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Design and Development of Double End Facing SPM for Oil Lock Collar

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Abstract

Special Purpose Machines (SPM) are designed and manufactured to perform specific operations, so that high volume of production can be achieved economically. Thus, according to customer requirements, SPM has been designed and developed, which performs double end facing operation on product oil lock collar.

In this paper, the construction and working of machine with controlling systems such as PLC, pneumatic and hydraulic system is dealt. Thus, combining action of cutting tools, motor with rotating spindle and revolving center performs double end facing and chamfering operation on oil lock collar. It takes a short time (14 sec) to finish one part and thus mass production is economically viable.

Keywords: SPM, PLC, Facing, Chamfering

1. *Introduction*

1.1 *SPM*

Special **P**urpose **M**achines (SPM) are designed and developed for performing specific operations. These machines are particularly used for mass production because they perform only one kind of operation repeatedly and thus, they are not used to produce variety of products.Special purpose machine is used for production of specific product of known quantity. Whenever production of specific product completed, the SPM becomes obsolete. Thus, the life cycle of SPM is up to that time, when the product is in demand.SPMs are useful for producing large quantities of high quality products at low costs. These machines can also be altered to produce similar components when necessary. High accuracy, uniform quality, and large production quantities are important characteristics of SPMs.

2. *Problem Identification*

The given product is **Oil Lock Collar** and industry requires such a machine whichperforms double end facing operation on the product, so that large quantity of products are produced in short time. (Minimum 2000 parts per day)

Thus, the objective is to design and manufacture SPM which continuously performs double end facing operation on oil lock collar so that mass production is achieved as per requirement by the industry.

2.1 *Double End Facing*

It is the machining operation generally performed on lathe machine in which single point cutting tool is use to face both the ends of work piece (cylindrical shape) independently.

2.2 *Oil Lock Collar*

The oil lock collar is one of the parts of shock absorber in suspension system of automobiles. It is made up of material CEW (Cold drawn Electric Resistance Welded) Clean Bore Tube and having weight 41.2 grams. The design of this product or job on which double end facing operation to be performs is shown below.

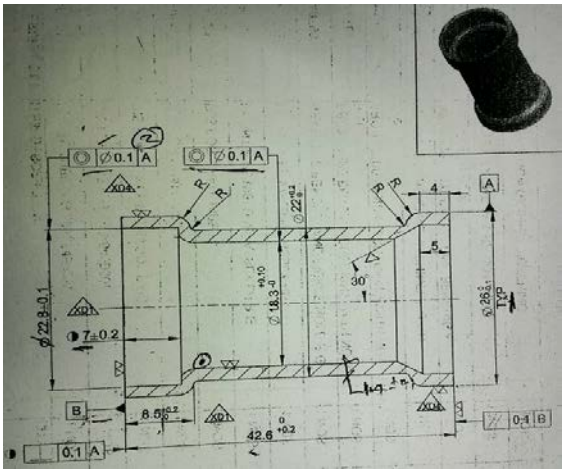

Fig. 2.1: Oil Lock Collar

2.3 *Possible Solutions*

The double end facing operation can also be performed by using lathe machine but cycle time requires for it is more and thus required quantity of parts cannot be produced by the above conventional method.

Cycle time required by lathe machine is shown in table.

Sr. No.	Unit	
1	Cutting Speed	200mm / min
2	Spindle Speed	2546.48 rpm
3	Feed / revolution	0.05 mm
4	Feed / min	127.32 mm
5	Load / Clamp job from one side	7 sec
6	Facing Operation from one side	3 sec
7	Chamfering Operation from one side	3 sec
8	Unload job	7 sec
9	Load / Clamp job from another side	7 sec
10	Facing Operation from another side	3 sec
11	Chamfering Operation from another side	3 sec
12	Unload job	7 sec
	Total time	**40 sec**

Second method is to use the CNC lathe machine for performing double end facing operation on the product. However, it is not economically viable.

Thus, in order to produce the required quantity of parts in most economical manner

the manufacturing of SPM is theavailable option.

