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Multi Spindle Drilling Machine

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Abstract- This paper discuss the case study and comparison of productivity of component using conventional radial drilling machine. The growth of Indian manufacturing sector 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. There are frequent needs of tightening and loosening screws, drilling, boring, grinding machine. Huge and complicated designed parts cannot be machined in ordinary machines. In a single machine all the above specified operations can be carried out, after drilling, the drill head is removed from the barrel key and the required tools like grinding application. By this we can achieve our industrial requirements and production targets.
Keywords: Radial drilling machine, Drill Head, Productivity, Other operations.

I. INTRODUCTION

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) along with quality is by use of special purpose machine. Usefulness and performance of the existing radial drilling machine will be increased by designing and manufacturing of multi spindle drilling head attachment. This paper deals with design and development of multi spindle drilling head for cycle time optimization of the component. Multi-spindle head machines are used in mechanical industry in order to increase the productivity of machining systems. Such machines are equipped by spindle heads that carry multiple tools for performing machining operations.

The most noteworthy aspect when using multi-spindle machines is the cycle time, due to parallel machining the total operating time is dramatically decreased. Added benefits include less chance for error, less accumulated tolerance error, and eliminate tools changes. In such a multi-spindle machine, a part to be machined is fixed on the table. It is not possible neither to fix two or more parts on the table nor use two or more tables at the same machine. Thus, in every moment only one part can be present on such a machine. No part can be loaded before the previous part is not finished [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.

Another way of achieving good quality during production is to use the statistical quality control techniques at every stage of production. If the production is statistically under control the process can continue and there is no need for a change in the process.

II. VARIOUS METHODS OF MULTI-SPINDLE

The various methods of multi spindle drilling head are

A. Adjustable multi spindle drilling head can be used in many components, where change the centre distance to some range.

1) It will increase drilling capacity in single special purpose machine.

2) These are the gear adjustable centre drilling head, in which drill Spindle is fitted on slotted plate and the gear is mounted on the drill spindle.

3) By changing the gears as per required pitch circle diameter the drill spindle is adjusted in the slotted plate.

B. Fixed Multi spindle drilling head where cannot change the centre distance to some range. Is planetary gear train, compound gear train.

Fig.1 Fixed drilling machine

Fig.2. fixed drilling machine

C. Features Of Both The Type Multi Spindle Drilling Head Are

1) By using this multi spindle drilling heads, increase the productivity is substantial.
2) Time for one hole drilling is the time for multiple no. of holes drilling.
3) Multi spindle drilling ensures the positional accuracy.

Multi spindle heads can be of fixed centre construction for mass and large batch productions, Adjustable centre type design is offered .

III. PROBLEM DEFINITION

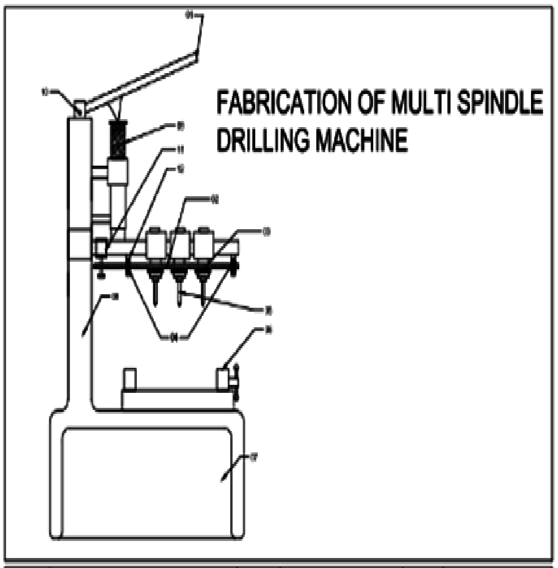
In the conventional manner only one job can be worked at a time for either of the above operations, but with increase in productivity demands a special purpose device or attachments is need which will increase productivity by,

