (1/4 horsepower (hp)) by pedaling than by hand-cranking. At the rate of 1/4hp, continuous pedaling is for can done only short periods, about 10 minutes. However, pedaling at half this power (1/8 hp) can be sustained for around 60 minutes.**

History of hacksaw machine

Historical matter of hacksaw machine related with hand hacksaw. Hacksaw have been seen in now since ancient Egyptians. New version of hacksaw was first invented by kulibert Stanley tool company, new Britain.

Objective

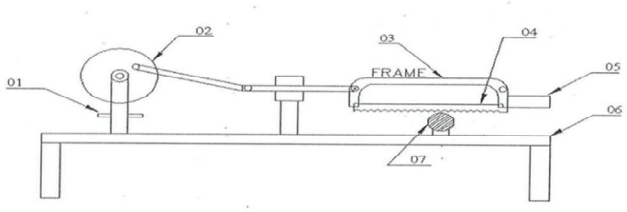
In modern era, every manufacturing organization are looking for maximum production rate and output efficiency, best product quality and less uses of resources by using technology And researches to stable their position in competitive global market.But, due to the high cost implementing the automation it is not affordable to use new advancement in technology for Small scale industries. So, based on that problem we tried to make new modification in existing machine as solution. Pedal hacksaw machine is very efficient, easy to operate and less time consuming than hand hacksaw.

Working of pedal hacksaw machine.

Pedal power hacksaw machine is commonly used to cut the various types of materials like wooden blocks, PVC pipes, metal rods such as aluminum, steel, brass etc., plastics, and acrylic and wps materials. In the mechanism the rotary motion of gear is generated by the foot pedal and it's crank.Rotary motion is converted into linear movement by attaching one end of connecting rod to the crank and other end with hacksaw.So,there would be chances of fluctuation and less efficient.

Here, we are going to design and fabrication the model of hacksaw cutting machine by implementing the flywheel to alleviate the fluctuation and maximize the efficiency. In the working firstly, the power generated by the pedal –crank

Arrangement is transferred to the gear and it's transferred to the pinion with help of roller chain drive mechanism. Mild steel flywheel is mounted at the end of the same shaft of pinion.Then,flywheel revolves on the shaft by the centrifugal motion of the pinion due to same shaft.Here, the flywheel eliminating fluctuation load and also store the energy and release energy when required. Now, the one end of connecting plate is joined on the surface of the flywheel at some distant from the center of flywheel and another end is attached to the frame of the hacksaw with by using nut, screw and washers with implementing flexibility in joint. After that, hacksaw movement is carried in linear motion to cut work piece by manipulating blade which fitted on hacksaw frame.



II. LITRETURE REVIEW

1. "Jagdeeswara reddy,Dr.K.Hemchandra ruddy"
"Design and fabrication of a pedal operated cutting machine".
ISSN: 2455-2585
YEAR:September-2017

Conclusion: In this research paper they used CATIA design software to visualize actual the model in 3-dimensional with extra drawing details. They physical made model by using various components such as cycle frame, base frame, pedal arrangement and they used concept of rotary motion into linear motion. Also, they exploited bearing cam mechanism and hacksaw arrangement for cutting operation.But,they did not utilize of flywheel arrangement to reduce the fluctuation of load on the hacksaw .So, there would be chances of early damage of hacksaw blade and declining the life machine.

2. "M.khaja gulam hussain, John babu"
"Fabrication of pedal power hacksaw machine"
ISSN: 24552631
YEAR: August-2016

Conclusion: In this research paper they made the basic concept of "to and fro motion "in their model. Also, constructed the machine with help of pedal hub bearing arrangement, hacksaw linkages and frames.Here,they used a flywheel to reduce fluctuation of load and to transmit smooth motion to the hacksaw arrangement Also, they directly connected hacksaw frame and crank of pedal by connecting rod that shows not sufficient use of flywheel to eliminate to fluctuation while in operation.