3. *Design of SPM*

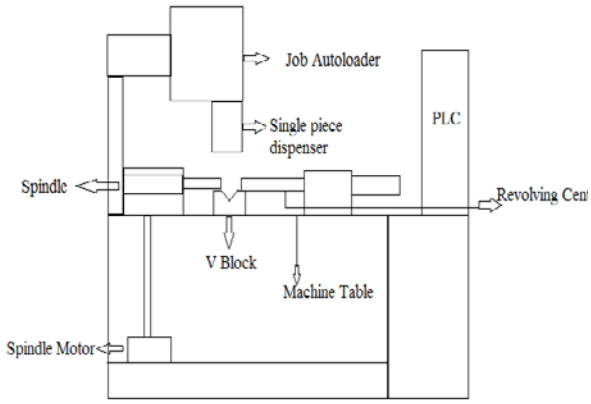

Fig.3.1: Block Diagram of SPM

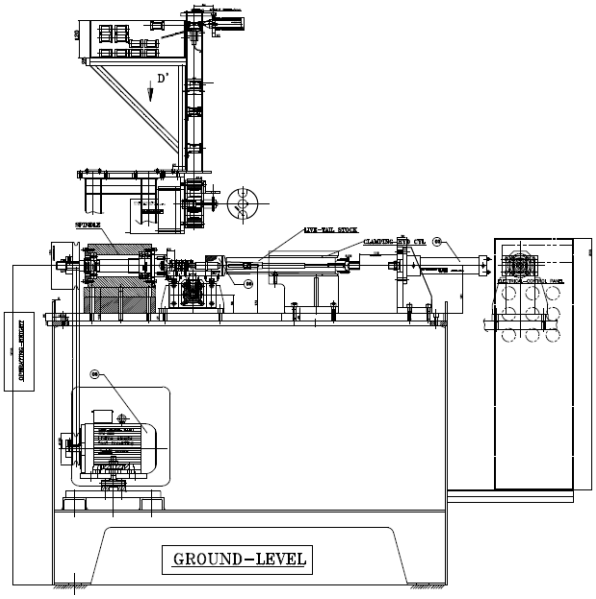

Fig. 3.3: Front view of SPM

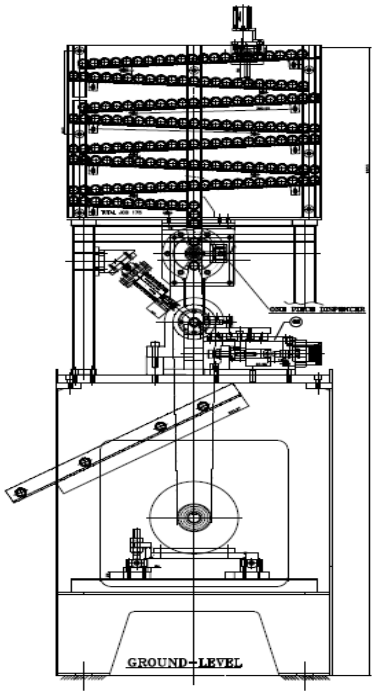

Fig. 3.2 : Side view of SPM

4. *Standard Material List*

Sr. No.	Description	Quantity
1	Ball bearing	2
2	Ball bearing	1
3	Hydraulic Cylinder (Tail Stock)	1
4	Hydraulic Cylinder (Slide)	1
5	Spindle Electric Motor	1
6	Tail Stock Live Center	1
7	Pneumatic Cylinder (Chamfering)	2
8	Pneumatic Cylinder (Chamfering)	1
9	Guide Rail	4
10	Hydraulic Power Pack Motor	1
11	Pneumatic Cylinder	1
12	Pneumatic Cylinder (Autoloader)	1
13	Sleeve	1
14	Step Motor (Autoloader)	1
15	Pressure Gauge	2
16	FRL	1
17	PLC	1

5.*Construction of SPM*

It consists of following main units,

1) Machine table
2) Job autoloader and single piece dispenser system
3) Motor with spindle and Revolving center
4) Hydraulic and Pneumatic system with actuators
5) PLC for controlling operations
6) Job unloading system

5.1. *Machine table*

It is a rigid structure made up of mild steel material and having length 125cm, breadth 70 cm and height 70 cm. Its inner part is hollow for collection of chips during operation. It provides rigid support to the machine along with its accessories

5.2. *Job autoloader and single piece dispenser system*

It is used for mounting the jobs one by one on the working table or V block. Job autoloader consists of a frame having length 60 cm, height 65 cm and thickness 4 cm. Inside the frame jobs are allowed to move over the slopes made at an angle of 5^0.

Then single piece dispenser hold single job and put it in right position on the V block. It consists of small single phase induction motor with 1200 rpm and sensor. Sensor sense position of the job and then motor rotates and placed it inrequired position.

5.3. *Motor with spindle and Revolving center*

It consists of 3 phase induction motor with 2830 rpm which is fixed at bottom side of the table which transmits power by means of V belt to the spindle.This spindle is used to hold one end of job and another end is hold by the revolving center. Spindle is provided with bearings and as spindle rotates by using the power transmitted by spindle motor along with job, the revolving center also revolves.

