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Fabrication of cam operated low cost Sheet metal bending machine for startup industries in rural areas

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Abstract

The rotary motion of the cam is converted in to linear reciprocating motion of the punch. The machine is manually operated and does not require any other external sources. This machine is very useful in sheet metal and other related industries. Also it can be used for different forming operations by changing the punch and die. The machine is portable and requires no skills to operate. The machine works on the eccentric rotation of the cam that is achieved by fixing the cam eccentrically to the shaft. The cam rotates

inside the fixed square block with circular hole. The cam rotates due to the rotation of the shaft to which the handle is connected. The movable blocks of the machine are having a rectangular slot on which the guide block slides due to the revolution of the shaft and attached punch causes bending action due to the sliding action of the movable blocks. The sheet is kept on the die which is placed on the fixed block. The machine is designed to bend sheet metals from gauge 17 to 32. Since the initial cost of power screw bending machine is more, the cottage or small scale industries find difficult to adopt such machines. Compared to such bending machines the cost of this machine is less. The time required to bend the sheet metal is also minimum and safer for the operation. This paper focuses on an innovative idea of producing the bending machine with low cost considerations so that it affordable to the needy masses. It can be used for different forming operations like V-bending, U-bending and punching. It can also be used to produce patches to make leak proof containers, various fabrication works depending upon applications and also for the basic workshop laboratory. In this research work mainly the cottage and small scale industries are given prior importance. The bend angle aimed towards is 900. However because of the spring back effect slight variation will be observed. By over bending and bottoming the effect can be minimized.

***Key Words*:**Bending; Sheet metal; Gauge number; Spring back; Press work.

1 Introduction

Sheet metal work plays a very important role as many engineering components are made from it. Some articles are used for home applications and others find the applications in industries. Sheet metals are obtained from rolling process. Depending upon the thickness the sheet metals are available in various sizes. Usually all the sheet metals are identified by the gauge numbers. The sheet metals are subjected to plastic deformation in press working process. In order to avoid spring back effect many allowances are needed to be given. It helps to get the accurate size and proper shape of the finished article. The stamped parts are useful in automobile and electrical

industries

RADIUS SHOULD BE AS LARGE AS POSSIBLE. TO OBTAIN EXACTLY 90 THE DIE ANGLE SHOULD BE SLIGHTLY LESS THAN 90. HARDER

2 Objectives

A. To make a bending machine to bend metal sheets from 17 to 32 gauge.

B. To make machine on simple working principle.

C. To reduce the time for operation.

D. To make in minimum cost.

3 Literature survey

P. S. Thakare1 et al, 2012 carried out a comparative study on manually operated and power operated sheet metal bending machines. The limitations of manual efforts over the power operations were discussed [1]. Gwangwava N et al, 2013, designed a dual operating mode sheet folding machine. The machine was operated by means of hydraulic cylinders. The machine was so designed that it could overcome the fluctuations in power supply [2]. Qiulei Du and Lin Jin, 2014 carried out research work on sheet material bending machine & in their design they have included a design, mechanism and principle of sheet metal bending material [3]. Vaibhav S. Deore et al, designed a special machine known as pyramid type of bending machine. It could bend the sheet metals of 2mm thickness. Method of bending and material needed to be bent are focused upon. As a part of their work they have carried out stress analysis [4]. Mahesh Gadekar and, Mr. Amol, designed and developed a three roller bending machine. The machine eliminated the formation of flat spot which is a common problem during bending [5]. Vishal Tambat, et al, 2015 designed a fabricated a pneumatic shearing and bending machine, the usage of pneumatic means reduced the human effort and increased the productivity. The efficiency improvement and cycle time reduction were considered during design [6]. Aniruddha Kulkarni et al, 2015 carried out discussion on productivity factors by manual method and when using power for

the same machine [7]. Santosh J et al, 2016 designed and developed bending machine for laboratory work. The machine was performing four different works namely loading rotating, bending and fatigue testing. The machine was easy to handle and safe for operation too [8].

4 Constructional features

The press described in this article is manually operated machine and used for bending sheet metal. The machine consists of the following parts. Mild steel is used for constructing the various parts.

