DESIGN AND FABRICATION OF PIPE BENDING MACHINE

A thesis report was submitted to the department of mechanical engineering for the fulfilment of the degree of Bachelor of Science in Mechanical Engineering.

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Abstract

Now a days Pipe bending a current developing process is an available service in the present market; however, each pipe bender has a different mechanism with its pros and cons. Automatic pipe bending machine is portable and can be mounted in a workshop, as part of production machinery or on the construction site to aid pipes, rods and angle irons bending operations to enhance productivity and early completion of projects. Pipe bending machines have passed through many enhancements, developments, and augmentations over time. Choosing a different type of bending for a pipe plays a critical role in industries, instruments, and transporting of fluids. The main concern is the required bend angle on which this pipe will bend on. The following report will include a description of the usability of this machine. The critical parameters that should be accounted for in the pipe bending are bend radius and angle, pipe diameter, and thickness. In addition, this machine is convenient, accessible and affordable.

APPROVAL

This is to certify that the project on **"Design and Fabrication Of Pipe Bending Machine"** By Md. Atikur Rahman (ID NO: BME1903019210), Md. Billal Hossain (ID NO: BME1903019030), Md. Almas Miah (ID NO: BME1903019134), Md. Habibur Rahman (ID NO: BME1903019211), Md. Anamul Haque (ID NO: BME1903019230), Afsana Hossain Ananna (ID NO: BME1903019175) has been carried out under our supervision. The project has been carried out in part to the requirements of the degree of Bachelor of Science (B.Sc.) in Mechanical Engineering in the year 2023 and has been approved as to its style and contents.

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Chapter 1
Introduction

1.1 Indtroduction

A pipe bending machine is a mechanical device that is used to bend pipes and tubes into various shapes and angles. These machines are commonly used in industries such as construction, manufacturing, and plumbing, where pipes and tubes of different materials such as steel, copper, and aluminum need to be bent for various applications.

Pipe bending machines come in different types, including manual, hydraulic, and electric models, and they are designed to handle pipes and tubes of various sizes and materials. Our project the pipe bending machine is a electric system. An electric pipe bending machine is a type of pipe bending machine that uses an electric motor to power transfer a shaft, which in turn, drives wheel or other bending components to deform pipes and tubes into various shapes and angles.

1.2 Organization of this project

This Project is organized as follows:

Chapter 1 Introduction: The first chapter contains the statement of the introduction, our background study for the project, the objectives of the study.

Chapter 2 Literature & Review : The chapter two contains our literature review part.

Chapter 3 Methodology: Chapter three describes the process of project & working principle .

Chapter 4 Design & Construction: Chapter four describe the Design & Construction our project.

Chapter 5 Results & Discussion: Chapter five is all about our project Results & Discussion

Chapter 6 Conclusion: Chapter six is all about our project Application, conclusion, limitation & future Scope.

1.3 Objectives

We have some specific objectives for this project and they are pointed out below:

- To Design and Fabrication of Pipe Bending Machine.
- To Study & Research
- To implement of Pipe Bending Machine.

Chapter 02
LITERATURE & REVIEW

2.1 Background

Pipe bending machines are very much utilized worldwide in industries to perform different types of functions on metal sheets. The size of these machines is very much significant as compared to the other machines..

The design of these projects is helpful for industries to minimize the cost of a specific project. The onset of the industrial revolution took place from the 17th century until the mid-18th. This revolution was the reason forthe existence of functioning machines today. The main branch of this revolution is manufacturing since it allowed the use of machines that significantly made daily human tasks much more accessible. Cold bending has been around since 1800B.C; it slowly developed until the industrial revolution in the 1760s'.

Figure 2.1: Pipe Bend

Many types of bending are available nowadays. A pyramidal type was chosen with a three-roller bending setup because of its various capabilities with just two degrees of freedom. The goal is to improve this type of process using analytical geometry and empirical techniques to achieve an ameliorated design. There are many types of bending techniques present now, but every type has its advantages and disadvantages. The rollers on the bottom are used to fix the work piece in a horizontal direction, and the upper roller will apply a downward force. The upper roller is adjusted using a hydraulic jack; thus, the roller only moves in the vertical direction. When defining the current bend angle, this clamp is locked.

The bottom rollers start to rotate, thus making a bending force Figure 1 on the work piece, which will result in deforming the work piece hence achieving plastic deformation. The main advantages of this process are that this mechanism is straightforward and straightforward. It can remedy the work piece that has been deformed in a wrong way, such as skew (Bending Error), accurate, consistent, and convenient. However, the disadvantages of such a process are unusable scrap parts. It occurs mainly in vertical three roller bending [2], which means if the pipe is long, due to its weight (work piece weight) while being rolled, it will bend to a side and cause torsion. Moreover, it is a type of manufacturing inaccuracy of unwanted deform action or deflection.

Our revolutionary life and inventions depend heavily on rolling part bearings. They are used in

nearly all rotary devices, assisting rotation and helping complex forces. If a rolling part bearing fails without being noticed and followed up on, it may have disastrous consequences for the system. We try to keep an eye on these critical components by measuring their temperature, noise, vibrations, and oil wears debris, among other things.

Vibration signals have proved to be extremely useful for maintenance workers, not just in detecting the location of a fault but also in finding the source. Input from vibration signals has lately been used to provide observers with an understanding of the scale of the fault and, as a result, to estimate the bearing's usable remaining life. On the other hand, vibrations picked up by accelerometers must go through a series of rigorous processing steps to extract fault symptoms and identify and quantify fault size.