3. "Stephen tambari,dan orawari Gloria, oruene.w. diabi,ayejah victor."
"Technical study on the design and construction of a pedal power hacksaw cutting machine."
ISSN: 2278-1684
YEAR: July-2015

Conclusion: In this research paper they used simple principle of slider crank mechanism. They made machine to cut the materials like wood,PVC,mild steel pipes and plastic pipes. They used components such as pedal arrangement, hacksaw cutter linkages stand and flywheel. But they could not show sufficient use of flywheel. Their research paper showing much greater theoretical mechanical efficiency.

4. "Adarsh ranjan,kushagra sharan,sudeep mazumdar"
"pedal operated washing machine"
ISSN: 2277-8616
YEAR:November-2014

Conclusion: In this research paper authors developed manual washing machine with the use of foot pedal force.Here,project model contains gear chain drive arrangement, belt drive arrangement and utilization of flywheel to increase the torque(1.19 N.M.) and power (2.5 watt) of final output at the washing machine with help of slider crack mechanism and quick return mechanism.Here,the maximum efficiency found at less pedal effort.Also,they used housing bearing to support the system. They carried project at different r.p.m. of input shaft at different washing process.

5. "R.subash, c.m. meenakshi,k.semuel jaykaran,c.venkateswaran,r.sasidharan."
"fabrication of pedal powered hacksaw using dual Chain drive."

Conclusion: In this research paper cutting operation is done by two chain drive mechanism, hacksaw blade (reciprocating velocity=0.68 m/s),guide way, centrifugal pedaling force, cycle frame, stand and three gear arrangement, bench vice and connecting rod. In this project high effort required to transmit the motion of Gear to pinion through chain drive due lack use of

flywheel in power transmission.

III .COMPONENT OF HACKSAW MACHINE

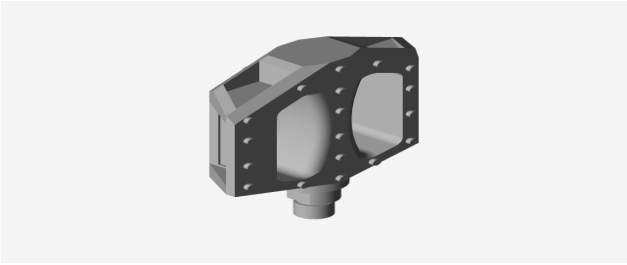
SERIAL NO.	PART NAME	QUANTIY	MATERIAL
1	FRAME	42 ft.	MILD STEEL
2	PEDAL	2	FIBER & CAST IRON
3	GEAR & PINION	1	CAST IRON
4	CHAIN	1	ALLOY STEEL
5	FLYWHEEL	1	MILD STEEL
6	CONNECTIG PLATE	1	MILD STEEL
7	HACKSAW FRAME	1	MILD STEEL
8	HACKSAW BLADE	1	HSS,HSC BMS
9	PIPE VICE	1	MILD STEEL
10	BEARING SLIDER	1	CHROME STEEL
11	SHAFT	1	MILD STEEL
12	DEAD WEIGHT	16	MILD STEEL
13	BALL BEARING	2	CHROME STEEL

1 FRAME

It is base structure of the hacksaw machine. It's used to support and hold all the components of machine.Here,we used L-section mild steel material.

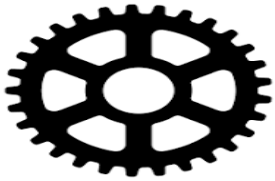
2. PEDAL

Pedal is used to transmit the foot power through the chain drive.



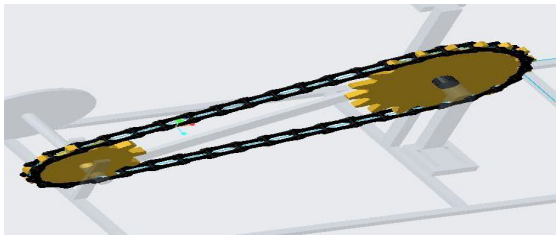
3. GEAR AND PINION

Gear and pinion are used as transmission system in this machine. Foot pedal power is firstly given to the gear then next transmit to the pinion.



