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Design of Two Speed Gearbox for CNC Lathe

Aswin Krishna[1], Rinso Biju[1], S R Stalin[2], V Ramkumar[3]

[1]B E Student, Department of Mechanical & Automation Engineering, PSN College of Engineering & Technology, Tirunelveli, Tamil Nadu, India

[2]Assistant Professor, Department of Mechanical & Automation Engineering, PSN College of Engineering & Technology, Tirunelveli, Tamil Nadu, India

[3]Professor, Department of Mechanical & Automation Engineering, PSN College of Engineering & Technology, Tirunelveli, Tamil Nadu, India

ABSTRACT

Since gearboxes in lathe are positioned inside the headstock, an aftereffect of vibration is experienced in the spindle and further leads to inaccuracy in the finished products, also causes inconveniences during the maintenance and also increases difficulties if any replacements are needed. In a complex work the accuracy plays a major role and hence the above problems are to be eliminated accordingly.

This projectaims to design a gearbox which can be placed outside the headstock and also aims to design in such a way that a single base is utilized for Lathe and new gearbox.

Key Words: Gears, Gearbox, CNC, Lathe, Direct Drive, Power Transmission

I. INTRODUCTION

Gearboxes provide for a wide range of cuttingspeedsandtorque from a constant speed power input enabling proper cutting speeds or torque to be obtained at the spindles asrequired in thecase of cuttingdrivesand desired feedratesin the caseof feeddrives. The design of gearbox isintimately linked with the whole structure of the spindledrives. The gearbox can be built integral into the spindlehead housing. This type of arrangement promotes morecompactspindledrives,higherlocalizationofcontrols,fewerhousing and less assembly work involving in the fitting ofjoiningsurfaces.

Main drawback is the possibility of transmitting vibrationfromthegearboxtothespindle,heatingofthespindleheadbytheheatgeneratedin thegearbox.

The gear box can also be arranged in separate housing andlinked to the spindle head through belt transmission. Thistype of arrangement has advantage that neither the heatgeneratedbyneitherfrictionallossesnorvibrationsdeveloped in the gearbox are transmitted to the spindlehead.

1.1 IndirectDrive

Design of gearbox mainly depends upon the tool workpiece combinations used.Here we are using aluminiumwhose cutting speed varies from 188 rpm to 3000 rpm.Motorisselectedwhichisworkingunderaspeedrangeequalto1500rpmto6000rpm.Whileselectingmotorpower ratingshouldbekepttominimumvalueinordertomaintainlow economy of lathe.From SIEMENS motor catalogue,motorselectedis“SIEMENS”squirrelcageinductionstandardthree phase motor” – 1PH8087. Its specifications are givenbelow

- Ratedpower–3.7KW
- Ratedspeed-1500rpm
- Ratedcurrent-10A
- Ratedvoltage–400V

Sincewearedesigning two speedgearboxit ispossiblefor obtaining two different rpms from an input motor rpm.

stages we could get a lower rpm of 188 to a higher rpm of3000withthemaximum torque/ power.

Designing a ray diagram is necessary for finding out speedratiosbetweenrotorshaftofmotoranddrivershaftof gearbox, driver shaft and driven shaft, driven shaft and outputshaft.Procedurefordrawingraydiagramisgivenin thenextsection.

1.2 DisadvantagesofExistingSystem

The indirect drive involved power transmission throughgears throughout the entire speed range of the motor. Thisresults in power loss in the form of frictional losses in thegears.Whenthespeedrequirementforcuttingcomesintheconstantpowerrangeofthemotorpowertransmissioncanbedirectlytothespindletherebytransmissionlossthroughgears can be avoided in these speed ranges. Hence a newgearboxdesignwasdevelopedincorporatingaclutch whichbypassestransmissionthroughgearsfortheconstantpowerspeedrangeof themotor.