2.2 Comparative Study

During the roll bending operation, the sheet or pipe is passed through a series of rollers that progressively add pressure to the pipe, as developed by Prof. A.D.ZOPE. The radius of the pipe or layer changes as a result of this friction. This project aims to create a portable metal bending system. This unit bends sheets into curves and other forms of curvature. In comparison to other computers, this machine is tiny. It is ideal for on-the-go jobs. We are working on a metal bending system that uses a metal shaft, a hydraulic bottle jack, a pedestal bearing, and a brace. Instead of a complex architecture, this computer uses a primary kinematic device. It can be used by a small factory, fabrication shop, or small-scale industry, and is lightweight and portable.

A bending machine is a machine that is used to bend metal in a machine shop. For bending a pipe, there is no suitable small-scale bending unit. Steel is bent using a roller in a Metal Bending rig. The bent machine has three rollers. Pipe (square and circular) bending and sheet bending are two of the most popular products of metal bending machines The board, plate, or pipe is passed through a series of rollers that progressively add pressure to the pipe during the roll bending operation. The radius of the pipe or layer changes as a result of this friction. Because of the different arrangements of the three rollers, the rolling process is usually done by a three-roll bending system, also known as a pyramid type. The procedure is divided into three steps:

The sheet or pipe must be properly positioned.

The central roller is lowered.

By repeating feed of pipe. (Ref-6)

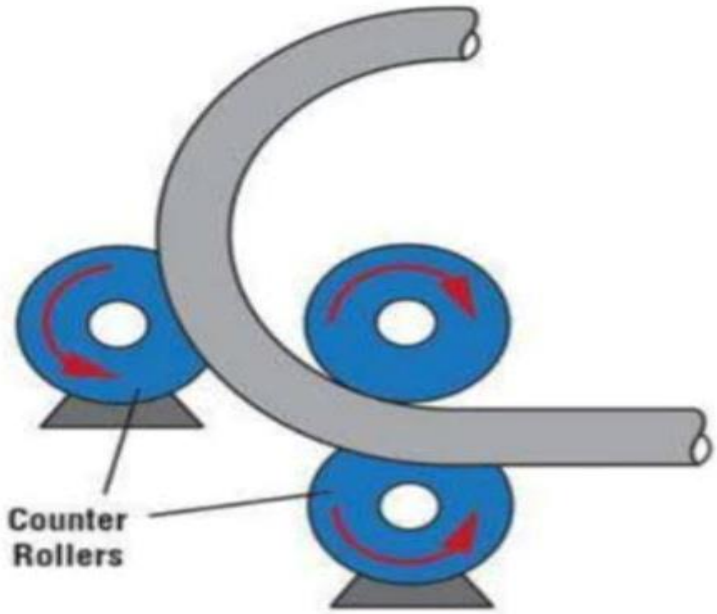

Figure 2.2: Block diagram of metal bending machine (Ref-6)

Anand Jayakumar, PhD all of this creativity has made it more attractive and cost-effective.It is beneficial to the building industry and specific other sectors. Bending is a method of deforming metal by plastically deforming the material and altering its shape. The substance is strained past its yield strength but not yet to its maximum tensile strength. Sheet metal and metal bars can all be bent with a roll. If a bar is used, the cross-section is considered uniform but not strictly rectangular, as long as there are no overhanging contours. Between the rollers, the bar section would take on the form of a cubic polynomial, which approximates a circular arc. The rollers are then rotated, which causes the bar to rotate as well. As a segment of the bar leaves the region between the rollers, theelastic deformation is reversed. To obtain the desired radius, this "spring-back" must be compensated when changing the middle roller. The sum of spring back is determined by the material's elastic conformity (inverse of stiffness) to its ductility. Steel bars are more difficult to fold into an arc than aluminum bars. Pumping may be done with the aid of a handle on the jack. The oil inside the cylinder assists the piston rod in moving upwards asthe handle is pressed once. A roller is fixed to the piston rod's tip. A pipe is held within these arrangements for the bending phase. This breakthrough has made them more appealing and cost-effective. This prototype, titled "ROLL BENDING MACHINE," was created in the hopes of being very cost-effective and beneficial to construction and other industries. (Jayakumar, 2019) P. P. Khandare et al. built a project to design and construct a compact pipe bending system that could turn steel pipes into curves and other shapes. It was simple to transport and use at any time and in any place, requiring less human labor and requiring a less trained workforce. It can bend pipes with a thickness of up to 4-5 mm, but it is only suitable for use in a small workshop or welding shop. (Ref-9,11)

This paper aims to create a roller bending machine used in a workshop to bend metal strips. This project aims to develop and construct a mobile roller bending system. Metal strips are bent into curves and other curvature forms using this unit. The machine's scale makes it ideal for mobile work. It is entirely made of titanium. Furthermore, it is simpleto transport and use at any time and in any place.

Figure 2.3: Manuel Roller Bending Machine

This computer requires less human effort and requires less ability to run. We are developing a manually controlled roller bending system through the use of rollers, chain sprockets, and assistance. The bending system for rollers is run by hand. As a result, our goal is to improve precision at a low cost without sacrificing bending efficiency. Instead of a complex architecture, this computer uses a primary kinematic device. It may be used by a small workshop or fabrication shop due to its portability. A bending machine is a machine shop instrument that is used to bend metal. (Pachange, 2019).