A. Performing operations on more than one job at a time,
B. Performing multiple operations in one cycle

IV. SOLUTION

The Multi-spindle drilling attachment is an ideal solution to the above problem where in the conventional drilling machine is used to perform three operations at a time, so also different operations like drilling, reaming, countersinking or spot facing can be done simultaneously. The multi-spindle drilling attachment is easy to mount on the drilling machine, where in the MT-2 taper arbor directly fits into the drilling machine sleeve; if necessary an support sleeve can be attached to the casing plate for extra stability. In the multi-spindle drilling attachment three spindle are driven simultaneously which carry three dill chucks. The drill chucks can receive twist drills, reamers, countersink drills or spot facing cutters to perform the desired operation. 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. Another way of achieving good quality during production is to use the statistical quality control techniques at every stage of production. If the production is statistically under control the process can continue and there is no need for a change in the process. However, if it is not statistically under control, the assignable causes should be discovered and removed from the process.

V. DESIGN



S.NO	PART NAME	S.NO	PART NAME	S.NO	PART NAME
01	HANDLE	05	DRILLING TOOL	09	SPRING
02	ELEVATING SCREW	06	VICE	10	PIVOT
03	GEAR	07	BASE	11	MOTOR
04	BEARING	08	COLUMN	12	BEARING SUPPORT

Fig.3. Multi spindle drilling machine design

A. *Designing Of Shaft*

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.

Maximum Tensile stress = 60 N/mm

Maximum Bending stress = 70 N/mm

Maximum Shear stress = 40 N/mm

$N_1 D_1 = N_2 D_2$

$N_2 = N_1 D_1 / D_2$

$= 1440 \times \frac{40}{80}$

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

B. Torque Calculation

Power of motor = ½ hp =373 watts

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

$$= {2\times 3.14\times 720\times T}/{60}$$

$$T = {373\times 60}/{4521.6}$$

= 4.97 Nm

= 4970 Nmm

Considering 25% over load

T_m = 6175 N-mm

C. Calculation Of Maximum Bending Moment

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

= 12000 N-mm

Equivalent bending moment of shaft

$M_e = ½ \times [M+(M^2+T^2)^{1/2}]$

= 12747 N-mm

Considering bending failure of shaft

$$M_e = {\pi}/{32\times fbD^3}$$

d = 12.25 ≈ 15 mm (approx)

D. Design Of Pulley Shaft

Let M = Bending moment

T = Twisting moment

Maximum HP to be transmitted by pulley = 0.5 HP

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

Angle of deflection = 0.25°

$$\theta = 0.00436 \text{ rad}$$

Length of the spindle = 15 cm

E. Modulus Of Rigidity

G = 0.84×10^6 Kg/cm^2 (plain carbon steel)

Let T = torque transmitting by shaft

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

= 597 Nmm

To find the diameter of shaft

Then using relation

$$\frac{T}{J} = \frac{G\times\theta}{L}$$

d^4= 29.4 cm

d= 2.23 cm

d= 22 mm

Hence the diameter of shaft = 25 mm

F. Shear Stress Induced In Spindle

Let’s select
C- 30 as a material for spindle
Then
6y = 400 N/mm^2
Factor of Safety
FOS = 3

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

Induced shear stress, fs =0.577 × [6y]
=76 N/mm
Then using relation,
Torque,

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

fs= 194.6 Kg/cm^{2}fs
=19.46 N/mm^2
fs< 76 N/mm^2
Hence design is safe.