5.4. *Cutting tools*

Two facing tools and two chamfering tools are used for performing facing and chamfering operation separately. These tools are made up of carbide materials. These tools are mounted on either sides of the V block opposite to each other.

Fig.5.1: Facing tool

5.5. *Hydraulic and Pneumatic system with actuators*

These are used to control movements of different parts of the machine as indicated by PLC signals. In hydraulic system, oil is used as fluid for actuating the cylinders while in pneumatic system compressed air is used as fluid for exerting pressure on the cylinders or actuators.

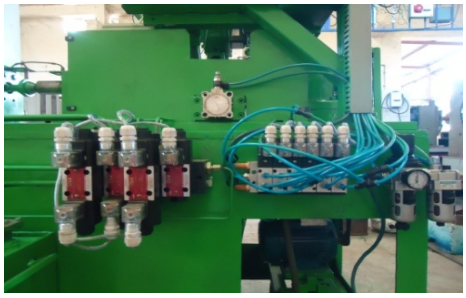

Fig.5.2: Hydraulic and pneumatic systems

5.6. *PLCfor controlling operations*

All the operations performed by machine are controlled by using ladder programming in PLC. Electrical setup consists

of PLC, SMPS, Power contactors, Connectors, Relay boards and Overload Relays.

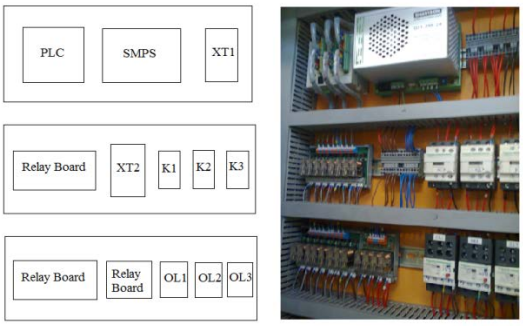

Fig.5.3: Block diagram of Electrical Setup

Where,

XT1 and XT2 – Connectors

K1, K2 and K3 – Power contactors

OL1, OL2 and OL3 – Overload relays

5.7. *Job unloading system*

It consists of cylinder working on pneumatic system which is used to pick the finished part and put in the carrier.

6. *Working of SPM*

Firstly large quantities of specific cylindrical pieces (jobs) are loaded inside the autoloader over the inclined platforms. At top central position of the autoloader sensors are placed which sense the correct position of job along with two cylinders in which one is vertical and another is in horizontal position. The vertical cylinder restricts path of the jobs moving over the platforms and if the job is not in right position then horizontal cylinder push it outside the autoloader otherwise allow it to move forward. These jobs roll over the platforms and come down one by one at the top of single piece dispenser. Then single piece dispenser put them in correct position on the V block with the help of motor and sensor.

Then the job is keep rotating by rotating spindle of motor from one side of the job and by revolving center on another side. Initially facing tools come forward with the help of slides powered by hydraulic system and performs facing operation on both ends of the job. After completing facing operation chamfering tools comes forward by using slides powered by pneumatic system and performs chamfering operation on both ends of the job. Then revolving center and rotating spindle moves backward and leaves the finished job on the V block. This job is then picking up by the cylinder which works on pneumatic system and released it in the carrier. Then next job is placed on the V block by single piece dispenser and same process is repeated. Thus, in this way facing and chamfering operations are performed on both ends of the job.

7. *Results*

7.1 *Time Calculation Chart*

Sr. No.	Unit	
1	Tool Material	Carbide
2	Tool Diameter	25 mm
3	Cutting Speed	200mm / min
4	Spindle Speed	2546.48 rpm
5	Feed / revolution	0.05 mm
6	Feed / min	127.32 mm
7	Load / Clamp job	4 sec
8	Facing Operation	3 sec
9	Chamfering Operation	3 sec
10	Unload job	4 sec
	Total time	**14 sec**

7.2 *Cost Comparison Chart*

Sr. No.	Machine	Cycle time	Cost
1	Lathe	40 sec	2,00000
2	CNC Lathe	30 sec	12,00000
3	SPM	14 sec	6,00000

8. *Conclusion*

Double end facing SPM for oil lock collar requires short cycle time of 14 seconds for finishing the job and thus it is most economically viable as compared to conventional method.

- Automation is used in the SPM which reduces the human participation.
- Payback period is
- Less space requirement.
- Material movement is restricted.
- Consistent quality of oil lock collar.

Fig.8.1: Photograph of SPM

Acknowledgement

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