

STUDY OF DESIGNING, MANUFACTURING AND TESTING OF MULTI-SLIDE PRESS TOOL FOR ARCH-CHUTE COMPONENT

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ABSTRACT

The press tool life is major criteria in high volume production of sheet metal components. For a Progressive die, proper tool life and component accuracy are necessity for achieving higher productivity and low cost per component. In this project we are going to form a basis by accumulating factors for tool life selection and making data easily available for industrial designers. The data is based on old tool which was analyzed and its characteristics were studied closely and improvements were made which is a part of our project. In this work, we will use the designing software for modifying a progressive tool for Arc Chute plate. Here, a multiple station dies with initial operation as Trimming and later as parting off is performed. In each stroke, one operation is performed with four punches, thus in one stroke we get four final plates. The main aim of our project is to manufacture large number of components in less time. The press tool in this project will have a very short stroke. After making the press tool we will inspect the component and then finalize the tool for production. We will also record the data for cost estimation. Thus, factor selection is made easy by specific data made available and the usefulness of the system is demonstrated by sample run of Arc Chute plate analysis. It caters for obtaining the final components conforming to required dimensions and standards.

Keywords: Press tool, Tool life, Arc chute plate, Progressive die.

I. INTRODUCTION

A multi-slide press tool can perform many operations compared to other dies and also it can able to eliminate the loading & unloading time which results in faster production rate. Multi-slide press tool is a kind of assembled die where in more than one operation can be done at a time. This multi-slide press tool is applicable mainly on sheet metal operations, where in all the tools are previously loaded in a sequence as per the operation requirements. Multi-slide press tool perform a series of fundamental cutting and forming operations typically on continuous sheet metal strip, or coil, stock. These operations are performed simultaneously at two or more stations during each press stroke as the strip progresses through the die to produce a part. Positioning of the stock at each station is accomplished by pilot holes or slots. As the stock advances through the die stations, unwanted material is cut out leaving one or more tabs, ribbons, or bridges to connect the partially completed part to the strip until completion. By combining stock material transfer, along with cutting and forming

operations within a single multi-slide press tool arrangement, significant cost savings are realized especially on high volume production runs. Multi-slide press tools for producing sheet metal parts in mass production have been widely applied in various industries such as aerospace, electronics, machine tools, automobiles, and refrigeration. These dies can perform piercing, notching, cut-off, blanking, lancing, bending, shaving, drawing, embossing, coining, trimming, and other miscellaneous forming operations at a single setup. Hence a multi-slide press tool is generally very complex. Stamping process planning and die structure design are difficult and demanding tasks. The productivity, accuracy, cost, and quality of a multi-slide press tool mainly depends on the strip layout, and hence a stamping process. The diverse knowledge sources (KS's) related to stamping process planning include unfolding knowledge to produce a flat pattern, nesting knowledge to produce a blank layout, various types of planning knowledge for different stamping operations like piloting, piercing, notching, cut-off, blanking, bending, etc., and staging knowledge to sequence the stamping operations. A discussion of some knowledge based multi-slide press tool design work related to our study can be found in the next section. However, the existing work is based on the conventional architecture of knowledge based expert systems, which are incapable of managing heterogeneous KS's effectively. In addition, this work doesn't provide a representation scheme for experts to model their valuable, but difficult-to-articulate, knowledge in terms with which they are familiar.

1.1 Problem Statement

We have to make press tool which will cater the requirement of a press tool having high tool life and to obtain mass production. We offered from a choice of manufacturing a new tool with improved characteristics. The company wants to design a press tool for a multipurpose press machine.

1.2 Objective

The main objective is to manufacture a multi-slide press tool with high tool life with good productivity. For this we have to design a press tool to carry out various operations for archute component. We will have to study the press machine, their functions and the limitations for the design. We need to provide effective utilization of material by selecting most feasible strip layout. We will focus on reducing stroke length for effective utilization of cutting forces. High precision component can be obtained. The tool life is also very high. The tool life is 2 Crore parts.

