Design of Three Spindle Drilling, Spot facing Horizontal SPM for Cylinder head

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Abstract – *Drilling and drilling-related operations like spot facing or counter boring constitutes more than 60% of all machining processes in manufacturing industries. Consequently, it is important to know how to perform these operations properly. The aim of this paper is to design a special purpose machine which can perform drilling and spot facing operations simultaneously. The efforts are done to reduce operation time, reduce the cost of product and ultimately increase the productivity of the machine. In the same way it can reduce human fatigue and minimize the problem of availability of skilled labor. The concept is that the cutting tool is a combination of drill and spot facing tool. Hydraulic system is used for controlling the gear box movement and for holding the job.*

Key Words: Five spindles SPM, drilling and spot facing combination tools, Hydraulic system, Productivity.

1. INTRODUCTION

In the conventional manner, only one job can be worked at a time for various operations such as drilling, tapping, spot facing, etc. but to increase the productivity, it demands a special purpose machine which will increase productivity by performing multiple operations in one cycle. Increasing the quality of production and reducing cost and time of production are very important factors in achieving higher productivity. Achieving this goal requires reconsidering current production methods that could lead to introduction of new production techniques and more advanced technologies.

2. DEFINATION OF PROBLEM

1) On drilling machine it is very difficult to spot face on intricate shapes and surfaces.

2) Performing required operations on all jobs on conventional machines is very time 33+consuming.

3) Parts or job holding or clamping on conventional machine is very difficult and time consuming for mass production.

4) To run the separate machines for separate operations, so many electrical parts or circuits are required which are consuming high electrical power, which is very costly for such operation.

5) Overall conventional method increases cost per unit production

3. PROJECT METHODOLOGY

1) Survey and study of SPMs
2) Study of cylinder head
3) Development of ideas
4) Design calculations
5) Drawing of parts and assembly
6) Ansys of parts
7) Manufacturing
8) Testing

4. DESCRIPTION OF SPM

Fig.1. shows general layout of SPM. There is a rigid bed is provided on which all other systems are installed. Gear box provide a rotation motion of tools. Hydraulic system control the linear movement of gear box , hold the job. Jig plate is provided to hold the job. Pin type locators are used. Drill type fixture is used. Two motors are used one is to provide rotational motion to gear box and second is for hydraulic system.

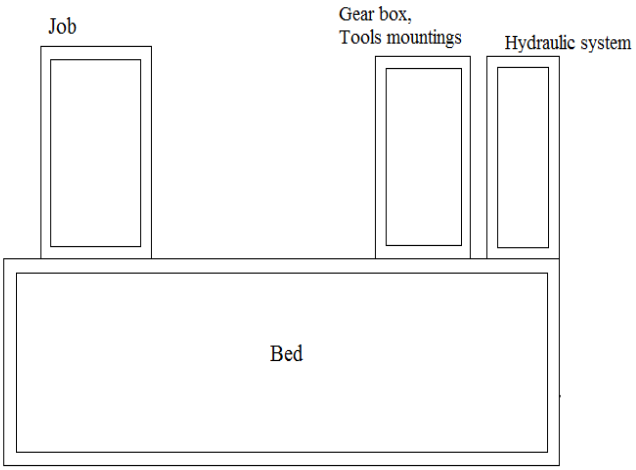

Fig -1: General Layout of SPM

4. DESCRIPTION OF COMBINATION TOOL

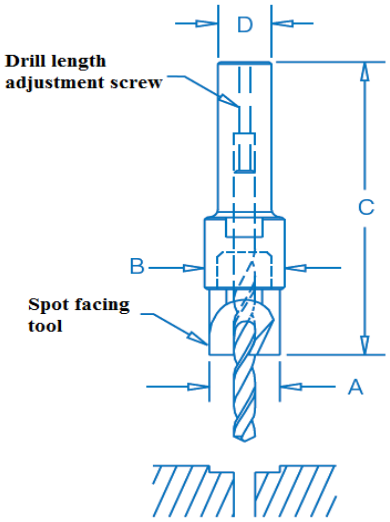

Fig -2: Tool design

Fig.2. Shows schematic diagram of combination drilling-spot facing tool. Positive stop screw in the shank provides drill length adjustment. Dual set-screws in the cutter head provide secure support and driving force. Robust cutter heads can be sharpened repeatedly and are easily replaced. This tool is so designed that the operations of drilling and spot facing for cylinder head can be completed simultaneously. Spot facing provides a seat or flat surface at the entrance and surrounding area of a hole, it commonly done on casting where irregular surfaces are found. In spot facing, feed motion of the tool is parallel to axis of the work piece. It is followed by a mechanical drilling. After the initial hole is drilled, a larger well, or recess, is drilled into the material. This recess allows to easy fittings for tightening the stud nuts or fasteners. Highly recommended where spot facing must be perfectly aligned with drilled holes.

