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Design & development of multi spindle drilling head (msdh)

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Abstract- *The growth of Indian manufacturing sector depends largely on its productivity & quality. Productivity depends upon many factors, one of the major factors being manufacturing efficiency with which the operation /activities are carried out in the organization. Productivity can be improved by reducing the total machining time, combining the operations etc. In case of mass production where variety of jobs is less and quantity to be produced is huge, it is very essential to produce the job at a faster rate. This is not possible if we carry out the production by using general purpose machines. The best way to improve the production rate (productivity) alongwith quality is by use of special purpose machine. Usefulness and performance of the existing radial drilling machine will be increased by designing and development of multispindle drilling head attachment. This paper deals with such development undertaken for similar job under consideration alongwith industrial case study.*

Keywords- *Various methods, working of multispindle drilling machine, Design, Manufacturing.*

I. INTRODUCTION

Multiple-spindle drilling machines are used for mass production, a great time saver where many pieces of jobs having many holes are to be drilled. Multi-spindle head machines are used in mechanical industry in order to increase the productivity of machining systems. The multiple spindle drilling machines is a production type of machine. It is used to drill two holes in a work piece simultaneously, in one setting. The holes are drilled on number of work pieces with the same accuracy, so as to make them interchangeable. This machine has two spindles driven by a single motor and all the spindles are fed in to the work piece simultaneously. Feeding motions are obtained either by raising the work table or by lowering the drills head. The centre distance between the spindles can be adjusted in any position as required by the different jobs. For adjusting the centre distance between the drill spindles they are connected to the main spindle by universal joints. In mass production work drill jigs are used for guiding the drills in the work piece so as to achieve accurate results.[1]

In today's market the customer demands the product of right quality, right quantity, right cost, & at right time. Therefore it is necessary to improve productivity as well as quality. One way to achieve this is by using multi spindle drilling head. On the other hand, in order to meet quality requirements of final product.[2]

II.VARIOUS METHODS OF MULTISPINDLE

The various methods of multispindle drilling head are:

2.1 Adjustable multispindle drilling head

Can be used in many components, where change the centre distance to some range. It will increase drilling capacity in single special purpose machine.

2.2 Fixed Multispindle drilling head

Where cannot change the centre distance to some range. Is planetary gear train, compound gear train.

Features of both the type multispindle drilling head are

a. By using these multispindle drilling heads, increase the productivity is substantial.
b. Time for one hole drilling is the time for multiple no. of holes drilling.
c. Multispindle drilling ensures the positional accuracy.

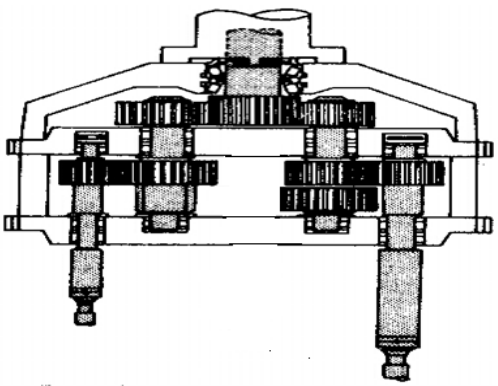
Multispindle heads can be of fixed centre construction for mass and large batch production and for batch production, adjustable centre type design is offered **[3]**

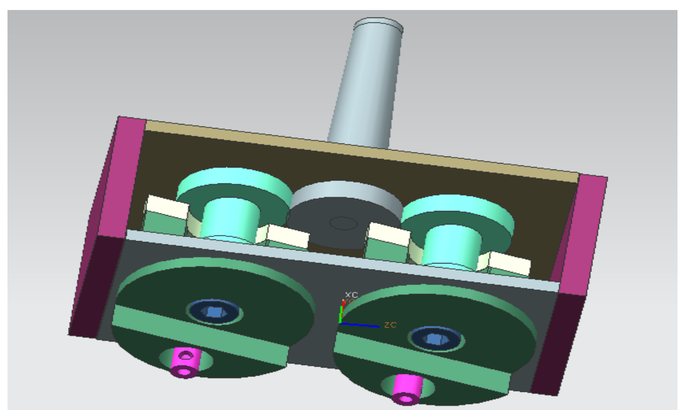
Here planetary gear train type adjustable multispindle drilling head is selected.

