Low-Cost Automatic Cutting Machine

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***Abstract*— Cutting off is an essential first step in every manufacturing process, despite the fact that it does not contribute in any way to the value of the final product. Cutting is typically accomplished with instruments that are totally automatic; nevertheless, the expense of automation requires to be reduced in order to enhance productivity, accuracy, and efficiency. By utilising an electro-pneumatic circuit, a proximity sensor, and only a few moving parts, this is designed to reduce the amount of time that is spent in the cycle. The goal of the project is to identify issues that arise during the process of cutting sleeves from pipes, such as feeding, precision, clamping, power use, cycle duration, and the output, and to develop low-cost automated solutions to address these issues. The theoretical approaches will be used to design the most significant components of the system, and Catia will be used to create three-dimensional representations of those components.**

Keywords*— *Cutting off, Automation, Clamping, Productivity

I. INTRODUCTION

The operation of a typical cutting machine is depicted in Figure 1, which demonstrates that each stage in the process requires the assistance of a human. However, time and patience are required for the majority of the cutting process. As a result, a brand new cutting machine that can speed up the cutting process is required. During the cutting stroke and the return stroke, certain modern machines are able to automatically feed the work piece and bar stock to the stopper. Before beginning the cutting process, the machine clamps the bar stock and then releases it during the return stroke. The demand for low-cost automation in machines like these is being pushed forward by the presence of a proximity sensor that can recognise the work piece and automatically clamp, declamp, feed, and retract the cutter.

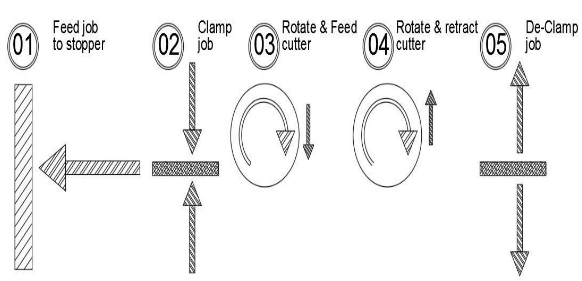

Fig 1. Conventional cutting operation

II. LITERATURE SURVEY

When cutting thin-walled steel pipe using the old approach, deform occurred, which had an adverse effect on both the dimensional accuracy and surface finish of the finished product. In order to solve this problem, there was an urgent requirement for modern equipment that was capable of delivering both great precision and productivity. Because of the nature of the cutting operation, the stainless steel pipe was put through a variety of stresses, including bending, shearing, and twisting. It would appear to be of the utmost importance to conduct research into the real strength of the items in question as well as their mathematical modelling in order to guarantee their safety and dependability. [1].

Other Case Study [2] describes in detail the design and analysis which occurred while developing the latest pipe cut technology. The existing method of cutting demands the employment of labour, which results in a significant loss of time. Furthermore, the amount of precision that could be achieved by using this typical approach was quite low. This piece of machinery is intended to automate the process in question, with the goals of alleviating labour problems, lowering costs, improving accuracy, and increasing reliability. The primary function of this high-tech cutting machine is to precisely cut wire into the number of pieces selected by the user. It is a simple machine that can be transported easily, and it was designed to provide for the lowest feasible prices for cutting procedures while also minimising the overall amount of time spent doing those operations.

Due to the convenient supply of compressed air in confined spaces, the pneumatic circuit was developed in order to address difficulties relating to a decrease of associated costs. A clamping configuration that is tailored to the unique needs of every job is made available. The rollers are there to make the supply of the pipes, which are powered by air motors, easier to accomplish. In order to regulate the climbing movement of the cut operation, a direction control valve is being put into service. [3, 4].

III. TEST SET UP

A 3D isometric representation of the work may be seen in Figure 3, while Figure 2 depicts the layout of the project. During the cutting process, a holder for the grinder is fabricated and mounted on vertical sliders so that the grinder can move along the Z-axis. In order to clamp the pipe, a pneumatic clamping cylinder is placed, and a Z-shape clamp is used to install the proximity sensor on its foundation framework. All of the air that enters the pneumatic system can be controlled individually by a 5/2 direction valve for control..

A longitudinal slider and a cutting feed mechanism are two of the many constructional characteristics that are included in this piece of equipment. Dual rectilinear bearings and another guiding mechanism make up its constituent parts. It also has an extensive array of helical compression spring as a part of its construction. The forwarded cut operation is carried out by use of a dual-operated pneumatic cylinder, with the air supply regulating the cutter feeding and a normal rapid motion being utilised for the reverse stroke. A piece of work is directed in a guide bars, and a pair of movable clamping is utilised for fastening work-pieces of varying sizes. [5-6]

Additional pneumatic cylinder is utilised to perform feeding, along with to a clamping cylinders that is utilised for clamping and release during the feed and hold processes. The task is recognised by a proximity sensor, which then triggers the pneumatic system. The output of a proximity sensor is connected to the input connector of the relay with eight pins, which then shifts the pneumatic circuit's output. [7]

