Design of Slider-Crank Mechanism to Improve Productivity of Powder Metallurgy Press

Tejaswini Pansare, Snehalkumar Ghaytadkar, Aditya Ballal, Gaurav Singh, Prof.V.V.Shinde

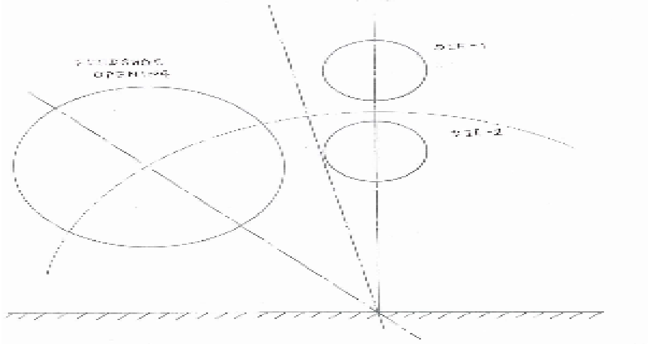
Abstract- **Powder metallurgy press implementing double cavity die with oscillatory motion of the feeder shoe had seen an increased rejection rate of the components. In order to overcome this problem, conversion of oscillatory motion of the feeder shoe to linear motion was required. Through brainstorming sessions, various mechanisms as a solution were thought of. The design purpose was to build a mechanism which would be reliable, cost efficient, has a compact size and is easy to manufacture. This led to the selection of slider-crank mechanism amongst many other. The design is evolved with the aid of two position synthesis of slider crank mechanism. The analytical and graphical study will prove that the design is appropriate. In this paper detailed design process of slider crank mechanism is discussed.**

Index Terms— **Slider Crank Mechanism, Productivity, Powder Metallurgy, feed shoe.**

I. INTRODUCTION

The powder metallurgy press machine under study uses a single cavity die for production. Charging of the press is done by simple gravity flow of the powder from hoppers. Die is filled by moving a feeder shoe over die cavity. A flexible pipe extending from hopper replenishes the feed shoe. The motion of the feed shoe in this machine is oscillatory in nature.

Due to the demand of productivity improvement, a need was felt to change single-cavity die to double-cavity die. Use of double cavity die saw components having density variations which were falling out of the desired limits. Therefore use of double cavity die was stopped immediately.



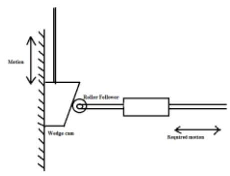
Fig(1). Problem due to oscillatory motion of the feed shoe

Fig(1) shows the oscillatory motion of the feed shoe involving a double cavity die. The radial distance of the die 1 is greater than that of die 2. It is seen from the figure that due to the oscillatory motion of feedshoe, the opening of the feed shoe reaches the die-2 prior to die-1, resulting in uneven filling of the powder metals in the dies. This induces a density and length variation in the compact product.

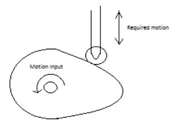
Erick Hjortsberg and *Bjame Bergquist*,2002, presented a study including the property selection which effects the density variation of the powder metal components. Theoretical and practical study led to conclusion that the increased density variation in the double cavity was due to oscillatory motion. The Linear motion of the feeder shoe would reduce the density variation.

II. SELECTION OF MECHANISM

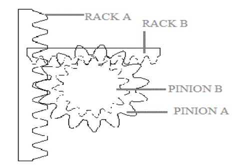
The oscillatory motion can be converted to linear motion using various methods. Some were the use of cam & follower mechanism, Rack & pinion mechanism, using a swivel joint or using scotch-yoke mechanism.



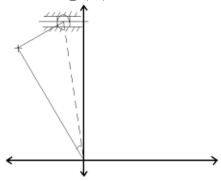
Fig(2) wedge cam follower



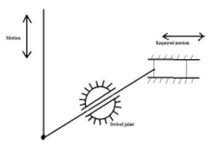
Fig(3) Cam follower



Fig(4)Rack and pinion



Fig(5) Slider-crank



Fig(6) Swivel Joint

The table(1) gives a comparative study of some of the mechanisms. The limited space available is one of the major factors that will decide the selection. As we can see the space requirement for the slider-crank and the swivel joint mechanisms is lesser, these two surely gets an upper hand as compared to other mechanisms. The design of the wedge cam, swivel joint and cam follower may be easy but the

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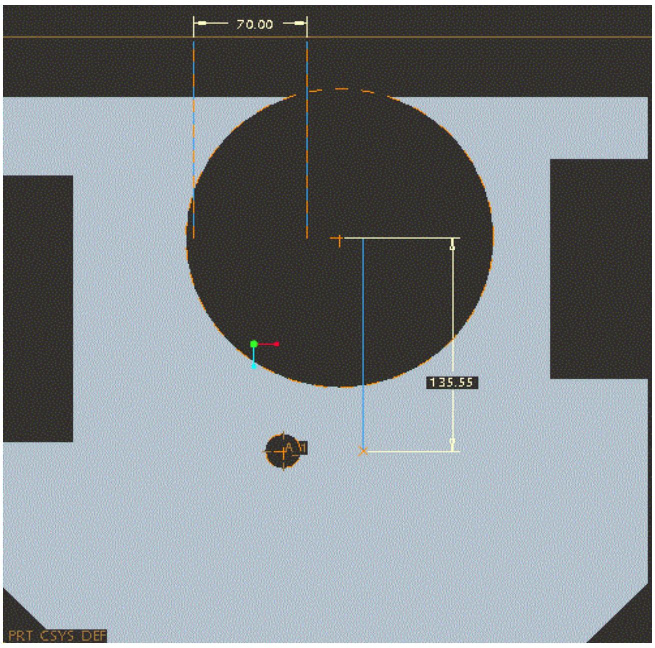
production and its cost of production is certainly higher compared to the slider crank mechanism. Due to the above factors the slider-crank mechanism proved to be more reliable than others and hence selected for the design.