III.Multispindle drilling machine

As the name indicates multiple spindle drilling machines have two spindles driven by a single power head, and these two spindles holding the drill bits are fed into the workpiece simultaneously. The spindles are so constructed that their centre distance can be adjusted in any position within the drill head depending on the job requirement. For this purpose, the drill spindles are connected to the main drive by means of universal joints.

The rotation of the drills are derived from the main spindle and the central gear through a number of planetary gears in mesh with the central gear) and the corresponding flexible shafts. The positions of those parallel shafts holding the drills are adjusted depending upon the locations of the holes to be made on the job.





Each shaft possesses a telescopic part and two universal joints at its ends to allow its change in length and orientation respectively for adjustment of location of the drills of varying size and length

IV.DESIGN

4.1. DESIGNING OF SHAFT

4.1.1. COMBINED BENDING AND TORSION

In practice the shaft in general are subjected to combination of the bending and twisting stresses.

Following stresses are normally adopted in shaft design[4]

Max^m tensile stress = 60 N/mm^2

Max^m bending stress = 70 N/mm^2

Max^m shear stress = 40 N/mm^2

$N_1D_1 = N_2 D_2$

$N_2 = N_1D_1/D_2$

$= 1440*40 / 80$

We have selected exactly ½ the diameter of driven pulley to reduce the RPM to ½ and increase TORQUE.

= 720 RPM.

4.1.2. TORQUE CALCULATION

Power of motor = ½ hp = 373 watts

$P = 2 \pi N T / 60 = 2 *3.14 * 720 * T / 60$

$T = 373 *60 / 4521.6$

= 4.94 N-M

= 4940 Nmm

Considering 25 % overload

T_{max} = 6175 N-mm

4.1.3. CALCULATION OF MAXIMUM BENDING MOMENT:

M_{max} = force due to belt tension x distance

=12000 N – mm

Equivalent Bending moment of shaft;

$M_e = ½ *[M +(M^2 +T^2)^{1/2}]$

= 12747 N-mm

Considering bending failure of shaft,

$M_e = 3.14 / 32 * fb D^3$

d = 12.25 ≈ 15 mm (nearest)

4.2. DESIGN OF PULLEY SHAFT

Let M = bending moment
T = twisting moment

Maximum HP (i.e. h.p. of motor) to be transmitted by pulley = 0.5 HP

N =460 rpm. (by experiment minimum rpm required for drilling)

Angle of deflection = 0.25^0

Θ = 0.00436 rad.

Length of the spindle = 15 cm.

Modulus of rigidity ;

G = 0.84 x 10^6 kg/cm^2 (Plain carbon steel)

Let T = torque transmitted by shaft

$$T = \frac{P \times 60}{2 \pi N}$$

$$= 597 \text{ N.mm}$$

4.2.1. TO FIND THE DIAMETER OF SHAFT

Let , d = dia of the shaft

Then using relation,

$$\frac{T}{J} = \frac{G\,\Theta}{L}$$

d^4 = 29.4 cm

d = 2.23 cm.

.d = 22 mm.

Hence the diameter of shaft = 25 mm.

4.2.2. SHEAR STRESS INDUCED IN SPINDLE

Let's select

C –30 as a material for spindle

Then

бy = 400 N/mm^2 (yield stress from PSG data book.)

Factor of safety,

fos = 3

$$[6y] = \frac{400}{3} = 133 \text{ N/mm}^2$$

Induced shear stress, $f_s = 0.577 \times [6y]$

$= 76 \text{ N/mm}^2$.

Then using relation,

Torque,

$$T = \frac{\pi}{16} \times f_s \times d^3$$

$f_s = 194.6 \text{ kg/cm}^2 f_s$

$= 19.46 \text{ N/mm}^2$

$f_s < 76 \text{ N/mm}^2$

Hence design is safe.