2.3 Types of Bending Machine

There are many kinds of bending mechanisms in our world. Some of these bending machines are given below –

2.3-1 Press Bending

Press bending is typically used for bending pipes or tubes with larger diameters and thicker walls, as the press can apply greater force to achieve the desired bend radius. It is also often used for bending pipes or tubes with complex shapes or multiple bends, as the press can be programmed to make multiple bends at different angles.

Figure 2.4: Press Bending System

2.3-2 Rotary Draw Bending

Rotary Draw Bending is the most complex form of bending and requires a toolset to execute. The tube is held by the clamp and pressure die, and rotated around the bend die. A mandrel and wiper support the inside and outside of the tube and help prevent wrinkles or flattening.

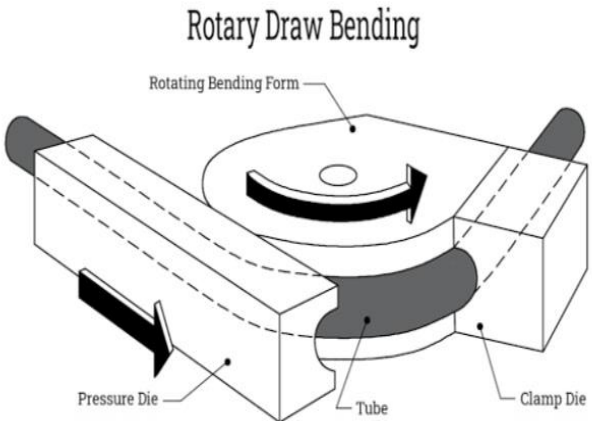

Figure 2.5: Rotary Draw Bending

2.3-3 Mandrel bending

In mandrel bending, a pipe or tube is clamped into a bending machine and a mandrel is inserted through the inside of the pipe or tube. The pipe or tube is then bent around a die, which is typically a curved surface that matches the desired bend radius. The mandrel helps to keep the inside of the pipe or tube smooth and round, preventing it from flattening or wrinkling during the bending process.

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Figure 2.6: Mandrel Bending

2.3-4 Roll Bending

Roll-bending is a process whereby we obtain cold process deformation with a wider bend radius that theoretically can range from 5 times the cross-section to infinity. To achieve this process, the equipment used consists of roll-bending machine July 3, 2018.

Figure 2.7: Roll Bending

2.3-5 Bending Springs

Bending Spring is a metallic, flexible spring used to bend PVC Conduit Pipes by providing them a stable internal structure needed to achieve a neat, distortion-free bend. One of the ends of the bending spring is tapered, while the other has a ring end.

Figure 2.8: Bending Springs

2.3-6 Heat Induction Bending

Induction Bending is a controlled means of bending pipes through the application of local heating using high frequency induced electrical power.

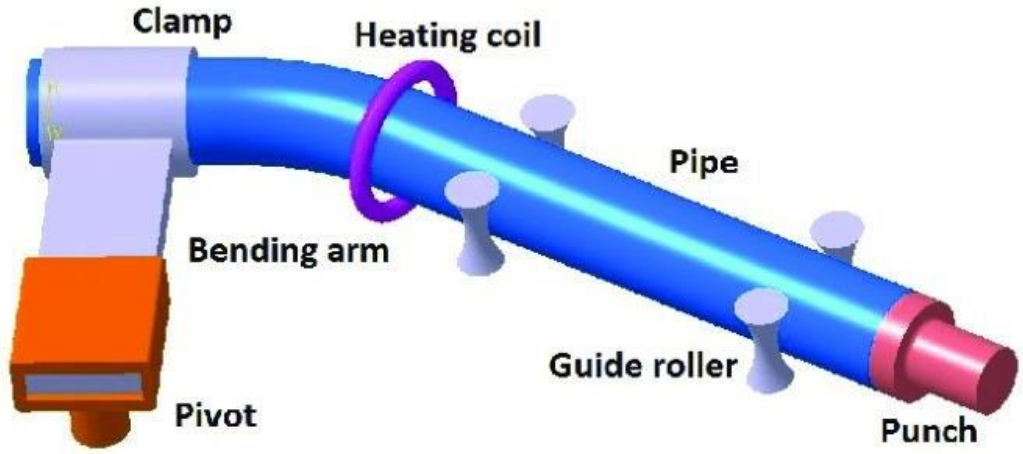

Figure 2.9: Heat Induction Bending

2.4 Review

Akbar Khan, Pravin Ghule, anjit Shingar[1] (2011) "Journal of Industrial Engineering and its application" is published a mechanical model of symmetrical three-roller setting round process to finding this way we can conclude that successfully we manufacture the low cost less effort required manually operates pipe bending machine is developed. (Ref-5)

A.D Zope, R R Deshmukh .D.R mete[2] published in ISOR Journal of mechanical and civil Engr IOSR-JMCE to determine a to develop portable bending machine used for bentsheet into a curve shape. This machine is very small in size compared to other pipe bending machines. These machines are used to bend up to 8mm thick sheets. These 3 roller used for bending machines in a paper on the design and development of metal bending machines.