VI. WORKING

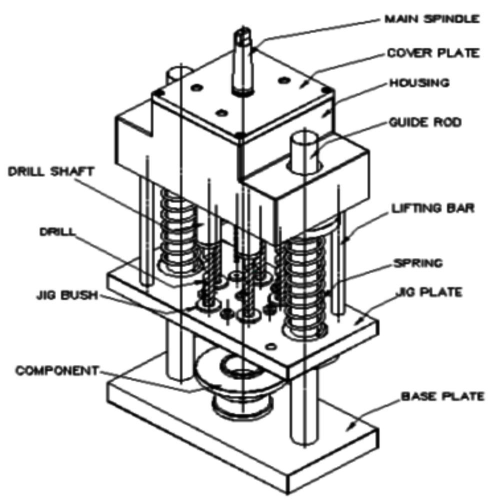


Fig.3. Multi-spindle drilling machine

In the conventional manner only one operation can be performed at a time, but with increase in productivity demands a special purpose device or attachments is need which will increase productivity by multi spindle drilling machine.A multi spindle drilling machine will drill a number of parallel holes simultaneously in a work piece. Multi spindle drilling machines are employed for work of light character, especially repetition work, such as drilling small components for the automobile and Aircraft industries. A Multi spindle drilling machine has a number of drill spindles driven by a single motor. All the spindles holding the drills are fed into the work piece at the same time.For this purpose, the drill heads can be lowered to the work piece with the handle. It can be moved up and down. Here the work piece is clamped in the vice on the lower table. The main eccentric is driven by the drilling machine spindle which is driven by a single motor .The several drill holding eccentrics are driven by the main eccentric through a revolving plate. Eccentric is a mechanism which is usually used to convert reciprocating motion into rotary motion. Here we convert the rotary motion into revolutionary motion and into rotary motion. (ie) when the main spindle rotates, the rotary motion of the spindle is converted into revolutionary motion of the revolving plate. Due to the rotary motion of the sun gear the planetary gears also rotate according to the motion of the gear.

VII. DESCRIPTION OF EQUIPMENTS

A. Drilling

Drilling is the operation of producing circular hole in the work-piece by using a rotating cutter called DRILL. The machine used for drilling is called drilling machine. The drilling operation can also be accomplished in lathe, in which the drill is held in tailstock and the work is held by the chuck.

B. Drilling Machine

It is the simplest and accurate machine used in production shop. The work piece is held stationary. Clamped in position and the drill rotates to make .

C. Components of drilling machine

1) Spindle The spindle holds the drill or cutting tools and revolves in a fixed position in a sleeve.
2) Sleeve The sleeve or quill assembly does not revolve but may slide in its bearing in a direction parallel to its axis. When the sleeve carrying the spindle with a cutting tool is lowered, the cutting tool is fed into the work when it’s moved upward, the cutting tool is withdrawn from the work. Feed pressure applied to the sleeve by hand or power causes the revolving drill to cut its way into the work a fraction.
3) Column The column is cylindrical in shape and built rugged and solid. The column supports the head and the sleeve or quill assembly.
4) Head The head of the drilling machine is composed of the sleeve, a spindle, an electric motor and feed mechanism. The head is bolted to the column.
5) Worktable The worktable is supported on an arm mounted to the column. The worktable can be adjusted vertically to accommodate different heights of work or it can be swung completely out of the way. It may be tilted up to 90 degree in either direction, to allow long pieces to be end or angle drilled.
6) Base The base of the drilling machine supports the entire machine and when bolted to the floor, provides for vibration-free operation and best machining accuracy.
7) Hand Feed The hand- feed drilling machines are the simplest and most common type of drilling machines in use today. These are light duty machine that are operated by the operator, using a feed handled, so that the operator is able to “feel” the action of the cutting tool as it cuts through the work piece.
8) Power feed The power feed drilling machine are usually larger and heavier than the hand feed ones they are equipped with the ability to feed the cutting tool in to the work automatically, at preset depth of cut per revolution of the spindle these machines are used in maintenance for medium duty work or the work that uses large drills that require power feed larger work pieces are usually clamped directly to the table or base using t –bolts and clamps by a small work places are held in a vise. A depth –stop mechanism is located on the head, near the spindle .

VIII. ADVANTAGES

A. It Reduces The Manual Work.
B. Quick Operation
C. Accuracy Is More

IX. APPLICATIONS

A. Used in small scale industries
B. It can be used in welding shop for grinding
C. For performing the operations in huge part which cannot be done in ordinary machines.

X. CONCLUSION

By using multi-spindle drilling head productivity will increase. The cost per piece is reduced. This innovation has made the more desirable and economical. This project “Multi Spindle drilling machine” is designed with the hope that it is very much economical and help full to large scale industries, workshops, etc...