4.3. DESIGN OF BUSH BEARING

Here assuming,

Working hours = Lb = 12,000

And L = 696 million revolutions

From PSG 4.2

$L = (c/p)^k$

For Bush Bearing k = 3

$C = P \times (L)^{1/k}$

$C = 1000 \times (696)^{1/3}$

C = 8862 N

C = 886.2 kgf

From PSG data book, 4.13 series 62

Bearing of basic design no (SKF) 6204

.d = 20mm. B= 14mm. D=47mm.

4.4. DESIGN OF WELDED JOINT

Checking the strength of the welded joints for safety

The transverse fillet weld welds the side plate and the edge stiffness plates,

The maximum load which the plate can carry for transverse fillet weld is ,

$$P = 0.707 \times S \times L \times ft$$

The load of tool force along with the friction is 30 kg = 294.3N

Hence,

$$294.3 = 0.707 \times 5 \times 130 \times ft$$

Hence let us find the safe value of 'ft'

Therefore;

$$ft = 0.64 \text{ N/mm}^2$$

Since the calculated value of the tensile load is very smaller than

the permissible value for material at welded joint.

Hence welded joint is safe.

4.4. MAIN BODY SPECIFICATIONS

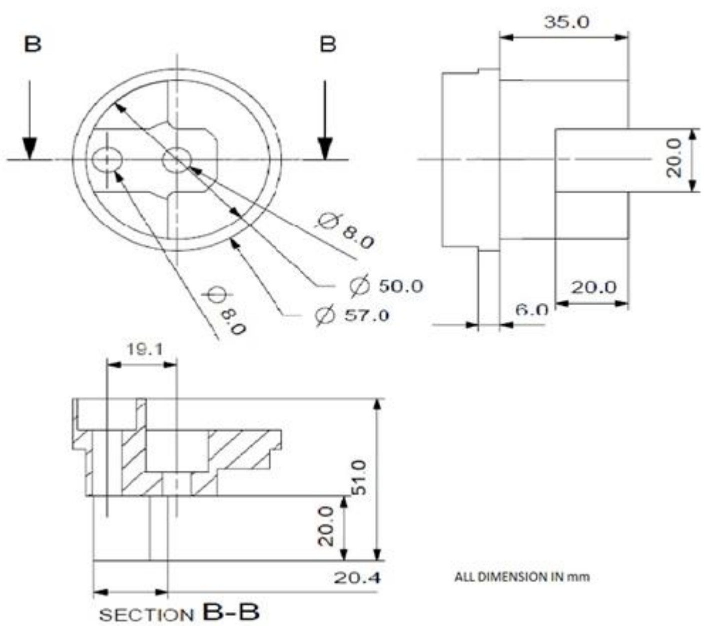
The process sheet for the component main spindle gear is as shown below, which shows the stepwise manufacturing process & machine require to manufacture the part**[5]**.

Material: **-** M.S.

Raw material Shaft ø 60 * 55 mm

Sr. No.	Operation	Machine	Measuring devices	Tool	Time (Min)
1	Turning ø 57 mm	Lathe	Vernier caliper	Side Tool	5
2	Step turning ø 50 mm	Lathe	Vernier Caliper	Side Tool	5
3	Face cut 10 mm deep	Milling	Height Gauge	Face Mill cutter	8
4	Face cut 35 mm deep	Milling	Height Gauge	Face Mill cutter	10
5	Milling 20 mm deep	Milling	Height Gauge	End Mill cutter	15
6	Milling cut 22 mm thick	Milling	Vernier caliper	End Mill cutter	15
7	Readies Milling R 10	Milling	- - -	End Mill cutter ø 20	10
8	Center Hole ø 8 mm	Jig & Boaring	Vernier caliper	End mill cutter	9
9	Step Hole ø 17 mm	Jig & Boaring	Vernier caliper	End mill cutter	5
10	Hole ø 9 mm	Jig & Boaring	Vernier caliper	End mill cutter	10
11	Step Hole ø 17 mm	Jig & Boaring	Vernier caliper	End mill cutter	8

4.4.1. MAIN BODY DIAGRAM



4.5. GEAR SPECIFICATIONS

Material: - EN8[6]

Raw material: - ø35 X 180 mm   3 Nos.

4.5.1. BIG GEAR:-

Pitch Circular Diameter= 33 mm.

