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Design Development and Experimental Study of Pipe Bending Machine

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Abstract

The objective of this research paper is to present the new design and development of manually operated pipe bending machine which is useful to bend a pipes of different thickness in workshops as well as in engineering works. This paper gives the brief description about the design and construction of the pipe bending machine which is used to bend metal pipes into curve and the other curvature shapes, the size of machine is very convenient for portable work. It is fully made by steel. Moreover it is easy to be carry and use at any time and any place. It reduces human effort and also required low less skill to operate this machine. We designed manually operated pipe bending machine with use of dies, gears and support (frame). Our objective is to increase accuracy at low prize without affecting the pipe bending productivity. This machine works on simple kinematic system instead of complicated design. This machine can bend up-to 01-10 mm thickness of pipes. In this paper we study this machine experimentally in different workshops and as well as taken the readings at different degrees of bending which gives the opportunity to reduce cost of machine and to reduce the human efforts.

Keywords: *Bending dies, Tommy bar, Piston cylinder Metal Frame, Bending pipes*

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INTRODUCTION

The hydraulic bending press is one of the most flexible machines in the market, allowing the fabricator or iron worker to shear, punch, bend, scroll, and press thousands of different parts. When considering industrial machinery, the hydraulic bending machine is the perfect machine shop tool for the metal fabricator. The hydraulic pipe bending press fits any small to medium-sized industry when machinery for large-scale production must necessarily make way for machinery with distinctly lower production costs. The operating procedure of manually operated pipe bending machine is simple when compared to other pipe bending machine. Tube bending as a process starts with loading a tube into a pipe bender and clamping it into place between two dies, the clamping block and the forming die. The tube is also loosely held by two other dies, the wiper die and the pressure die. The process of tube bending involves using mechanical force to push stock material pipe or tubing against a die, forcing the pipe or tube to conform to the shape of the die. Often, stock tubing is held firmly in place while the end is rotated and rolled around the die. Other forms of processing including pushing stock through rollers that bend it into a simple curve. For some tube bending processing, a mandrel is placed inside the tube to prevent collapsing. The tube is also held in tension by a wiper die to prevent any creasing during stress.

A wiper die is usually made of a softer alloy i.e. aluminum, brass to avoid scratching or damaging the material being bent. Much of the tooling is made of hardened steel or tooled steel to maintain and prolong the tools life. However wherever there is a concern of scratching or gouging the work piece, a softer material such as aluminum or bronze is utilized. For example, the clamping block, rotating form block and pressure die are often formed from the hardened steel because the tubing is not moving past these parts of the machine. On the other hand, the pressure die and the wiping die are formed from aluminum or bronze to maintain the shape and surface of the work piece as it slides.

LITERATURE REVIEWS

Hiroyuki goto,Ken ichiru, Hidenobu saitro, Yuu ishikura,and Yutaka tanaka (2011). This research presents a new flexible bending machine and its practical applications. The proposed machine uses a new method. When tubes

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are fed into the fixed and mobile dies, they are bent by shifting the relative position of the mobile die. The bending radius is controlled by the relative distance and orientation between the mobile die and the tube.

Prashant Khandare, mayor Aher, Swapnil Patil (2013) in his research paper ―Study of Three Roller Bending Machine‖ concluded that Such type of bending machine more important for small scale work as well as industrial work in less cost and more precision and accuracy of different type of pipe bending. The machine capacity can be increased according to the need. Manual bending tends to minimize wrinkles and can reduce springbuck. By its design the defects can be easily overcome. Simpler design not only reduces the defects but also contributes to fluid pressure test during bending. It should be noted the tendency to wrinkle and the cross section of tube deformation are reduced.

Mohan Krishna S A (2014) ―Study of Hydraulic and Pneumatic bending machine‖ he concluded that this work has provided an excellent opportunity and experience, to use limited knowledge. It has gained a lot of practical knowledge regarding, planning, purchasing, assembling and machining while doing this project work. The work is a good solution to bridge the gates between institution and industries. The work is completed the work with the limited time successfully.



Fig: 1 Hydraulic Pipe bending machine.