Jun Zhao Gaochao Yu Rui Ma [3]"Journal Of Material Processing Technology" discovered a mechanical model of symmetrical three-roller setting round process to finding the mechanical model of these static bending deformations in the symmetrical three-roller setting round process is established, and the quantities relationship between the upper roller load, bending curvature of each micro-pipe-wall element and reduction are predicted. This not only lays a theoretic foundation for the development of the three-roller special setting round machine and control strategies, but also provides an idea for resolving many degrees of statically in determining problems with an elastic- plastic deformation. (Ref-3)

K. Chudasama & HK Raval [4] (2013) "journal of the manufacturing process" is published bending force prediction roll bending during 3 roller conical bending process. To determine As the thickness of the plate increase the bending force increase which is an obvious fact that it will require a higher force for bending

the thicker plate. As the rate of decrease in bending force increases as the radius increase, as has been observed. It is also observed that as the bend radius increase, the required bending force decrease for the same value of the coefficient of friction and the thickness of the plate. It suggests that a bend with a larger radius can be produced with less effort. (Ref-4)

Dhaval T sutar, Kiran R Malvi, Denesh k Patel[5] of "journal of research in mechanical Engr & technology" to determine a to Determine Final working of Rolling Pipe Bending machine. The current Machine Design Has The following feature.

Accuracy of operation

Cost & strength. The material used for the component of the machine is mild steel. Which is of considerable strength as well as of low cost.

Figure 2.10: Experimental bent tubes with large diameter (Hea, 2012)

Advances in exploring the typical problems in tube bending are summarized by studying bending characteristics and various defects, including wrinkling instability at the intrados, wall thinning (cracking) at the extrados, springbuck phenomena, cross-section deformation, shaping limit, and process/tooling configuration. The benefits and disadvantages of specific recently established bending techniques are discussed. Finally, the growth developments and related obstacles for realizing precise and high-efficiency tube bending deformation are posed in light of the urgent requirements for high- performance complex bent tube components with difficult to deform and lightweight materials in aviation and aerospace sectors. (Hea, 2012) (Ref-1)

Hiroyuki Goto and colleagues describe a new versatile bending machine and its implementations. The proposed computer employs a novel approach. Tubes are twistedby changing the relative direction of the mobile die as they are inserted into the fixed and mobile dies. Also, the relative distance and direction between the mobile die and the tube determine the bending radius. The length of the fed conduit determines the bent angle. This shaping method has a significant benefit. A variation in the anticipated bending form will not necessitate a tooling device change. However, it will necessitate a new understanding of the active die's motion and the length of the fed tube. A 6-DOF Parallel Kinematic Mechanism (PKM) with a hydraulic servo drive controls the active die motions. The PKM is used to achieve a full motion over six axes and a high dynamic (Ref-9)

motion of the bending machine. Designer interiors, universally manufactured goods, and car components are examples of where the bending machine can be used. These processes have previously been impossible to accomplish with a traditional bending system. (Goto, 2008)

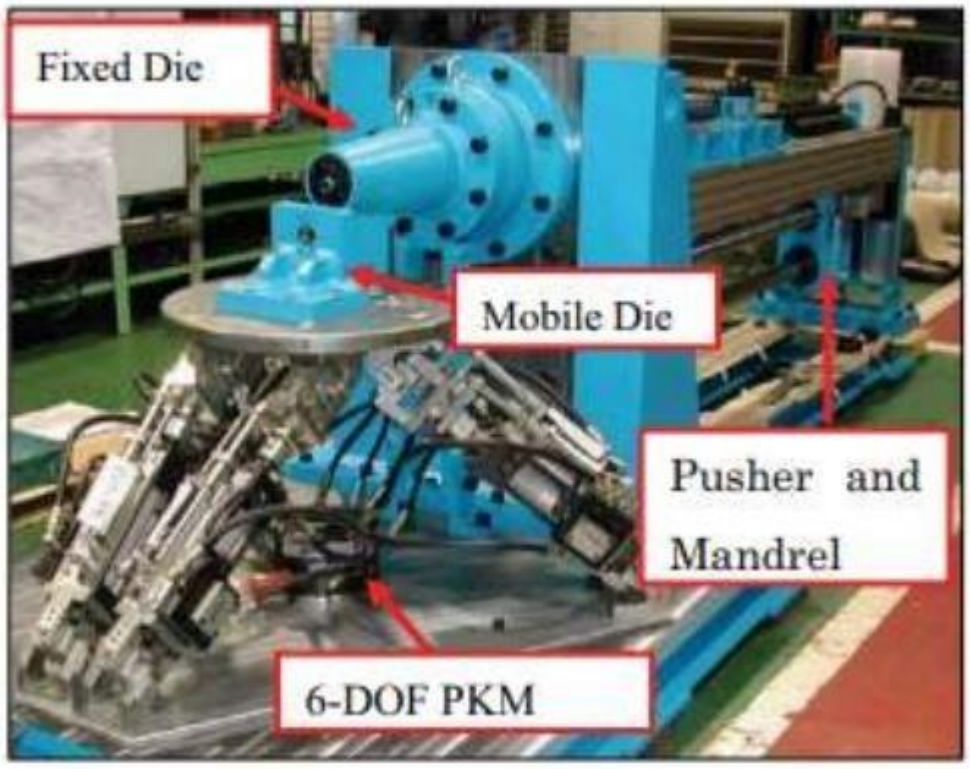

Figure 2.11: The Proposed Bending Machine (Goto, 2008)

