Study of Development and Fabrication of Multi-Spindle Drilling Machine with Varying Centre Distance

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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 cycle time, combining the operations etc. In case of mass production where variety of products 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. Productivity and performance of the existing drilling machine will be increased by Design & Fabrication of Multiple Spindle Drilling Head. This paper deals with improvement in Design & Fabrication Process of Multiple Spindle Drilling Head for cycle time optimization of the component.

Key words: Multi-Spindle Drilling Machine

I. INTRODUCTION

Multi-spindle head machines are used in mechanical related factory in order to rising the productivity of machining processes. It is commonly used to drill holes for different pitch circle diameters. The centre distance between the spindles can be managed in any position as per the requirement of the various product.

A. Concept of Multi Spindle Drilling Head

In the conventional drilling machine only one work piece can be drilled at a time. To improve productivity, a special purpose attachment is required which drill the holes more than one at a time. Now a day, the customer demands the product of specific quality, demandable quantity, and right cost & at right time.

Therefore it is necessary to improve productivity as well as quality. This is achieved by multi spindle drilling attachment to conventional drilling machine.

B. Various Methods of Multispindle the Various Methods of Multispindle Drilling Head Are:

1) Adjustable Multispindle Drilling Head: In this attachment the centre distance between drilling spindles can be vary according to requirement.
2) Fixed Multispindle Drilling Head: In this attachment centre distance cannot change. Features of both the type multispindle drilling head are:
   a. By using these multispindle drilling heads, increase the productivity.
   b. Time for drilling one hole is equal to the time for drilling multiple no. of holes.
   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. Planetary gear train type adjustable multispindle drilling head is used [2][3][4].

II. LITERATURE REVIEW

In Indian manufacturing sector the growth of manufacturing depends largely on its productivity. Drilling machine is used primarily in drilling holes, there are a few other functions that the multiple spindle drilling machine is capable of performing the functions include tapping, spot facing, reaming, countersinking, and counter boring to name a few (Takalwe and Naik, 2012). Multispindle drilling attachment works mainly on planetary gear system arrangement. Multi Spindle drilling attachment main function is more than one drilling operation at a time. It has many advantages like increase the production, decrease the operation time, reducing the labor cost, increase productivity and many more. Also reduce the cycles of operations. This is not possible if carry out the production by using general purpose machines.

Although these multiple spindle drilling attachment performs basic drilling operations, there are some specific functions that are performed more accurately and conveniently by each of these types. 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 along with quality is by use of special purpose machine (Spicer et al., 2005; Bhandari). Usefulness and performance of the existing radial drilling machine will be increased by designing and development of multispindle drilling head. Until the 1990s, many manufacturing experts believed that CNC multi-spindle automatics would never be very successful, given their high costs, complexity and susceptibility to failure. On the other hand, it could be foreseen that cam-controlled machines had no longer a future. Convincing solutions could only be achieved if multi spindle machines were designed and constructed in a completely new way with a view to CNC technology, that is, if "genuine" CNC machines were created.

A multi-spindle automatic can be a horizontal or a vertical lathe designed for series production according to a preestablished program with a fixed sequence of operations. The characteristic feature of these machines is, in accordance with European Standard EN 13788, the spindle

drum usually comprising six or eight work spindles arranged in parallel on a pitch circle. For example, a multi spindle drilling unit manufacturer, Auto Drill designs and manufactures Multiple Spindle Drilling units for its customers (Khurmi and Gupta, 2005). Based on the specifications and requirements of the customer, Auto Drill manufactures the Multi- Drill fixture which is capable of drilling all the hinge holes on a door in 3 separate hinge locations simultaneously.

III. WORKING PRINCIPLE OF THIS EXPERIMENT

1) 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.
2) 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, Allen bolt is used.
3) The power from the motor is transmitted by taper shaft to the central gear. Then after power at central gear is transmitted to the drilling spindle by compound gear train.