II. DESIGNOFINDIRECTDRIVE(UsingGears)

2.1. RayDiagram

Thespeedchartorraydiagramisagraphicalrepresentationofthedrivearrangementinthegeneralform.Inotherwords,theraydiagramisagraphicalrepresentationofthestructuralformula.

Araydiagramcanbeusedtoeasilyexplainthespeedreduction stages. Motor – gear box stage is the first V-beltstage.Vbelt-pulleyassemblyisusedtoprovideaspeedratioof 1:2. Second stage is gear box stage. Here two gear ratiosareprovidedtogivetherequiredspeedrange.Thelaststageisanother Vbeltstagewithaspeedratio1:2.

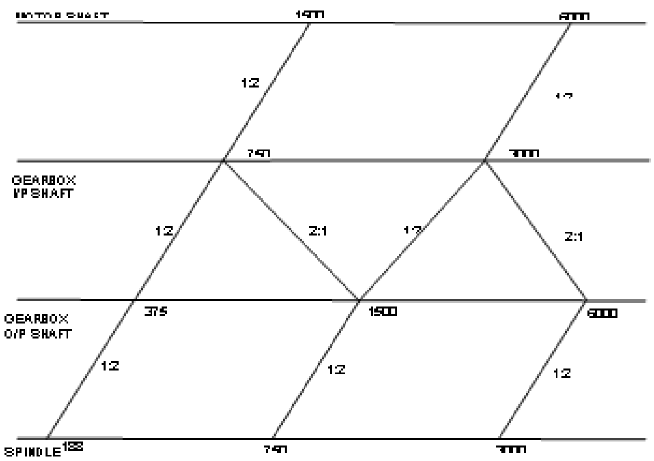

Fig.2.1.1RayDiagram

All these stageshelptogetaspeedrangebetween188RPMto3000RPM with a constant power from the induction motor. Thediametrical changes of the pulley initiate the first speedreduction. The next speed reduction in the gears dependsupon the gear ratio. The gear ratios are fixed to attain therequired rpm in the lathe. Thus, by these three reductionstages we could get a lower rpm of 188 to a higher rpm of3000withthemaximum torque/ power.

2.2. Designofindirectdrivesystem(Usinggears)

The whole assembly design of the gearbox consists of thegear pairs, input and output shaft, shaft bearings. Also, thedesignoftheV-beltdriveshouldbedonetocompletethefulldriving mechanism frommotor tolathespindle.

A 3D model of gear pairs, belt-pulley system and gearboxcreatedusingmodelingsoftwareSolidworksispresentedinfiguresgivenbelow.

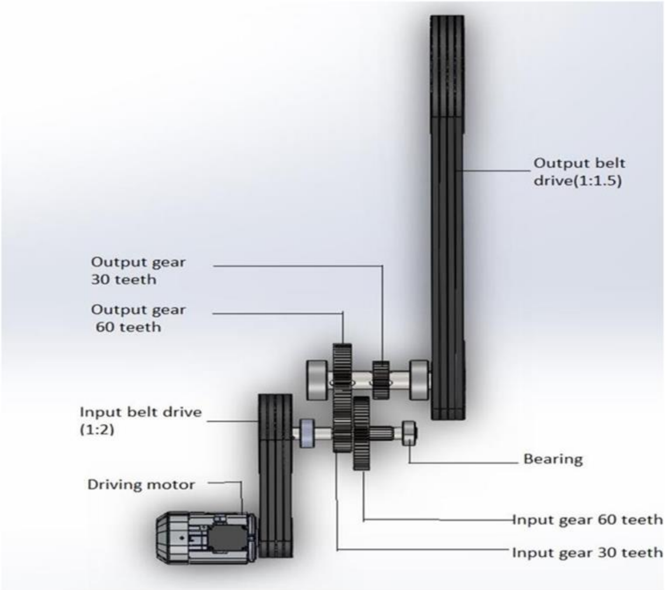

Fig.2.2.1 Top view of the gearbox

Fig.2.2.2 3D Model of the gearbox

2.3. Designofindirectdrivesystem(Usingclutch)

Whenthespeedrequirementforcuttingcomesintheconstantpowerrangeofthemotorpowertransmissioncanbe directly to the spindle. Also, transmission loss throughgears can be avoided in these speed ranges. Hence a newgearbox design was developed incorporating a clutch. Theclutch used is single plate dry friction clutch. This is a newdesignwhichisnotcurrentlyinuse.