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Amit Karamkar, Jayman Panchal, Jay Modi, (2015)‖Pneumatic Bending machine‖ concluded that, any manually operated machine can be converted to automatic machines by using pneumatic, electrical and electronic devices. For these purpose one should have the full know how of the devices which are being used. By doing so the existing old machines can be modified and made automatic by which the initial cost, to procure new automatic machines may be minimized. Thus there is a lot of scope in this area.

METHODOLOGY

Construction and Working Principle

The machine that was selected for manufacturing is the first modeled based on the Ensley tool machine. A large part of the for manufacturing was done using Reverse Engineering. First, using the internet and getting manuals for similar machines. Next, a similar model for the machine was studied thoroughly and their measurement was taken. Finally, a new design was implemented to overcome the problems of the large price and other problems of the original design.



Fig. 2



Fig. 3

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Implementations:-

- ***Maximum Stability:*** By comparing Ensley tools model which is fixed on a table to the one of Jesan Kovo, it is clear that the tripod fixation is not as stable as being fixed to a table. This is because when a force is applied on the jack arm; there will be a tendency for the whole machine to rotate over one of the tripod struts. Accordingly, by avoiding the tripod,

- ***Less Price:*** The price of the horizontal jacks in comparison to vertical jacks is very high (around 2000 L.E. for the horizontal to just 90 L.E. for the vertical jack with the same capacity—20 tons). Therefore, it is more economical to use the vertical bender.

Material Selection for the Machine Parts:-

Steel Material is chooses for the machine Part for the following reasons.

- Low Cost material
- Easy To Machine
- High strength Material Which can be withstand the load
- Long expected life durable
- Availability of the Material

Components Required For Machine:-

- ***Machine Frame:*** These are two identical plates between which the tube is supposed to rest. It should be strong and rigid so as not to move during the bending process, causing any of the previously mentioned defects.

- ***Rollers:*** They represent two points of the three points bending. They tube should rest on these rollers. Therefore, they should have additional mobility's (translation and rotation along its center line) to allow the sliding of the tube over them, else the tube surface will deform due to friction between it and the rollers. The slot engraved inside the rollers should fit the cross section of the largest tube section that machine is supposed to bend.

- ***Die:*** The die is the point of force application. It is circular sector with a slot engraved in it for the tube to rest on. The machine should have a special die set for each tube section.

- ***Hydraulic Jack:*** This is the source of the force. The used on is a 20 ton jack, however it should be used on a vertical direction. It total stroke is around 26 cm.

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- ***Others:*** Table, fixations between the bender and the table, fixation between the jack head and the die.

Working Of Pipe Bending Machine:-

As the jack moves upwards, the die moves until it meets the work piece. The three points in contact with piece; therefore bending starts. The jack gives a small feed of motion (2 mm per time). This is important because if its minimum feed was high, it could have caused sudden fracture. The small feed is an advantage because it gives a chance for very reliable and precision bending. The manufacturing of this Machine is done in the workshop and all the work is been done with the help of welding, drilling alignment and the lathe machine the different vies are shown in the figures of this Pip bending machine.



Fig: 3 Front view and the Top view of Pipe Bending Machine

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Above fig shows the front view and the top view of the Pipe Bending Machine in which consist of bending die attached to the piston cylinder and the which id fixed on the frame which is made up of cast iron and the steel material the frame consist of cross plates on which the circular holes are available to affixed the lever. When the manually pumping i.e. stroke will be given to the cylinder with the help of tommy bar attached to the cylinder then die will move in the upward direction and the bending pipe will be fixed in between lever and the die through which pipe will be bend in the direction given by the die attached.

We can use the different dies for the different degrees of pipe bending easily which we can use as shown in the fig.no 04



Fig: 4 Different Dies used for different degrees of Bending



Fig: 5 Vented oil bolt

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Operation and Handling Instructions:-

Before using, check the hydraulic oil in the cylinder by losing the vented oil bolt (fig. no .5) and visually ensure that the piston inside is covered in oil when the pipe bender is in the horizontal position.

Steps:-

1) Tighten release valve byturning clockwise.

2) Loosen vented oil bolt.