A bicycle integrated pipe bending system was engineered and developed by H. A. Hussain. The unit has a chain drive and a compound gear train for bending steel pipe withan outside diameter of 25 mm and a thickness of 2 mm. The bending mechanism's kinematic synthesis is completed. It was decided to do a dimensional analysis. The deduced relationships forecast the efficiency of the bicycle integrated pipe bending mechanism, and all of the parameters must be adjusted to achieve the best machine performance. (Ref-7 & 8)

Chapter 3
Methodology

3.1 Process of Project

- First of all make a idea for the design and construction of a Pipe Bending Machine and designing a block diagram & structural diagram to know which components we need to construct it.
- Collecting all the components of our system.
- Setting up all the components and assembling all the blocks on a board and running the system.
- After completed the project finally checking & Manufacturing

3.2 Working principle

Pipe bending industry, a wide range of power machines are used. As the industry is a large and growing industry different types of machines are used for different operations. Our project the pipe bending machine is very simple in operation by using sprockets & chain arrangement with a motor. This machine produces round pipes of different diameters and lengths. This machine can be used in various fields. This machine consists of two sprockets and chain which is coupled with a motor and connects the rolling main shaft. This machine is simple in construction and working principles. The Bending Force is applied by electric motor Thus pipe is bent. For the desired diameter of the bending curve, the pulleys are changed or altered.

Chapter 04
DESIGN & CONSTRUCTION

4.1 Design

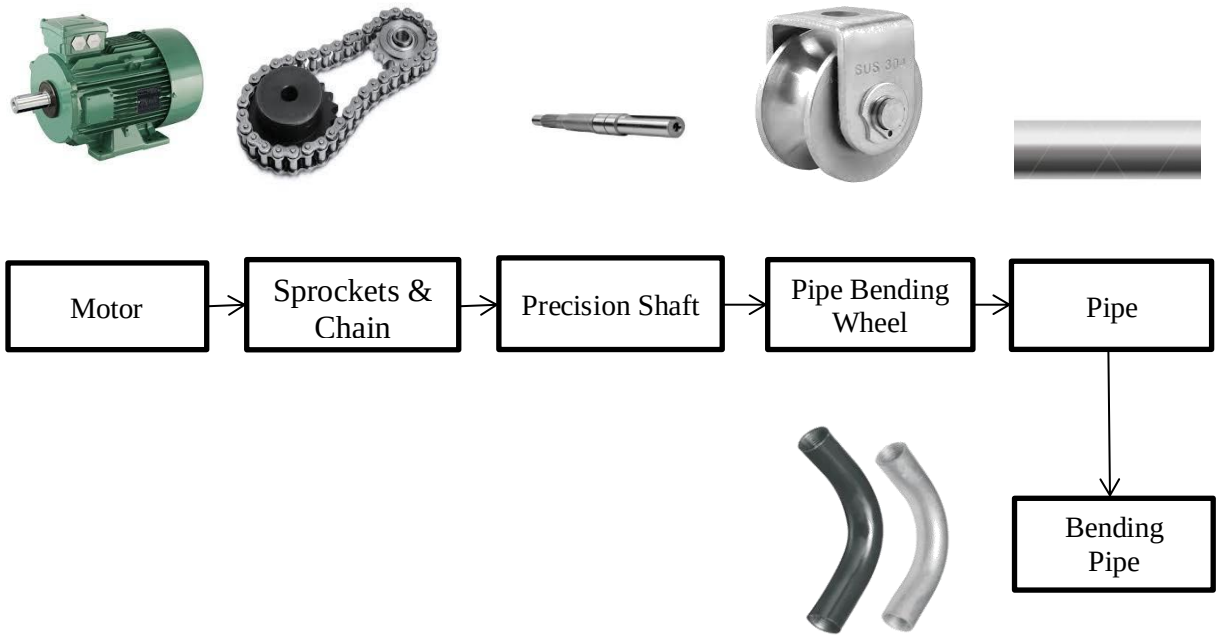

Figure 4.1: Our System Block Diagram

4.2 Required Equipment

- Sprockets
- Chain
- MS Steel Box
- Motor
- Pillow Block Bearing
- Precision Shaft
- Magnetic Switch
- Sensor
- Clutch Plate

- Relay Holder
- Pipe Bending Wheel
- U-Shaped Guide Wheel

4.3 Equipment Specification

SL No	Components	Specification
01	Frame	510mm x 510mm x 650mm
02	2 x Sprockets	230mm 20mm
03	Chain	Length 965 mm
04	MS Steel Box	38mm x 38mm
05	Motor	Power=200 watt and Speed=60 rpm
06	Pillow Block Bearing	Inner dia: 25mm ,Outer dia:35mm
07	Precision Shaft	Dia: 25mm, Length: 230mm
08	Magnetic Switch	220 volt, 3 phase,
09	Limit Sensor	Sensing limit 03 mm to 40 mm
10	Relay Holder	14 Point
11	Pipe Bending Wheel	Dia:65mm, Thick:39mm, Depth:33mm
13	U-shaped Guide Wheel	Dia:170mm, Thick:23mm, Depth:11

4.4 Construction

4.4-1 Frame

The frame of a bending machine is the main structural component that provides support for all the other components and withstands the stresses and forces generated during the bending process. It is typically made of high-quality steel or other strong materials that can withstand the weight of the machine and the forces involved in bending pipes.