II. LITERATURE REVIEW

Authors: Vishwanath M.C., Dr. Ramni, Sampath Kumar et al. [1]

The above authors have done a research on this topic before. They have done the research from a very basic level. They have noted down very important points regarding the designing and manufacturing of multi-slide press tool. They have concluded the following:- "By the implementation of computer in design field accuracy of design is improved and design field accuracy of design is improved and design process time is reduced drastically than by traditional method. In the process of creating the documentation for the product design much of required data base to manufacture the product is also created. Many design problems which are complicated to estimate by traditional methods are eliminated by using CAD system. As the designs have more standardization they can be imported to any other software and also CAD provide better functional analysis to

reduce prototype testing regarding progressive die design of progressive die is simple. Advantage of progressive die is it performs two or more operations simultaneously by a single stroke. Progressive die is used for high rate of production this design procedure can also be extended for manufacturing washers for M-series bolts by modifying the punches and die plate dimension.”

2.1 About Multi-Slide Press

The simplest way to describe a multi-slide, 4 slides or four-way is a horizontal stamping press that uses cams to controls tools. The key difference is instead of an “up and down” motion like in a punch press, the multi-slide machine works on right angles. Its moving slides that have tools attached, which strike the work piece to form it. These slides are driven by four shafts that outline the machine. The shafts are connected by bevel gears so that one shaft is driven by an electric motor, and then that shaft’s motion drives the other three shafts. Each shaft then has cams which drive the slides. This shafting arrangement allows the part to be worked for four sides, which makes this machine extremely versatile. A hole near the center of the machine is provided to expel the completed work piece. Examples of multi-slide parts we produce are flat springs, spring clips, brackets, collars, limiters, shunts, shims, connectors, friction plates, retainers, and terminals. They are basically the same machine. A multi-slide simply has a bigger bed size than a four slide. CAR Engineering has 12 multi-slides and one four-slide. Shown below is a video of the actual Multi-Slide and Four-Slide stamping presses from our factory: Because the die in a multi-slide works on right angels and can “attack” the work piece from many directions, the die is often more complex than a progressive die built for a punch press.



Fig No. 1: Components manufactured from Multi-Slide Press Process

A number of material-intensive parts can be produced as four slide metal stampings: balance clamps, base weights, brackets, brake flanges, bushing seats, conveyor flights, engine bases, flywheel shrouds, framed hangers, friction plates, gear and sprocket blanks, lock tabs, reinforcement plates, retainers, spring seats, upright bars, wear and swivel pads, wheel or backing rings and yoke guides. Stamping services use punches and dies to create three-dimensional parts and add surface definition such as lettering to flat-sheet materials. They can process ferrous and nonferrous metals, exotic metals and alloys, precious metals, and thermoplastic materials. Stamping services differ in terms of capabilities and may use deep drawing, fine blanking, multi-slide stamping, or progressive die techniques. Deep drawing uses a punch to fabricate deeply-recessed parts. The depth of a deep-drawn part exceeds its width, as with a cup made from a flat metal sheet. Fine blanking is a specialized, high-precision blanking technique in which material is sheared smoothly through its entire thickness. Fine blanking can be used to produce stamped parts that do not require the performance of secondary operations.

Multi-slide or multi-slide stamping incorporates the vertical motion of a punch with horizontal die applications from multiple directions, either simultaneously or successively. Progressive dies are used in production-efficient processes where multiple stamping operations are performed in successive stages or positions along the fabrication cycle.

2.2 About Multi-Slide Press Machine

The machine we are going to use for press operation is Germany made machine. Its name is Bihler. The machine's name is GRM 80E. It's a high volume manufacture of small stamped components from strip stock. It is a horizontal stamping press that uses cams to control tools. It has the ability to complete all of the operations required to form the work piece from start to finish. Due to this flexibility it reduces the cost of the finished part because it requires less machines, setups, and handling.