3) Grease die cover, swaging blocks and the tube to be bent.

4) Lift the upper plate and affix bending die to the end of the cylinder ram as shown in Figure 6. Place two swaging blocks into the holes of lower plate (Part# 54) and place tube in front of them. Turn the swaging blocks so their grooves face toward the tube die.

5) To account for the pipe shortening during the bending process, make sure the pipe extends beyond the swaging blocks.

Note: For short pipes, set the swaging blocks closer together, as shown in Figure 4, to ensure that the pipe extends beyond the swaging blocks to account for pipe shortening during the bend.

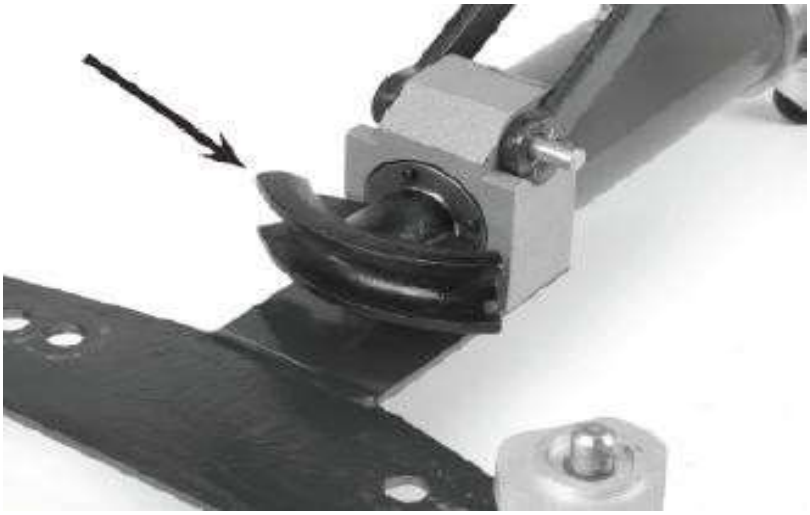

Fig: 6 Die Installed on Cylinder Ram

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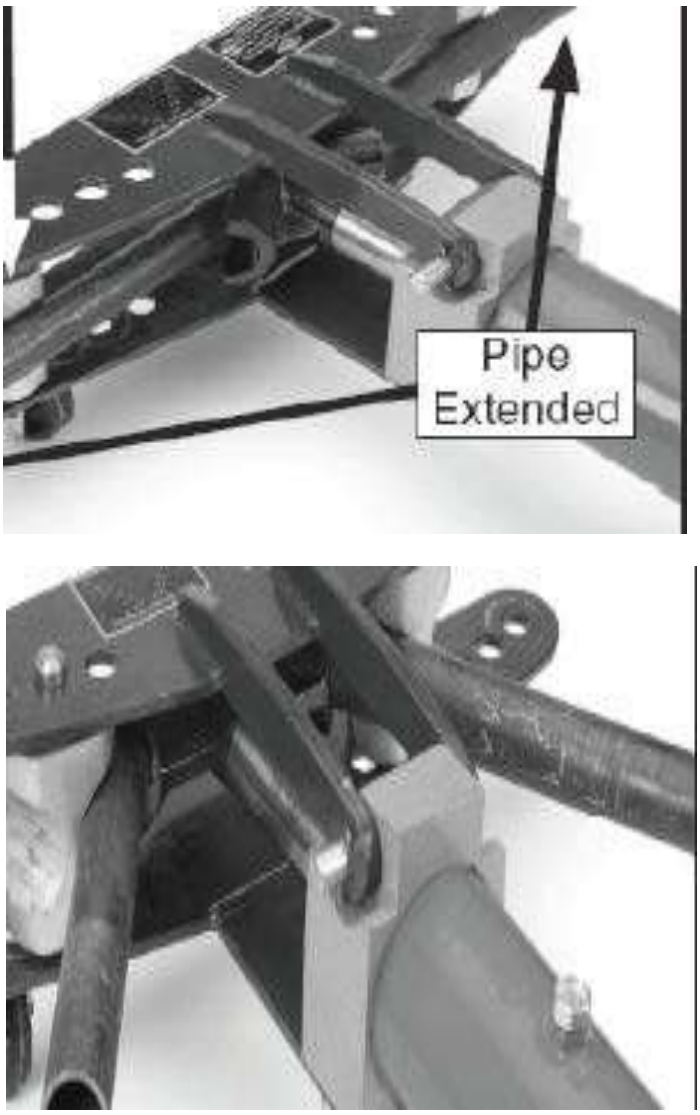

Fig. 7: Swaging blocks set close together for bending short pipes.