Figure 4.2: Frame

The frame is usually designed to be rigid and stable, to minimize flexing and bending during operation. This is important for maintaining the accuracy and precision of the bending process, as even small amounts of flex or movement can cause the pipe to bend incorrectly.

4.4-2 Sprockets

A sprocket is a toothed wheel that meshes with a chain, belt, or other flexible transmission element. Sprockets are commonly used in industrial machinery to transfer torque and power from one shaft to another.

Figure 4.3: Sprockets with Chain

Sprockets come in a variety of sizes and shapes, depending on the specific application. They can be made from a variety of materials, including steel, aluminum, plastic, and composite materials. Some sprockets are designed to be lightweight and durable, while others are designed to handle heavy loads and high speeds.

Sprockets are commonly used in conjunction with chains or belts, which are wrapped around the sprocket and provide a flexible connection between the sprocket and another rotating component, such as a wheel or shaft. The teeth on the sprocket engage with the links on the chain or the teeth on the belt, allowing for smooth and efficient transfer of power.

4.4-3 Chain

A chain is a series of connected links or rings that are typically made of metal or other strong materials. Chains can be used for a variety of purposes including lifting, securing, transmitting power, and transmitting motion.

Figure 4.4: Chain with Sprockets

There are many different types of chains, each designed for a specific purpose. Here are a few examples:

Roller chain: A type of chain commonly used for power transmission in industrial applications. It consists of a series of cylindrical rollers connected by links and can transmit high amounts of torque.

Conveyor chain: Used for moving materials along a conveyor belt, these chains typically have larger, flat plates that make contact with the belt and transfer the material.

4.4-4 MS Steel Box

Steel is an alloy made up of iron with typically a few tenths of a percent of carbon to improve its strength and fracture resistance compared to other forms of iron. Many other elements may be present or added. Stainless steels that are corrosion- and oxidation- resistant typically need an additional 11% chromium. Iron is the base metal of steel.

Figure 4.5: MS Steel Box

Depending on the temperature, it can take two crystalline forms (allotropic forms): body-centered cubic and face-centered cubic. The interaction of the allotropes of iron with the alloying elements, primary carbon, gives steel and cast iron their range of unique properties. In pure iron, the crystal structure has relatively little resistance to the iron atoms slipping past one another, and so pure iron is quite ductile, or soft and easily formed. In steel, small amounts of carbon, other elements, and inclusions within the iron act as hardening agents that prevent the movement of dislocations.

4.4-5 Motor

A motor is a device that converts electrical energy into mechanical energy. It works on the principle of electromagnetic induction, where a magnetic field is created by an electric current flowing through a wire, which in turn produces a force that causes the wire to move.

Figure 4.6: Motor

There are several types of motors, each with its own unique design and function. Here are some of the most common types of motors:

AC motors: AC motors, or alternating current motors, are the most common type of motor. They are used in a wide variety of applications, from household appliances to industrial machinery. AC motors are powered by AC electrical current and can be either synchronous or asynchronous.

DC motors: DC motors, or direct current motors, are another common type of motor. They are commonly used in electric vehicles, robotics, and other applications where precise control over speed and torque is required. DC motors are powered by DC electrical current and can be either brushed or brushless.

4.4-6 Pillow Block Bearing

A pillow block bearing, also known as a plumber block bearing, is a type of rolling-element bearing used to support a rotating shaft or other moving parts. The pillow block bearing is a mounted bearing that is contained within a housing that has a bearing mounting surface parallel to the shaft axis.

Figure 4.7: Pillow Block Bearing

The housing is typically made of cast iron or steel and is designed to provide support and protection for the bearing. The bearing itself is typically a ball bearing or a roller bearing, and it is designed to handle radial and axial loads.

Pillow block bearings are commonly used in a wide range of industrial applications, including conveyor systems, agricultural equipment, and industrial machinery. One of the key advantages of pillow block bearings is their ability to support heavy loads while operating at relatively low speeds. They are also able to compensate for minor misalignments between the shaft and the housing, which can help to reduce wear and extend the life of the bearing.

4.4-7 Precision Shaft

A precision shaft is a type of mechanical component that is used to transmit torque and rotational motion in machinery and equipment. Precision shafts are typically made from high-quality materials such as stainless steel, hardened steel, or aluminum, and are designed to be highly accurate and reliable.

One of the key characteristics of a precision shaft is its dimensional accuracy and consistency. These shafts are machined to very tight tolerances, which ensures that they fit perfectly into the

mating components and operate smoothly without any wobbling or vibration.

Figure 4.8: Precision Shaft

4.4-8 Magnetic Switch

A magnetic switch is an electrical switch that uses a magnetic field to detect the presence or absence of a magnetic object or field. It works by using a magnet and a switch that are arranged in such a way that when the magnetic field is present, the switch is closed, and when the field is absent, the switch is open.

There are two main types of magnetic switches: normally open (NO) and normally closed (NC).

Figure 4.9: Magnetic Switch

A normally open magnetic switch will remain open until a magnet is brought near to it, at which point the switch will close. A normally closed magnetic switch, on the other hand, will remain closed until a magnet is brought near to it, at which point the switch will open.

4.4-9 Limit Sensor

Limit sensors are used in a wide range of applications, including process control, material handling, robotics, and factory automation. They are designed to operate in harsh environments, and are often used in applications where reliability and accuracy are critical.