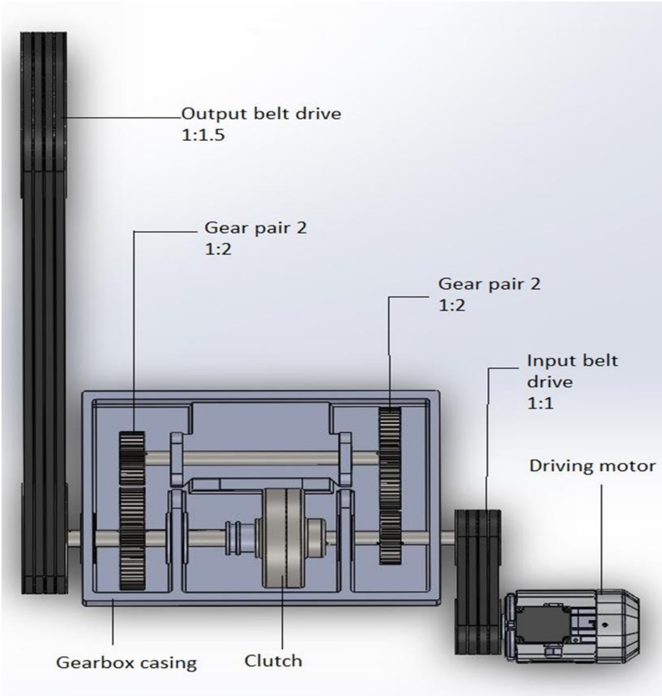

Fig. 2.3.1 Top View

Fig. 2.3.2 Isometric View

III. RESULTS

Here, we conclude that our design was successfully generated with the help of the software SolidWorks and the design is okay to proceed for the desired CNC lathe with the effect of the reduced vibration and in accordance with no increase in the base or space requirements of the initial machine (CNC Lathe). Thus we conclude that our design study was a success.

SL.NO	PORTIONS	INPUT	OUTPUT
1	PITCH CIRCLE DIAMETER		
	•Z = 30 & 60 •Z = 60 & 30	D1 = 90mm D1 = 180 mm	D2 = 180 mm D2 = 90 mm
2	No: of teeth	Z1 = 30 Z2 = 60	Z1 = 60 Z2 = 30
3	BELTS	Motor to gear	Gear to spindle
	LENGTH	Nominal pitch length= 1102mm Nominal inside length = 1067mm	Nominal pitch length= 3084mm Nominal inside length = 3048mm
	CENTRE DISTANCE	C = 286.5 mm	C = 1066.06 mm

Sl.no	PORTIONS	INPUT	OUTPUT
	No: of belts	N = 4	N = 4
4	PULLEY		
	Diameter	D1 = 220mm	D2 = 200mm
	Tension acting in belts	T1 = 236.26 N T2 = 22.02 N	T1 = 1020.38 N T2 = 77.95 mm
5	SHAFT		
	Diameter	D = 20mm (for z1 = 30) D = 25mm (for z2 = 60)	D = 25mm (for z1 = 60) D = 20mm (for z2 = 30)
	Width	B = 12mm A = 34.9 mm	A = 23mm B = 86.3mm