7) Return upper plate to original position and use the advance pump to quickly advance the die. Note: Only one handle is included with the bending machine. The picture below shows a piece of pipe being used as a handle in the advance pump. **See Fig 8 Below.**

8) Use the forming pump to apply heavy pressure to bend the pipe to its desired angle.

When finished bending, release the pressure by opening the release valve. The ram will automatically retreat. Lift the upper plate to take out the bent tube.

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After the manufacturing and the whole construction of this pipe bending Machine is studied by experimentally by bending the pipe at different lever holes position and calculated the no of stroke, piston displacement and the angle of bending pipe in degree as shown in the below table.

When lever pin at the different location of plate on bending machine i.e. at section a-a,b-b,c-c.

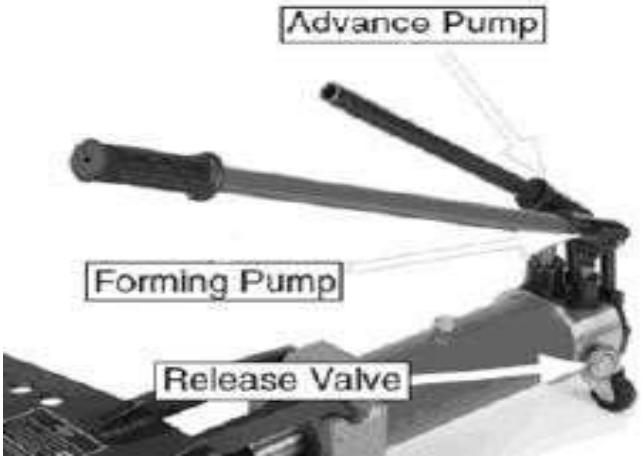

Fig: 8: Operating pump and release valve Table 1

Section a-a Lower hole			**Section b-b middle hole**			**Section c-c upper hole**		
No.of Stroke	Piston Displacement (mm)	Angle of Bending	No.of Stroke	Piston Displacement (mm)	Angle of Bending	No.of Stroke	Piston Displacement (mm)	Angle of Bending
04	3.2	4	-	-	-	-	-	-
07	4.7	13	7	4.7	14	-	-	-
10	6.1	21	10	6.1	21	10	6.1	18
13	7.4	30	13	7.4	30	13	7.4	30
16	9.0	36	16	9	36	16	9	41

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FUTURE SCOPE AND RECOMMENDATION

The scopes of the study are encompasses investigation of the difficulties in portable metal pipe bending machine. The investigation is starting with stating with the problem statements. The idea of designing a bending machine can be seen clearly through the problem statements, which is a solution of designing a bending machine can be generated to encounter those problems. From this investigation, a literature review can be conducted. In the literature review, it will discuss about the reason to design a bending machine for pipe bending, the comparison of existing bending machine, classification of bending machine, working principle of bending machine, etc.

The size of the plates used in the frames is heavy. Though it increases the machine stability, it should be considered to decrease the plate's thickness when implementing similar model. This may result in decrease in price.

DISCUSSION AND CONCLUSION

The machine can be run by one operator, but a second hand to help handle the pipe is recommended. It is also recommended that the angle be checked before and after performing the last bend to assure that it is correct. Keeping the ends of the pipe at the same level throughout the bending process is essential to keep ―spiralling‖ effects to a minimum. The replication of identical parts was achieved in a short amount of time, eliminating the need for the pipe to be shipped off for ―hot‖ bending work. The pivoting head acted like a vice, eliminating pipe slippage, and providing for safer operation.

This way we can conclude that successfully we manufacture the Low cost less effort required manually operated pipe bending machine is developed.

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