A. Fixed Block

The fixed block is a rectangular block which is fixed on the stand with the attachment of angle plates. It is having a circular hole of diameter 60 mm. The cam which is eccentrically fitted to the shaft rotates inside the circular hole.

B. Movable Block

The movable block is having guide ways on the inner side. The movable block moves up and down with respect to the fixed block.

C. Upper Block

The upper block is an I-section bar, which is fixed to the movable block with the use of bolts and nuts. The upper block is provided for the attachment of the punch.

D. Guide Blocks

These are rectangular blocks which slide in the slots provided in the movable blocks. Here the rotary motion of the cam is converted in to linear motion of the guide blocks. If these are not provided then the shaft passing through it may deflect. It also acts as a bearing for the shaft.

E. Shaft and Cam

The cam is located eccentrically to the shaft so that the rotational motion is achieved by the rotation of the cam by the handle which is fixed to the shaft. The entire load of the machine is acting on the shaft and the cam.

F. Punch and Die

The revolving motion of the punch is converted to vertical linear motion of the punch which forces the sheet metal to bend in the die. The punch is made up of mild steel and is 300 mm long, 23mm

height and 10 mm thickness shaped to a knife edge and the other side connected to the upper block through a blade attachment strip. Die is also made up of mild steel which is 300 mm in length, 25 mm height and 40 mm width. The die opening is 16 mm with an angle of 900.

5 Working principle

The machine works on the eccentric rotation of the cam. This is achieved by fixing the cam eccentrically to the shaft. The cam rotates inside the fixed block, which is a square block having a circular hole. The cam rotates due to the rotation of the shaft to which the handle is connected. The movable blocks which have guide ways are sliding with the fixed block. The movable blocks are having a rectangular slot on which the guide block slides due to the revolution of the shaft. The upper block is attached to the movable block which contains the punch causes bending action due to the slideing action of the movable blocks. The sheet is kept on the die which is placed on the fixed block. The main principle is revolving motion of the shaft is converted in to the linear motion of the punch.

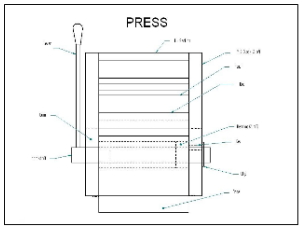

Fig 1. Mechanical press

6 Fabrication

The fabrication of the sheet metal bending machine is done on various machines. The fabrication processes involved are Lathe operations, Milling operations, Grinding operations, Drilling operations,Tapping, Welding, Gas cutting, Shaping etc.

Table 1. Various operations involved

S N	Operations	Description
1	Lathe	The operations done on Lathe are facing, turning, drilling, eccentric turning, boring etc. The operations are done on shaft, cam, and rectangular fixed block. The major operation done is boring of 60mm diameter hole through on the fixed block.
2	Milling	The operation done was cutting of guide ways on the movable blocks here end milling cutter of diameter 16 mm was used on the vertical milling machine also the finishing touches for slots in the movable blocks was given.
3	Welding	Welding done for attaching angle plates to the fixed blocks and welding of the lever to the handle.
4	Drilling	Drilling was done on the movable blocks, angle plates, shafts and cam etc for fixing of tools nuts, and grub screws.
5	Shaping	Shaping operations are done on guide blocks, fixed blocks, and punch, die.

The details of the fabrication are discussed in the diagrammatic representations of components with dimensions of the project are shown in the figure. The calculation part in fabrication involves the design of punch, design of die, design of shaft, design of cam, design of bolt, design of handle, determination of weld size, torsional and lateral deflection of shaft. Different set of readings can be taken by considering the sheets of gauges ranging from 17 to 32.

A) The spring back effect is to be taken in to consideration.

B) Sheets with gauge number more than 17 and less than 32 are to be checked.

C) The testing results are to be tabulated.

D) To avoid spring back effect over bending, bottoming, stretch forming and ironing are focused upon.

7 Spring back effect

Elastic stresses remaining in the bend area after bending pressure is released will cause slight decrease in the bend angle. Metal movement of this type is known as spring back and the magnitude of movement will vary according to material, thickness and hardness. A larger bend radius will cause greater spring back. Over bending is the simplest way of combating spring back problems, especially in V die bends. The work piece is bent through a greater angle than required and the work piece spring back to the required angle. Spring back for low carbon and soft-non ferrous materials is from 0 to 2. For 0.4 to 05 carbon steel and half- hard materials spring back may vary from 3 to 5. Harder materials exhibit more spring back effect. These figures should be used only as an approximation because of other variables that influence spring back.