Sl.no	PORTIONS	INPUT	OUTPUT
	Inner diameter	B = 17mm A = 35mm	A = 50mm B = 80mm
	Outer diameter	B = 40mm A = 80mm	A = 90mm B = 170mm
7	BEARINGS	INPUT SHAFT B Life = 4500 hrs Load = 4608.64 N Type = single row angular contact ball bearing (17BA02)	OUTPUT SHAFT A Life = 9000 hrs Load = 43340 N Type = cylindrical roller bearing (NU2210)
		INPUT SHAFT A Life = 4500 hrs Load = 42537.01 N Type = double row angular ball bearing (3307A)	OUTOUT SHAFT B Life = 9000 hrs Load = 141261.57 N Type = double row angular contact ball bearing (3316A)

Sl.no	PORTIONS	INPUT	OUTPUT
		INPUT SHAFT A Life = 4500 hrs Load = 42537.01 N Type = double row angular ball bearing (3307A)	OUTOUT SHAFT B Life = 9000 hrs Load = 141261.57 N Type = double row angular contact ball bearing (3316A)
8	KEYS		
	Size (b x h)	8mm x 7mm	8mm x 7mm

Table 3.1 : Design calculation results

IV. APPLICATIONS

- Extremely compact design.
- High accuracy and high-power density in a minimal space.
- Coaxial design. Gearbox integrated in-line between a water-cooled motor and a spindle inside a RAM.
- Large output bearings provide high tilt capacity.
- A large hollow shaft, that goes through the system, to facilitate the installation of hydraulic draw bar and spindle coolant system.
- Smoother motion due to optimized Servotak gears.
- Better performance compared to conventional two speed gearboxes.
- The low noise shift mechanism meets strict machine tool requirements.
- The actuator used for the speed change is integrated into the gearbox design.
- High speed for soft materials and high torque for hogging out steel or hard materials.
- Increased production rates thanks to high speed gears.
- Greatly reduced the cycling times.

V. CONCLUSION

The design of two speed variable speed gearbox for theheadstock of CNC lathe as per the requirement has donesuccessfully.Thedifferentspeedratiosarenowmade availablewiththisgearbox.Theworkswhichrequirelowe rrpm can done easily without anytrouble. The design ismainly basedonconsideration like compactness, longerservicelifewithminimumbreakdownperiods.Gea rboxusesexistingcastingofthemothermachine.Sincethe gearboxisfixedonthemachinecastingitselftheseisnonee dofseparate base. Thus no extra floor space is needed. Lesspowermotorisemployedforsupplyinghightorque.A lsothedesignedgearboxissmallyetefficient,durable,relia bleandprovidessufficienttorque.Ifthesizeofthegearboxi snotadesignconsideration,anintermediateshaftcanbee mployedforeffectivepowertransmission.Thiseliminate soverhanging gear on motor shaft. Speed increasing drivesarenotcommonlyusedingearboxofmachinetools. Soit can be replaced with a reduction gear of suitable gear ratio. The economic viability of design can be increased whilechoosingfactorofsafetyforeachcomponent.Howe verchoosinganoptimumfactorofsafetydevelopmentin materialscienceandmanufacturingtechnology,newmat erials with greater design stresses and reduced stressconcentrationandprecisionmachinedwillbe available.Theseresultsinamorecompact,safeandecono micaldesignsuitableforindustries

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VI. REFERENCES

[1]. PSG College of Technology "Design Data", KalaikathirAchchangam Publications.

[2]. Machine Design Data Book by K. Mahadevan & K. Balaveera Reddy

[3]. Machine Design Data Book by K. Lingaiah

[4]. Gearbox design for CNC lathe :- Prof. Reji Mathew, Linto P Anto, AdithShajan, Basil P Thomas, Elisa Manoj,Kuriakose M Renji (Apr-2014) (https://www.irjet.net/archives/V5/i4/IRJET-V5I4488.pdf.

[5]. Design of Machine Elements by V. B. Bhandari

[6]. Design of two speed gearbox in CNC lathe :- R.Stilwin, ., B.Mujeeb Sultan(Apr-2015)

[7]. (https://www.youtube.com/watch?v=QsqNGB0daPs&feature=youtu.be)