The main parts of the machine are motor, clutch, pneumatic system, hydraulic system and central lubrication. These parts form the housing of the machine. The forming unit includes straightener, presses and slides. The operations which can be done are blanking, bending, mounting, riveting and welding. Also complimentary operations include screw insertion, mounting, threading and evaluation.

III. SPECIFICATIONS OF THE MACHINE

- Strip width = 55mm / 60mm, Length = 220 mm, Height in BDC mm = 157 mm
- Width = 168.5 mm, Machine speed = 5- 250 s.p.m, Material dimensions = Max. Strip width 80 mm;
- Max. Wire diameter 6 mm, Stroke rate = 5 – 250 (1/ min) Stroke = 12 mm
- Nominal press force = 300 kN, Max. Bending unit nominal force (KN) = 90 KN
- Feed length to (mm) = 500 , Strip width; width increase to (mm) = 80 mm
- Central Mandrel (stroke mm, nominal force KN) = 80 /35 ,Center aperture = (W x H mm) = 644 / 200
- Axis- head positions = 32 Central gearwheel drive Spring mounted guide plate.

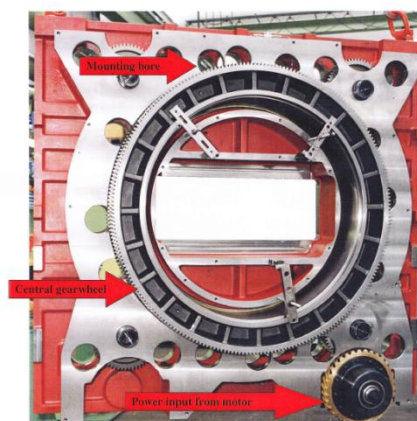


Fig No. 2: Central Gear Wheel in the Machine

In machines with central gearwheel, the energy is transferred to central gearwheel via worm shaft and idler gear from clutch/ brake combination. The gears on the corresponding forming unit mesh directly with the central gearwheel through the mounting bores. The front tool finish forms the front portion of the stamping, as well as partially bending its ends. At the same time, the cut-off tool retracts, ready for the next cycle. The right and left

tools can simultaneously advance to impart another 90 degree bending of the ends inward around the mandrels. Then the back tool advances to finish form the ends of the stamping around the mandrels. At this point, the tool slides retract. The stripper rod is attached to the stripper rod to push the formed stamping from the mandrel through an opening in the bed of the machine into a container. The same basic knowledge that the tool and die maker and the tool designer have for tooling a punch press is sufficient for tooling the multi-slide. In fact, the problems of building tooling are usually simple but perceptive skills are needed. Our next installment will discuss why it's better to make a music wire spring on a multi-slide instead of using a punch press. Many formed stampings, whether made of strip or wire, whether completed parts or just components can be produced by a multi-slide as well as on a punch press. But if the job can be made on either of the machines, it is necessary to know the capabilities of each in order to choose which can do the job most efficiently and economically. Today, increasing competition and a shortage of skilled labor have combined to put pressure on tool and die makers, tool designers, and plant engineers to produce parts faster and cheaper, and at the same time save on material. And that's where the multi-slide comes in. Trouble is, even though this machine has been around for some 80 years, few shops know how to use it effectively. Admittedly, there are a number of knowledgeable job shops that use multi-slides, but most other plants don't seem to realize that they can produce complex parts on a multi-slide with simple tooling at low cost, and on a short lead time. Over the years, the multi-slide has become a one-machine automated production line: raw stock is fed into it, and a completed part emerges with each stroke. It has a certain edge over the punch press in such operations as matching to bending, but that is not to say that generally the punch press is just as efficient as the multi-slide when correctly tooled for a selected part. Because of the multi-slide's versatility, the tooling designer is able to develop simple tooling for formed parts, whether they're made of strip or of wire. Certainly, a music wire formed part would be a tough job for a punch press. But it's a breeze for the multi-slide.