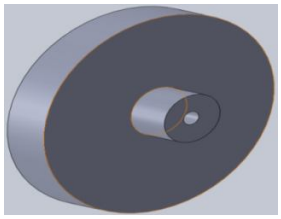
4. CHAIN

Chain are one type of linkages of simple rollers. Chain act as a transmission part in gear drive mechanism. Here, it is transmit power from foot pedal to the pinion.



5. FLYWHEEL

Flywheel serve as minimize the load fluctuation in power transmission. Also, store the energy during power carrying condition and release energy when it required.



6. CONNECTING PLATE

Connecting rectangular plate is used to convey the motion between flywheel and hacksaw. In model we join it with help of nut and bolt with washer.

7. HACKSAW FRAME

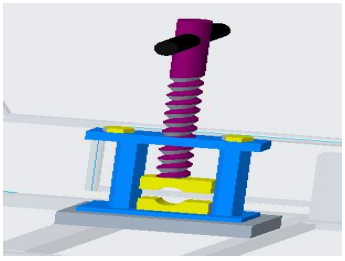
It is hold the hacksaw blade in proper position and give support to resist the cutting force.

8. HACKSAW BLADE

Blade is serve as removing the material from the workpiece.It contain regular teeth form by which material of job is removed.

9. PIPE VICE

Pipe vice hold the work piece material in proper direction for the cutting operation.

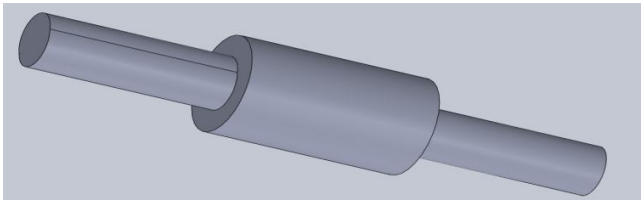


10. BEARING SLIDER

A slider which used to hold and prevent the damage of hacksaw blade on the mild steel base frame after the full cutting operation.

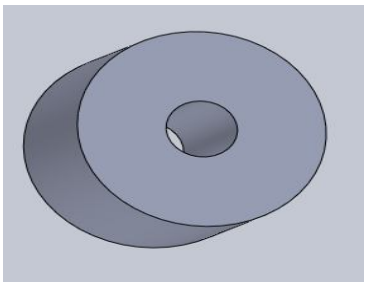
11. SHAFT

A part on which pinion and flywheel arrangement are done to carrying motion of foot pedal.



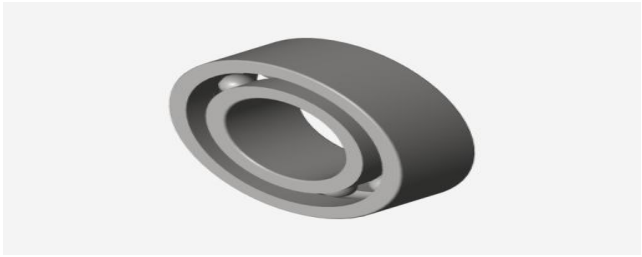
12. DEAD WEIGHT

Dead weight act as a constant load on part.Here,it is used to keep gradual weight on hacksaw.



13. BALL BEARING

It is mechanical part to hold and support thrust load and steady load of shaft.



IV. DESIGN METHODOLOGY

Chain drive
X=center distant between gear and pinion
P=pitch of chain=13mm
K=number of chain links
T1=number of teeth on gear-44
T2=number of teeth on pinion-18
L=Length of chain 1500 mm
L=Kp

$$K = \frac{L}{P}$$

$$= \frac{1500}{13}$$

$$= 115.38$$

$$X = \frac{P}{4}\left[K - \frac{T1+T2}{2} + \sqrt{\left(K - \frac{T1+T2}{2}\right)^2 - 8\left(\frac{T2-T1}{2\pi}\right)^2}\right]$$

X=546 mm.