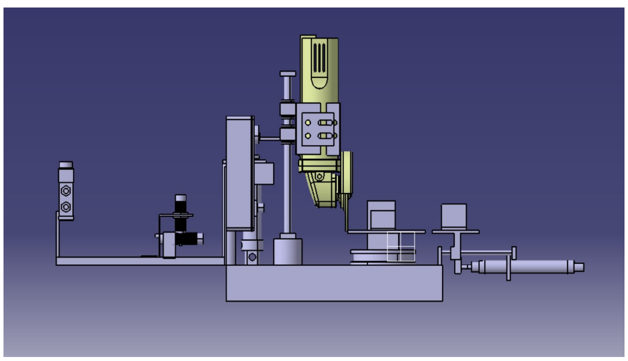

Fig. 2. The Layout (project work)

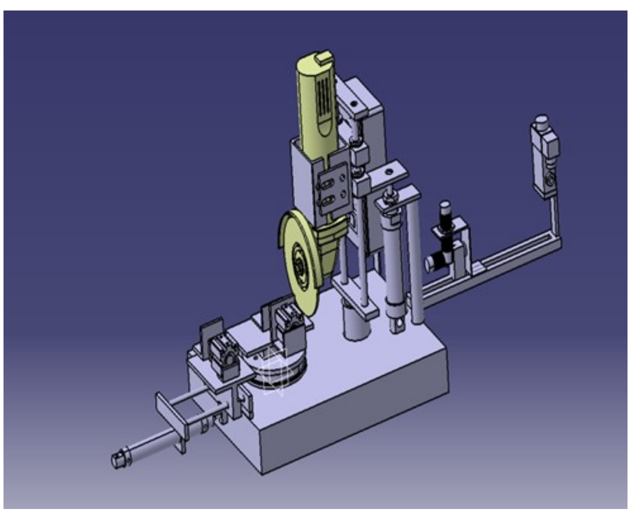

Fig. 3. Isometric Views

IV. Designing Methodol

A. Designing the circuit

Fig. 4 is a schematic of the circuit that was designed in order to accomplish the different tasks of clamp mode, cut, feed, and de-clamp autonomously. In order to do this, it requires a relay that is able to switch at specific intervals and take input. [8-10]

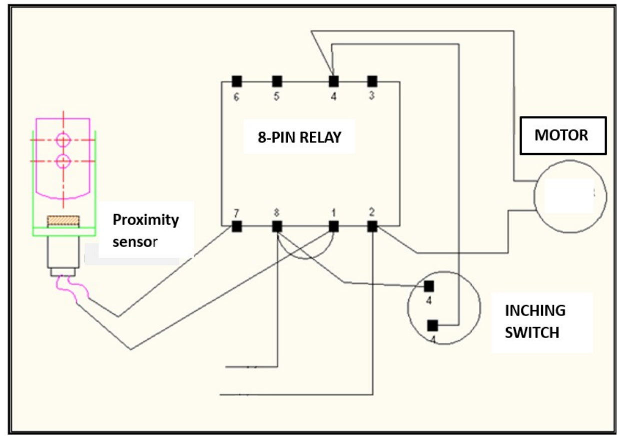

Fig. 4. Circuitry Designing

B. Crawling switch

Once the inching switch is activated, it permits temporary functioning of the motor by bypassing the proximity sensor and activating the motor instantly instead. This allows for more precise control over the motor's speed. Since it links among the proximity detector and the electrical relays, if this switch presses, it will trigger each of those parts to take on operational. This is due to what is linked between them. [9-12]

C. Proximity Sensors

Mounting the digital proximity detector to the metal sheet panels of the foundation framework requires the utilisation of a clamps in a shape of a Z. A sensor is intended to function like an indication in addition to determining whether or not an object is nearby. When something moves close to of the sensors, it sends a signal to the relay, which then begins the holding process and activates the pneumatic cylinder, which moves the cutter in downward motion. After cutting has been done, the relay will turn down and the cutter will go back to where it was before the cutting began. The relay also resets the clamping device so that it is in its initial setting. At the same time, the feed cylinders is activated and presses the pipe ahead, which enables the action of cutting to continue uninterrupted. [13-15]

D. To set the cylinder and choice

Following are the selection with certain assumptions:

Max clamp force	30 Newton
Avg. force required/assumed	27.3 Newton
Calculated area of cylinder	150 mm^2
Diameter	8 mm

Therefore, the type of cylinder that will be chosen needs to be chosen in such a way that the least effort that can be generated at a pressure equal to 2 bar (the working pressure for smooth engage and disengage) is greater than 30 N. In light of the fact that there is only one standard cylinder accessible, and taking into account the fact that 50% of the power is wasted in the friction, cylinder is chosen. [15-16]

E. Choice of the Motor for the Automated Transmission

The following are the parameters for the motor that was selected for the equipment that cuts wire: :

1 Phase AC Motor
Commutative motor
Completely Closed Fan-Cooled design
Continued varying speed range – (0-6000) rpm

The chosen motor is a 1-phase AC motor with an electronics speed variator that enables different speeds operating. By varying the supply of electricity to the motor brush, the power intake to the motor may be varied, which changes the motor's speed. Moreover, commutator motors, a kind of DC motors that are frequently employed in low-power applications. The TEFC structure shields the engine from moisture and debris.

V. Conclusions

Automating a manual pipe-cutt machine improves efficiency and reduces cutting time. After design calculations, CAD modelling, and other costs are calculated and approved, this will be the lowest-cost automated machine in the industry.

Single-phase AC motors with electronic speed variators are used. The motor's speed can be changed by changing the motor brush's current supply. Commutator motors are also used in low-power applications. TEFC protects the engine from moisture and debris.

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