Some common examples of limit sensors include end-

Figure 4.10: Limit Sensor

of-travel limit switches used in linear actuators, proximity sensors used to detect the presence of objects on conveyor belts, and limit switches used to detect the position of valves and other mechanical components.

4.4-10 Clutch Plate

An electromagnetic clutch plate, also known as an electromagnetic clutch disc or simply clutch plate, is a component used in electromechanical systems to transmit torque between a rotating shaft and a driven component. It consists of a flat plate made of friction material that is mounted to the driven component and a hub or central member that is mounted to the rotating shaft. The hub is designed to engage with the friction material when an electromagnetic field is applied to the clutch plate.

Figure 4.11: Clutch Plate

4.4-11 Relay Holder

A relay holder is a device that is used to securely mount and protect a relay in an electrical circuit. Relays are commonly used in many different types of electrical systems to control the flow of current, and a relay holder provides a stable and secure platform to mount the relay.

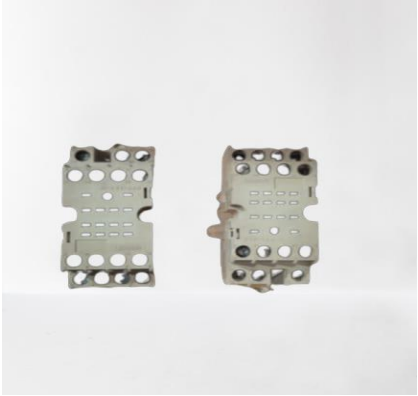

Figure 4.12: Relay Holder

Relay holders come in different sizes and designs to accommodate different types and sizes of relays. They can be made of different materials, such as plastic, metal, or ceramic, and can be designed for specific applications, such as automotive, industrial, or consumer electronics.

4.4-12 Pipe Bending wheel

Pipe bending wheel, also known as a pipe bending die or pipe bending form, is a specialized tool used in pipe bending machines to form pipes into specific shapes or angles.

The pipe bending wheel is typically made of hardened steel or other durable materials and is designed to fit onto the mandrel of the pipe bending machine. It is shaped to match the desired bend angle and radius of the pipe, which determines the shape of the finished product.

When a pipe is inserted into the machine and clamped in place, the pipe bending wheel is rotated around the mandrel, forcing the pipe to bend around it. The pressure and force of the bending process are carefully controlled to ensure that the pipe is bent to the correct angle and radius without kinking or cracking.

Figure 4.13:Pipe Bending Wheel

4.4-13 U-Shaped Guide Wheel

A U-shaped guide wheel, also known as a U-groove wheel, is a specialized type of wheel commonly used in industrial and commercial settings. It is designed with a U-shaped groove or channel in the outer circumference of the wheel, which allows it to guide and support a track or rail.

Overall, the U-shaped guide wheel is an important component in many industrial and commercial applications, providing reliable and efficient support and guidance along a track or rail.

Figure 4.14: U-shaped Guide Wheel

Chapter 5
Result and Discussion

5.1 Result

Finally, we were able to create our project successfully. After making the Mechanical body, we designed a circuit to control it and when we operated it, we called it working pretty well. It is very well controlled and can bend pipe very well. Below is a picture of our completed entire project.

Specefic pipe bending results (MS pipe)

Length of pipe: 500mm
Out diameter of pipe: 20mm
Inner diameter of pipe: 16mm
Thickness of pipe: 2mm
Bending Angle: 90 degree.

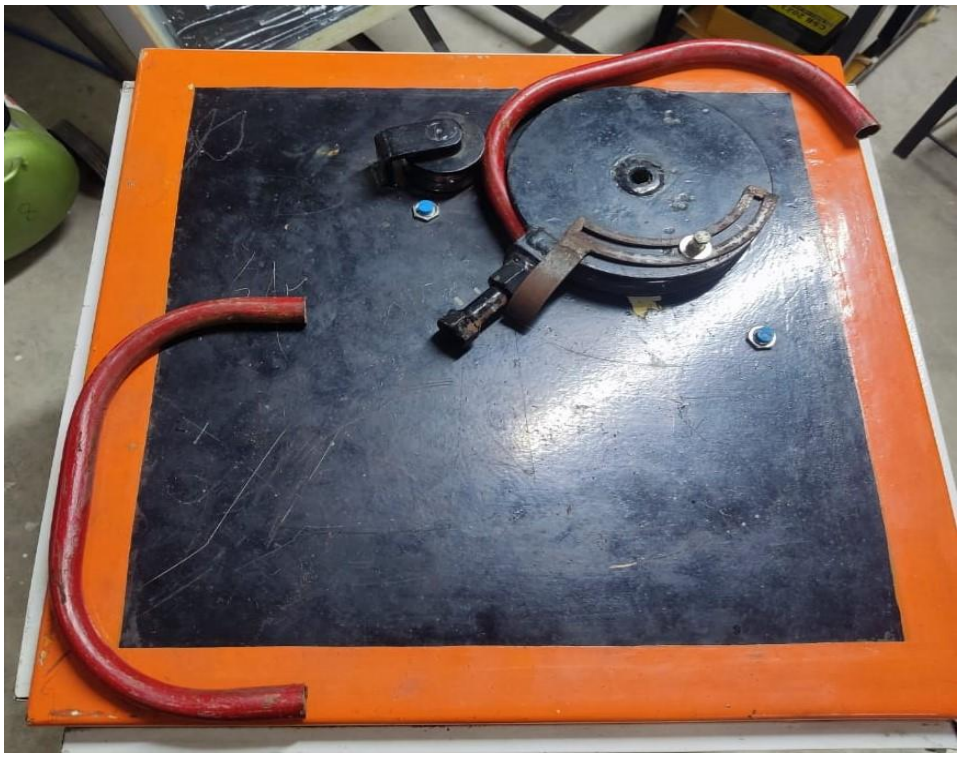

Figure 5.1: Bending pipe.