5. DESIGN CALCULATIONS

5.1 GEAR BOX DESIGN

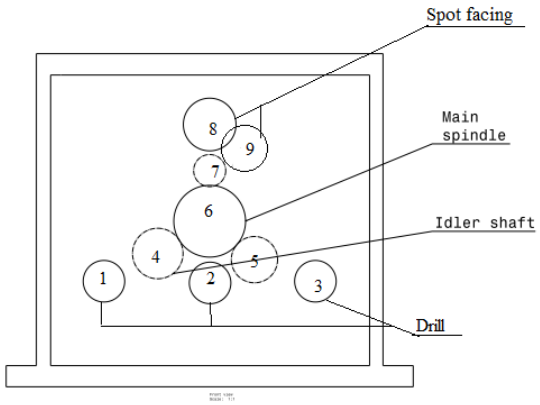

Fig -3: Gear box layout

Here ,

1,2,3 = drills
8,9 = spot face
} as shown in the figure

6 = main spindle

4,5,7 = idler shafts

As per the customer requirement drilling size is 32.5mm. Accordingly further calculations are as follows:

Diameter of drill = 32.5mm,

From Centre Machine Tool data handbook, for drilling operation and for feed = 0.2mm,

$$\text{Cutting velocity} = \frac{60 + 80}{2}$$

$\therefore$ Cutting velocity = 70 m/min

Now , $V = \frac{\pi DN}{1000}$,Therefore by using formula, $N = \frac{1000V}{\pi D}$

Table -1: Shaft and number of revolutions

Part	Pitch circle diameter	No. of revolutions
Drilling spindle	75	700
Idler shaft - I	72	730
Idler shaft - II	84	625
Main spindle	69	765
Idler shaft - III	84	630
Spot face spindle - I & II	75	705

5.2 HYDRAULIC SYSTEM DESIGN

Figure shows working of hydraulic system

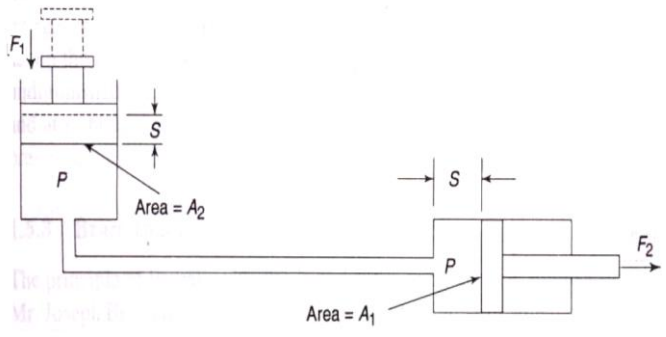

Fig -4: Hydraulic system

5.2.1 HYDRAULIC CYLINDE SELECTION

Force required for moving gear box and holding the job is up to 25 to 30 kg, for safety purpose 10kg of excess force is considered.

Therefore, F = 30 + 10 = 40kg
= 392.4N = 400N

According to force requirement following dimensions for hydraulic cylinder are selected from catalogue,

Bore diameter = 80mm
Rod diameter = 45mm
Stroke length = 325mm

5.2.2 HYDRAULIC OIL SELECTION

Hydraulic Oil ISO				
Mineral based hydraulic oil				
Property	Value in metric unit		Value in US unit	
Density at 60°F (15.6°C	$0.880*10^3$	kg/m^3	54.9	lb/ft^3
Kinematic viscosity at 104°F (40°C)	68.0	cSt	68.0	cSt
Kinematic viscosity at 212°F (100°C)	10.2	cSt	10.2	cSt
Viscosity index	135		135	
Flash point	204	ºC	400	ºF
Pour Point	-40	ºC	-40	ºF
Aniline Point	88	ºC	190	ºF
Color	Max.7.0		Max.7.0	

5.3 JIG PLATE AND RENEWABLE BUSH DESIGN

In plate type jig renewable bush is used. For this bush, liner is used on outside surface. Here liner is used because if the bush fails or breaks then the bush can be changed easily.

Cutter diameter = 32mm,
Cutter diameter = Inner diameter of bush,
Therefore, Inner diameter of bush = 32mm,
Outer diameter of bush = 38mm,
Outer diameter of bush = Inner diameter of liner,

Therefore, Inner diameter of liner = 38mm,

From machine design data handbook,

Outer diameter of liner = 50mm

3. CONCLUSIONS

The cycle time is reduced by replacing separate machines for drilling and spot facing by a single special purpose machine to perform and simplify both the operations in cylinder head. The efforts are done to reduce operation time, reduce the cost of product and for increasing the productivity of the machine.

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