Many job shops today have a wide range of multi-slides, so as to give them a choice that is dictated by the size of the part to be made and the tonnage required. In all multi-slide models, however, basic operations are the same: a slide feed pulls the material off a stock reel, through a straightener, and into the press head area. After the piece is punched, or goes through other stamping operations, it travels into the multi-slide's forming area, where it is parted and formed into shape by developed tool blocks that are arranged to suit conditions. And the positive feed is accurate in most cases within ± 0.002 in. In some cases, tolerances can be held within ± 0.001 in. The tools in the four slides can be adjusted in any direction, while the tools of a progressive die cannot be cross adjusted. This also allows flexibility in any necessary deviations from design specifications after the tools are made. Such corrections in a die might be impossible. Another quality and production consideration is that buckling of stock can be a serious problem with progressive dies. This can affect quality or cause undesirable machine downtime. Because forming takes place after the stamping operations buckling is reduced. Material cost, especially with strip stock, is usually lower with the multi-slide. Because of the operating characteristics of the punch press, many times pilots are needed to insure accurate feeding and this means extra stock for pilot holes. Or again, added stock width might be necessary to prevent buckling. Then, to allow for possible variations in feed lengths in the punch press, material is provided between blanking in the strip. With the close tolerance control on feeding in the multi-slide and because feed length usually equals blank length, less strip is consumed. Some feel that the initial tooling cost for the multi-slide is higher than the cost for a progressive die

for the same part. NOT TRUE, multi-slide tooling is significantly lower. Again, it is good to remember that one big advantage of the multi-slide is that it can form complex shaped parts completely in one machine without secondary handling. As was mentioned earlier, the tool life usually is longer in the multi-slide, so the number of final parts required affects the tool cost, too. Even if the multi-slide tooling cost 24% more initially than a progressive die. But the die life is half that of the multi-slide tools. Then the actual tool cost for the progressive die is 60% higher than the multi-slide tooling.

Other economies are realized because of the greater flexibility of the multi-slide machines. Hourly production can be doubled in some cases by manufacturing two parts simultaneously. Or, complex parts can be partially formed at the same level as the die, and then stripped to a lower level where a second set of tooling completes the forming operations. At other times, a third level and set of tools may be used again to complete the form in one machine without secondary operations. So many factors must be considered in determining which process is best. The modern stamping plant uses both kinds of machines for best results.

The multi-slide has far more potential as a cost saver than has been indicated so far in this series of articles. Most people don't set up more than single level operations with a combination of one or more of the four forming slides. But this same machine can increase its output substantially with multiples of four operations in the forming section. Thus stampings requiring four, eight, or twelve forming steps can be produced at no more cost than if the operation were limited to four forming steps. The trick here is to partially form the stamped part at one level, than strip it down to a lower level, where final forming is done with additional tools. These dual level tooling's is known as multiple block tool design. Stacked tool blocks, for example, are fastened together, and move together. The top tool performs part of the initial forming sequence, whereas the lower tool is the finisher. Multiple tool blocks, however, aren't necessary for each slide, because tools are designed according to the requirements at each station.

3.1 About Arch-Chute Component

The arc runner and arc chute limit and dissipate the arc energy during the interruption of an overload or short circuit event. During an overload or short circuit event, the contacts of the breaker separate and an electrical arc is formed between the contacts through air. The arc is moved into the arch chute by "running" the arc down the interior of the breaker along the arc runner. When the arc reaches the arc chute it is broken into small segmented arcs. The segmented arcs split the overall energy level into segments less than 25V. Each 25V segment does not have a high enough energy level to maintain an arc and all energy is naturally dissipated.