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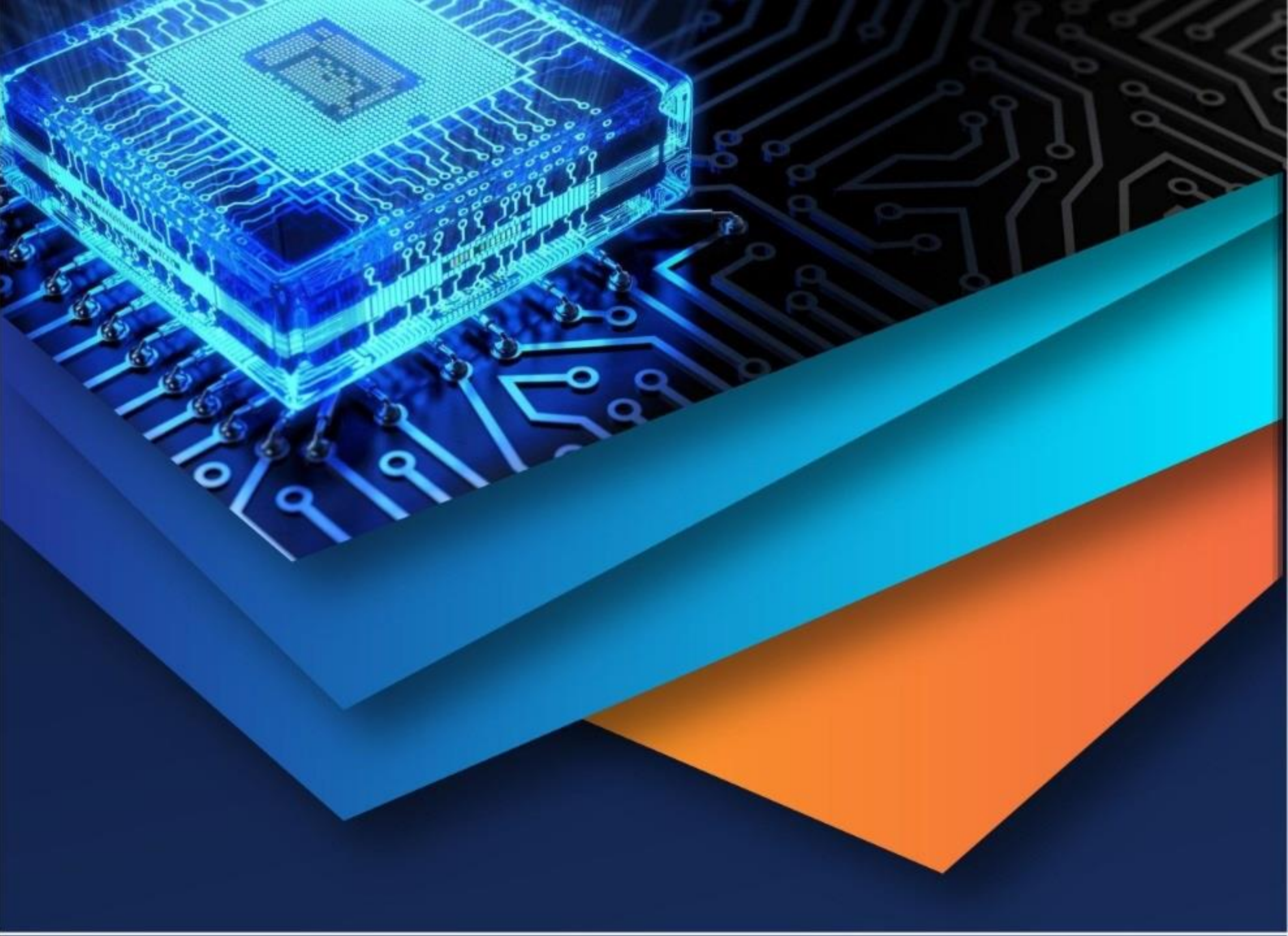

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