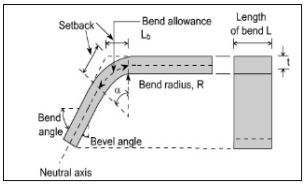

Fig 2. Bend parameters

The elastic stresses could be revealed by coining method. This is sometimes referred to as corner setting. The metal in the immediate corner is made to flow plastically and setup compression strains that overcome elastic stresses. Spring back can be prevented in wiping dies by ironing the material. To iron the bend effectively the distance between the punch and the die must be slightly less than the metal thickness. When severe ironing is required, a backup heel may be necessary to support the punch. Ironing at the corner will be effectively accomplished only by using the slight shoulder on the punch that contacts the work material near the end of the stroke. Severe ironing may cause the material to tear and will reduce the metal thickness depending upon the amount of interference between work piece and punch. The die may also be undercut to permit over bending when spring back is not too severe.

8 Specifications of machine

The following are the specifications of the sheet metal bending machine.

Table 2. Specifications

Type: Cam operated Sheet Metal Bending Machine		
Particulars	**Parameters**	**Dimensions**
Capacity	Length Thickness Bend Angle	294 mm 1 mm (19 Gauge) 90^0
Size of shaft	Diameter Length	34 mm 475 mm
Size of cam	Height Face Width	60 mm 25 mm
Size of guide block	Height Breadth Thickness	60 mm 50 mm 42 mm
Length of Machine	--	475 mm
Width of machine	--	150 mm
Height of machine	--	250 mm
Length of stroke	--	18 mm
Net weight of machine	--	52 Kg
Floor space required	--	475 x 160 mm^2

9 Results and conclusions

From the series of experiments conducted on different sheet metals of different gauges the following results were obtained. GI sheets were considered for experimental purpose and the results are tabulated in below table 3.

Table 3. Experimental results

Sample no	Gauge	Angle	Sample no	Gauge	Angle
1	32	99° 15'	9	24	95° 5'
2	31	98° 55'	10	23	94° 5
3	30	98°	11	22	93° 55'
4	29	97° 65'	12	21	93°25'
5	28	97° 45'	13	20	92° 65'
6	27	97°	14	19	92°45'
7	26	96° 5'	15	18	92°15'
8	25	96°	16	17	90°20'

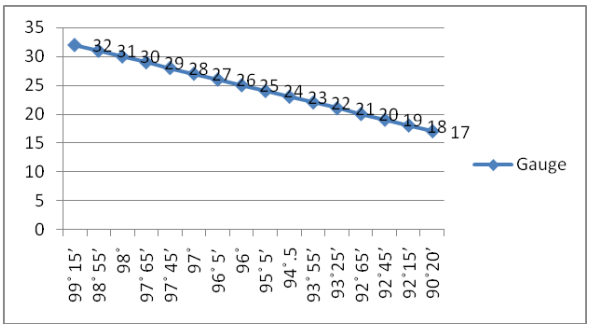

Fig 3. Gauge versus Angle of Bend

From the above results it is seen that the angle of bend is more or less than 90 but not exactly 90.This variation may be due to several reasons such as spring back effect which is material property .For accurate bending certain amount of bend allowance should be given and the bend materials cause more degrees of spring back where as softer materials cause lesser degrees of spring back. Thicker materials cause less degrees of spring back. Spring back can be prevented by over bending, bottoming, forming and ironing.

10 Applications

It can be used for different forming operations like V-bending, U-bending and punching can also be used to produce leak proof containers, various fabrication works depending upon applications and also for the basic workshop laboratory to bend the sheet metals.

11 Outcomes of research work

The Galvanized iron sheets are most commonly used in every sheet metal industries. The main focus is given upon the start up industries in rural areas. Low budget manufacturers cant afford to buy the expensive bending machines for simple works. In this project mainly the cottage and small scale industries are given prior importance. The bend angle aimed towards is 900. However because of the spring back effect slight variation will be observed. By over bending and bottoming the effect can be minimized.

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