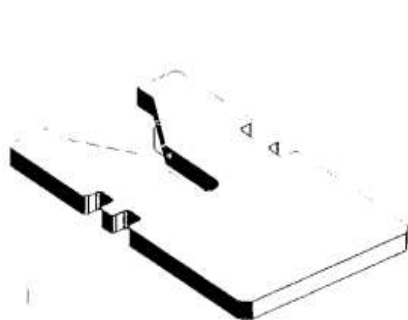


Fig. No. 3: Arch Chute Component

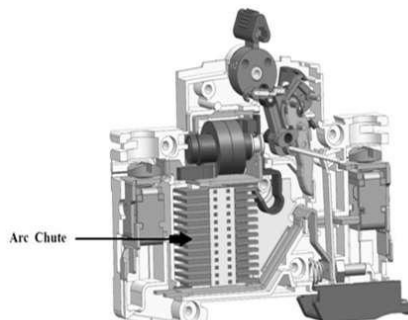


Fig No. 4: MCB consisting of Arch- Chute Component

Low-voltage MCB (Miniature Circuit Breaker) uses air alone to extinguish the arc. These circuit breakers contain so-called arc chutes, a stack of mutually insulated parallel metal plates which divide and cool the arc. By splitting the arc into smaller arcs the arc is cooled down while the arc voltage is increased and serves as additional impedance which limits the current through the circuit breaker. The current-carrying parts near the contacts provide easy deflection of the arc into the arc chutes by a magnetic force of a current path, although [Magnetic blowout](#) coils or [permanent magnets](#) could also deflect the arc into the arc chute (used on circuit breakers for higher ratings). The number of plates in the arc chute is dependent on the short-circuit rating and nominal voltage of the circuit breaker. In larger ratings, oil circuit breakers rely upon vaporization of some of the oil to blast a jet of oil through the arc. Gas (usually [sulfur hexafluoride](#)) circuit breakers sometimes stretch the arc using a magnetic field, and then rely upon the [dielectric strength](#) of the sulfur hexafluoride (SF₆) to quench the stretched arc. [Vacuum](#) circuit breakers have minimal arcing (as there is nothing to ionize other than the contact material), so the arc quenches when it is stretched a very small amount (less than 2–3 mm (0.079–0.118 in)). Vacuum circuit breakers are frequently used in modern medium-voltage switchgear to 38,000 volts.

Air circuit breakers may use [compressed air](#) to blow out the arc, or alternatively, the contacts are rapidly swung into a small sealed chamber, the escaping of the displaced air thus blowing out the arc. Circuit breakers are usually able to terminate all current very quickly: typically the arc is extinguished between 30ms and 150ms after the mechanism has been tripped, depending upon age and construction of the device. The maximum current value and let-through energy determine the quality of the circuit breakers.

3.2 Advantages & Disadvantages

Typically a multi-slide tool takes longer to set up than a punch press tool. The multi-slide tooling is often more complex than punch press making the lead time to design, build, and debug a multi-slide tool a little longer, typically 2-3 weeks of additional development. There are many cost-effective reasons to consider a multi-slide versus a more traditional production method. Often material usage can be reduced dramatically by manufacturing parts with a multi-slide. With a punch press, material is needed on either side of the strip in order to carry the part through the die. However with a multi-slide the material can be purchased slit to width, less material means less cost per work piece. It is especially important to consider a multi-slide stamping when the part is made out of expensive red metals such as copper or brass. The various motions provided by the die head, such as forming slides, vertical stripper mechanisms, and a range of auxiliary units, afford the DFM engineers at shop nearly limitless opportunities for tool and die manufacturing of stampings at considerably lower part cost-per-piece by eliminating secondary operations and handling. Because of their versatility, our multi-slides can be modified for simultaneous feeding and processing of multiple strips to complete an assembly.

In addition, prefabricated parts can be hopped, positioned, and fed for automated assembly as part the production metal forming process. A four-slide can tap without having to purchase expensive in-die tapping equipment or needing a secondary process. Our journeyman tool and die makers are the best in the industry. Because the die in a multi-slide works on right angles and can “attack” the work piece from many directions, the die is often more complex than a progressive die built for a punch press.

IV. CONCLUSION

By introducing progressive die for Arc Chute Plate, it is concluded that the tool is very feasible for the medium batch capacity and efficient in operation. By using two stage tool die, the tool life is 3 -12 lac components. Also, the accuracy of the component is high due to use of precision machine for production of the punch and die. The provision for replaceable inserts has made the maintenance simple. It is, thus, concluded that the productivity of any firm is directly proportional to its profit.

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