Velocity of chain drive

$$v = \frac{\pi DN}{60}$$

D=diameter of gear
N=r.p.m. of gear
v=velocity of chain drive

$$\frac{44\times120\times13}{60}$$

v= 1.44 m/s

Breaking strength of chain (Wb)

Total load on the driving side of the chain (W)
=Tangential driving force (Ft)
+Centrifugal tension in the chain (Fc)
+Tension in the chain due to sagging (Fs)
By calculation,
Fs=K×m×g×X m=mass of chain
=6×0.5×9.80×0.546

Fs=16.06 N

Fc=m^{w^2}

=0.5×1.44^2 (K) constant=6-cener line of the chain is inclined to horizontal at angle<40

Fc=1.0368 N

Power transmitted by chain (P)

$P=\frac{Wb\times v}{n\times Ks}$ n=factor of safety Ks=service factor

Ks=K1×K2×K3

=1.25×1.5×1

=1.875

K1=load factor-for variable load with mild shock

K2=lubrication factor

=for periodic lubrication

K3=rating factor

=for 8 hours per day

$P=\frac{Wb\times v}{n\times Ks}$

$n=\frac{Wb}{W}$

$P=\frac{w\times v}{ks}$

$Ft\times v=\frac{W\times v}{Ks}$

$Ft=\frac{Ft+Fs+Fc}{Ks}$

$Ft=\frac{Ft+16.06+1.0368}{1.875}$

Ft=19.53 N

P=Ft×v

= 19.53×1.144

=22.34 W

Flywheel

N1=320 r.pm –maximum speed of flywheel

N2=280 r.p.m-minimum speed of flywheel

Velocity ratio $=\frac{T1}{T2}=\frac{N2}{N1}$

$N2=T1\times\frac{N1}{T2}$

Speed of pinion N2= 294 rpm

Cs=Nmax-Nmin Cs=coefficient of fluctuation of Speed (N)

$\frac{N}{}$

$=\frac{314-274}{294}$ =0.13

Ideal mechanical advantage(IMA) $=\frac{Win}{Wout}$

$Wout=\frac{Win}{IMA}$ Win=angular speed of gear Wout=angular speed of pinion

$=\frac{2\times3.14\times Ng}{60\times IMA}$ (pinion=flywheel) Ng=r.p.m of gear

$=\frac{2\times3.14\times120}{60\times0.42}$ ((Faruk Yildiz, 2009,120 r.p.m)

Wout=29.90 rad/s

ΔE=maximum fluctuation of energy

ΔE=2ECs

$=Iw^2Cs$

$=\frac{mk^2w^2Cs}{2}$ Wout=w

I=moment of inertia

$=\frac{mR^2Csw^2}{2}$ k=radius of gyration=$\frac{R}{\sqrt{2}}$

$=\frac{4.75\times0.135^2\times29.9^2\times0.16}{2}$

ΔE=6.19 J

ΔE=2ECs

$E=\frac{\Delta E}{Cs}$

$=\frac{6.51}{2\times0.16}$

E= 19.34 J (joule) F=centrifugal force

Fc=mr^{w^2} r=radius of flywheel

=4.75×0.135×29.9^2

=573.28 N

Linear velocity (v) =r×w

=$29.90^{\times}$0.135

=4.03m/s

Power (p) =Fc×v

=573.28×4.03
=2.31 KW

Hacksaw linear velocity (v) =W×r
=29.90×0.0725
=2.16 m/s

Power (P) =Fc×v (hack saw)
=573.28×2.16
=1.238 KW

$$\text{Velocity ratio} = \frac{\text{effort distance}}{\text{Load distance}}$$

$$= \frac{\text{length of crank pedal}}{\text{Hacksaw cutting stroke}}$$

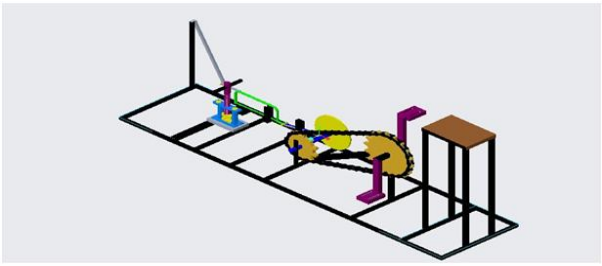
$$= \frac{140}{145}$$

$$= 0.96$$

$$\eta = \frac{\text{I.M.A} \times 100\%}{\text{V.R}} \quad \eta = \text{efficiency of machine,}$$