III. SYNTHESIS

Synthesis of the mechanism requires determining the lengths of various links that satisfy the requirement of the motion. If the angular displacement of the input link (ϴ) and the linear displacement (S_{12}) and eccentricity (e) are known the required slider crank mechanism can be obtained



Fig(7).Top view of the system on which the slidercrank mechanism is to be designed.

Initial Conditions:

The oscillatory input(ϴ) of 28degree is given through a linkage.

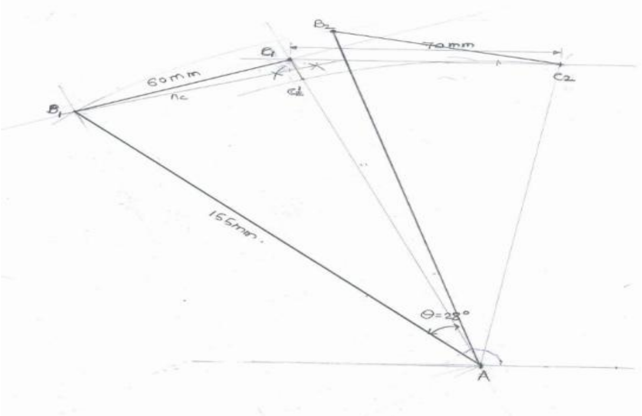
	Wedge cam	Cam follower	Rack and pinion	Slider crank	Swivel joint
Space consideration	**High**	**High**	**High**	**Mechanism can be accommodated**	**Medium**
Wear and tear	**High**	**Low**	**Low**	**Low**	**High**
Maintenance	**Regular**	**Regular**	**Less**	**Less**	**Less**
Design	**Easy**	**Easy**	**Difficult**	**Difficult**	**Easy**
Production	**Difficult**	**Difficult**	**Difficult**	**Easy**	**Difficult**

Eccentricity(e) is 135.55.

Table (1) Comparison of mechanisms

Stroke length required is 70 mm.

Through initial conditions it was known that the problem could be solved by two-position synthesis of slider crank mechanism.



Fig(8) Two position synthesis of slider crank mechanism

Two position synthesis gives us infinite number of solutions for the length of connecting rod and the length crank.

Due to space considerations of the system the length of the crank was taken to be 155mm and the length of connecting rod was calculated to be 60mm.

IV. VELOCITY ANALYSIS

The velocity of the feedshoe reaching the die cavity in the existing system is 70mm/sec. Efforts were made to the velocity of the feedshoe reaching the die cavity same as that of the existing system. The analytical study proved that the design is satisfactory.

Analytical method:

The velocity of the feedshoe is found out by general formula:

$$velocity = \omega * r\left(\sin\theta + \frac{\sin 2\theta}{n}\right)$$

The maximum velocity of the piston is obtained at initial position where ϴ =22

$V_{p\ max}$ = 94mm/sec

The minimum velocity obtained at ϴ=96

$V_{p\ min}$= 53 mm/sec

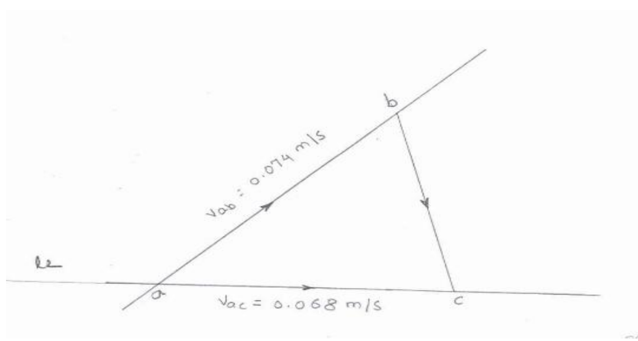
The average velocity of the piston is calculated by

$= \frac{Vpmax+vpmin}{2}$

=73.5 mm/sec

Graphical method:

The velocity diagram can be easily found out by drawing lines perpendicular to the direction of motion of each link. The completed polygon gives us the velocity of piston.



Fig(9)Velocity Diagram

The velocity diagram is shown in fig(9). Line ac gives the velocity of piston with respect to the frame and it was found out to be 0.068 m/s.

V. CONCLUSION

Two position synthesis formed the basis of the design. Analysis done by analytical and graphical method proved that the velocity of feed-shoe motion over the die cavity is almost as it was in the existing system.
The next step is to fabricate the mechanism and implement it. The test results is predicted to show a reduced rejection rate when implementing the double cavity die.

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