Tooth Thickness = 8 mm

No. Of teeth = 31

Module = 1

4.5.2.SMALL GEAR

Pitch Circular Diameter= 2o mm.

Tooth Thickness = 8 mm

No. Of teeth = 18

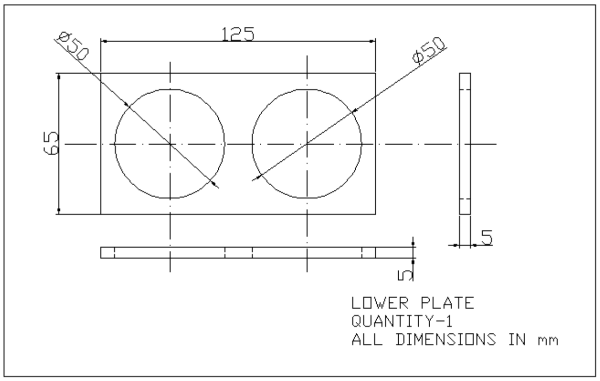
Module = 1

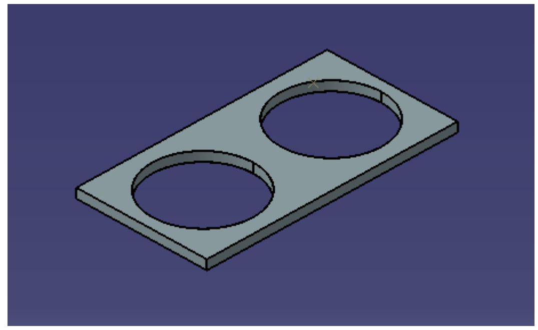
4.6. LOWER PLATE SPECIFICATIONS

Material: - M.S.

Quantity: - 1 No's

Row Material :- Plate 130 X 70 X 8



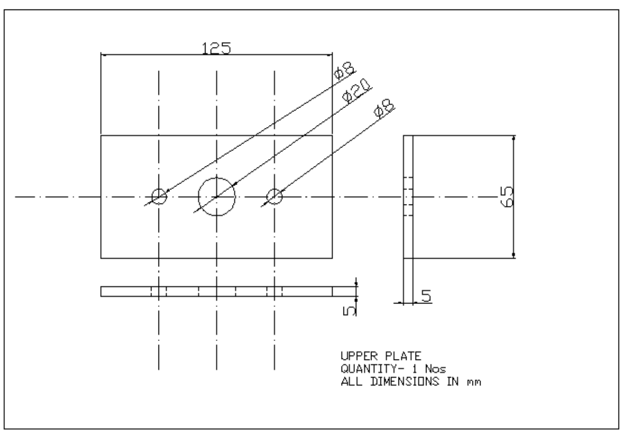


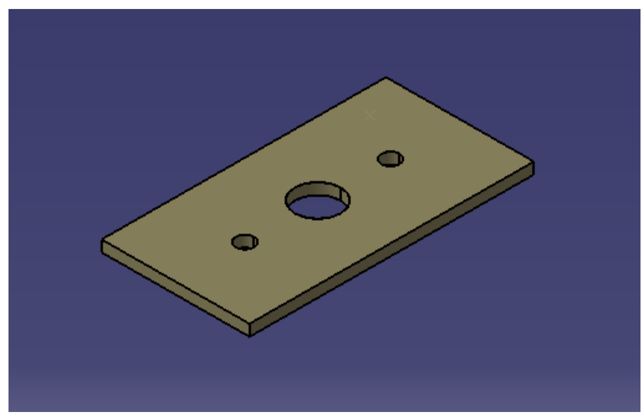
4.7. UPPER PLATE SPECIFICATIONS

Material: - M.S.

Quantity: - 1 No's

Row Material: - Plate 130 X 70 x 8





V.CONCLUSION

- With the help of this machine we can drill two holes at a time.
- The size of machine is smaller than the older machine so it is very simple to move from one place to another. So this machine can be easily transported. The overall space required is also minimum.
- The efficiency of this machine is better than the older machine.
- Large saving in power have been achieved.
- The machine is very simple to operate.

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