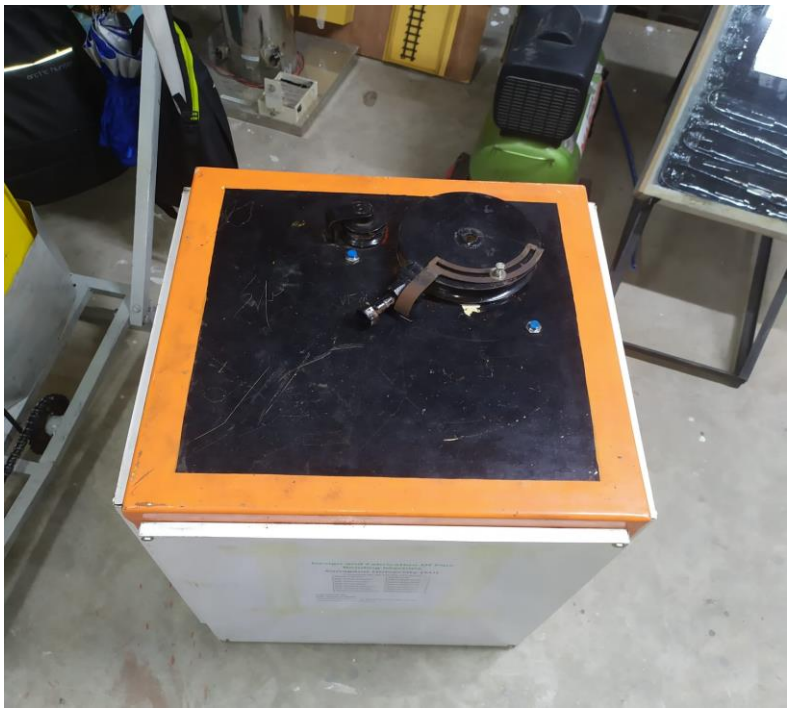

Figure 5.2: Complete Project Picture Top View

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Figure 5.3 : Complete Project Picture Side View

5.2 Discussion

While working on our project, we did face some difficulties as it is a very complex system but the results, we came up with were quite satisfactory. We have put the whole system through several tasks to validate our work and also have taken necessary notes for future improvements. Some future recommendations that we have involve improvement in system design and wiring, and adding features for more efficient.

Chapter 6
Conclusion

6.1 Application

Some of the application areas of the project have been pointed out below:

- Round Metal Bending
- U Shape
- Pipe Bending
- Tube Bending

6.2 Future Scope

By adjusting the roller guides on the bending unit, we can bend tubes and pipes. By incorporating various parts, the hydraulic bending system can be semi-automated and automated. Some of these future scopes are given below -

- In future we will be able to use different curves and different shapes of pipe.
- We will arrange this machine design by using two or more pulley arrangements.
- We can increase more productivity by using powerful motor.
- Movable stopper is used to give more accuracy.

6.3 Limitations

- We are installed1 set bending wheel shape so can bend a certain measures pipe or tube.
- Variations in the thickness of the material and wear on the tools can result in defect in parts produced.
- Material size & shape can be deformed .
- Unable to bend a large diameter pipe.

6.4 Conclusion

Electric pipe bending machines are an essential tool for various industries, including construction, automotive, aerospace, and manufacturing. They have numerous advantages over manual pipe bending, such as increased precision, speed, and efficiency.

One of the significant benefits of electric pipe bending machines is their ease of use. They are designed with user-friendly controls, making them accessible to both skilled and apprentice operators. Additionally, electric machines require minimal maintenance, which translates to reduced downtime and increased productivity.

With advancements in technology, we can expect electric pipe bending machines to become even more advanced, incorporating features such as automation, 3D printing, and environmentally friendly design. These innovations will continue to expand their applications and provide solutions for new industries.

References

[1] International Journal of Machine Tools & Manufacture.

[2] Dhavalsutar (2015) "International journal of research in mechanical engineering and technology"

[3] Jun Zhano Gaocgaoyu Rai Ma "Journal of Material Processing Technology"

[4] Chudasama (2014) Bending Force prediction for dynamic during the 3-rollerconical bending process. Journal of the manufacturing process.

[5] Akbar Khan & Pravin Ghule published "Design Development and Experimental Study of Pipe Bending Machine"

[6] A.D.Zope. (2017). Review paper on design and development of metal bending machine. *IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)* , 3.

[7] Goto, H. (2008). Applications with a New 6-DOF Bending Machine in Tube Forming Processes. *Proceedings of the 7th JFPS International Symposium on Fluid Power*, 7.

[8] Hussain, H. A. (2014). Design and Development of Bicycle Integrated PipeBending Machine. *Journal of Mechanical and Civil Engineering (IOSRJMCE)*, 6.

[9] Jayakumar, A. (2019). Design and Fabrication of Roll Bending Machine. *ISSN-2349- 5162*, 3.

[10] Roll bending machine July 2018-13