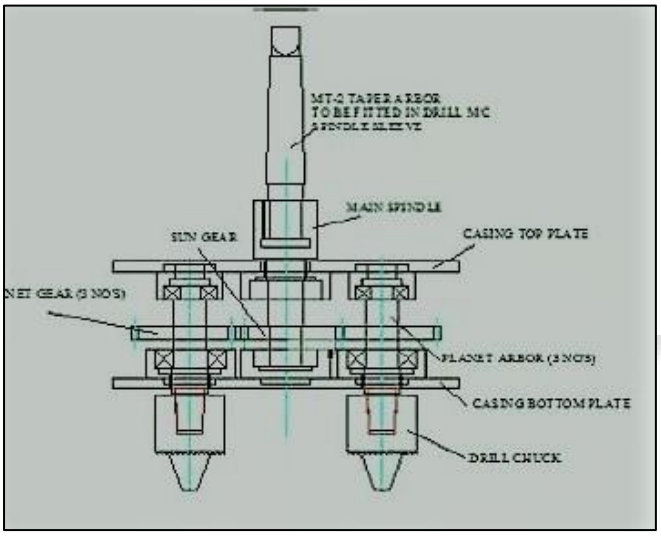

Fig. 1: Principle of twin spindle drilling

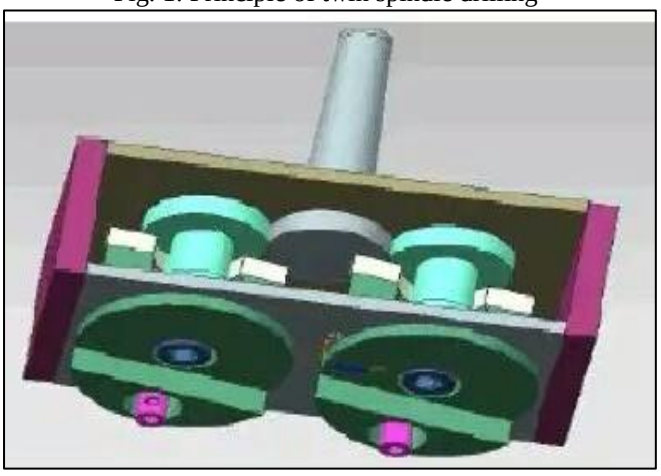

Fig. 2: Principle of twin spindle drilling in 2D

IV. DESIGN

The total design work has been divided into two parts:

1) System design
2) Mechanical design

System design mainly concerns with the various physical constraints and ergonomics, space requirements, arrangement of various components on the main frame of machine, no of controls position of these controls, ease of maintenance scope of further improvement; height of machine from ground etc. In Mechanical design the components are categories in two parts:

1) Parts to be purchased
2) Design parts For design parts detail design is done and dimensions

A. Cutting Speed (V)

For D=6mm

$$V=\frac{\pi DN}{1000} \quad (1)$$

$$=\frac{\pi 6\times 600}{1000}$$

V=11.30m/min

B. Select Suitable Feed (S):

This depends upon the type of material of the work piece (case hardening steel) Feed =0.1mm/rev

C. Select Material Factor(K):

k=1.25

D. Power in Kw (P):

For D=6

$$P=\frac{1.25\times 6^2\times 1.25\times 600\times(0.056+1.5\times 0.1)}{10^5} \quad (2)$$

=0.069525 Kw

=0.092795 hp

Therefore power for 2 nos. of drill (0.092795*2) =0.1855 hp By considering 80% efficiency of whole system of gear box, total power required

$$P=\frac{0.1855}{0.8}=0.2319 \text{ hp}$$

E. Torque (T) Kgf.m

$$T=\frac{975\times P}{N} \quad (3)$$

=0.3768 kgf.m

F. Thrust Force Coming On the Spindle

$$\text{Thrust force}= 1.16 \times k \times D \times (100 \times 0.15)^{0.85} \quad (4)$$

=86.93 N

=8.8619 kgf

For 2 nos. of spindle

=8.8619×2

=17.7238 kgf

G. Selection of Motor Single phase induction motor 1HP, 1440 rpm.

V. CONCLUSIONS

With the help of this process parameter, we can drill two holes at a time with previous of increasing Centre distance between two drilling spindles. It has advantage of portability. The size of machine is minimizing than the previous machine so it is very easy to move any direction from one place to another.

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