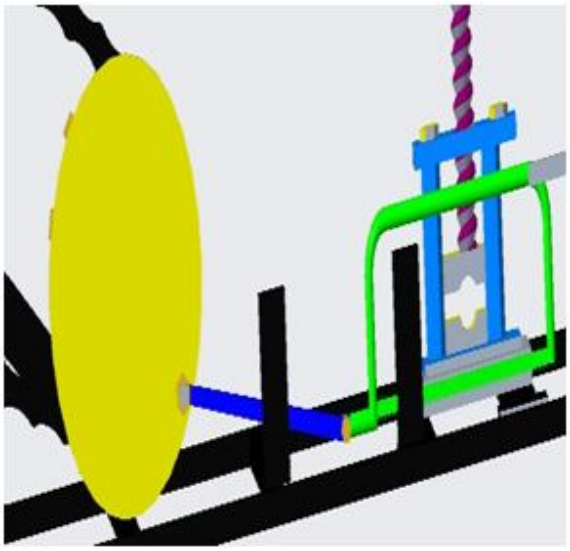
$$= \frac{0.42 \times 100\%}{0.96} = 43.75\%$$

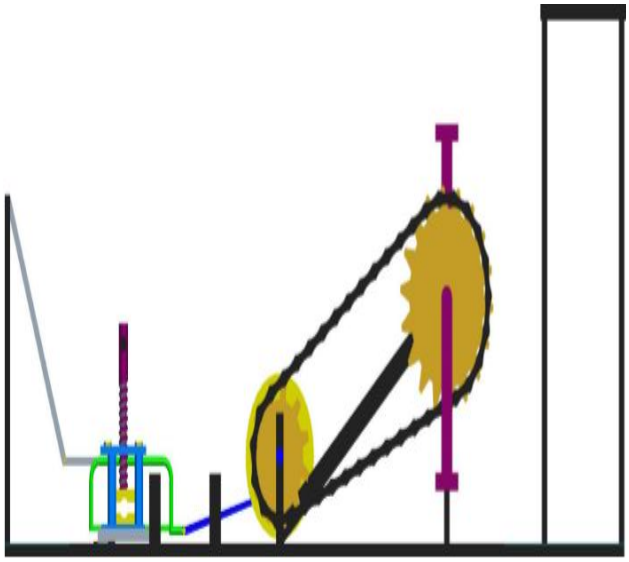
Assembly of pedal hacksaw machine (IN CREO)



RESULT OF THIS EXPERIMENT

Sr. no.	material	Size (mm) (diameter)	Time (second)	Thickness (mm)	Speed (r.p.m)	Depth of Cut(mm/sec)	Total area to be cut (mm^2)	Cutting rate (mm^2/sec)
1	PVC.	21	11	3	90	1.90	169.56	15.41
			14	3	75	1.5		12.11
			17	3	60	1.23		9.97
2	Wooden block	12	29	30	90	0.41	360	12.41
			33		75	0.36		10.90
			45		60	0.26		8
3	Aluminum	18	11	1	90	1.63	53.38	4.85
			14		75	1.28		3.81
			17.1		60	1.05		3.12
4	Stainless steel	19	110		90	0.17	56.32	0.512
			140	1	75	0.135		0.40
			167		60	0.110		0.33
5	Mild steel	25	130	2	90	0.19	75.36	0.570
			153		75	0.16		0.49
			194		60	0.12		0.38
6	Mild steel (full solid)	16	225	-	90	0.07	200.96	0.89
			267		75	0.06		0.7526
			338.8		60	0.04		0.59





V. CONCLUSION

1. The operation of this machinery is very simple and easy compared to traditional way.
2. This machine having free maintenance except the lubricant SAE 10 on chain atlong time period about half year.
3. 3. There is no electricity required to propel this.So, this machine is more beneficial inremote and internal area where electricitynot found easily.
4. Machine can save up to 75% of the time to cut the material than hand hacksaw method.

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