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Development of Pneumatic Sheet Metal Shearing Process for Precise Cutting

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ABSTRACT

Scissors are employed for the purpose of performing uncomplicated sheet metal cutting. The manual process of working with sheet metals can result in occasional wastage due to errors, such as incorrect dimensions. Additionally, even a basic cutting task can be time-consuming. Sheet metal cutting can also be accomplished using hydraulic machines. However, this particular technique is exclusively employed for the purpose of heavy metal cutting and is associated with a substantial financial investment. A pneumatic system is being employed to facilitate the process of sheet metal cutting in a simplified manner. The device is operated through the utilization of a pneumatic hand lever that is connected to a two-way control valve. The control valve is actuated by a compressor.

1. Introduction

The process of cutting is included in virtually all of the manufacturing processes. Thus, we propose a pneumatic-based cutting machine that cuts small sheets and pipes instantly. Manual cutting machines waste time and aren't accurate enough for production. The pneumatic cutting machine always cuts at the same pace, ensuring consistent output. The machine has a pneumatic cylinder with a connecting link. Assembling this joint requires a cutter blade. With a bed, material can be supported horizontally in front of the cutter [1]. After assembly, a metal frame secures these parts. A circuit-controlled valve connects the pneumatic cylinder to a compressor. Pipes and valves connect this. The circuit has two pushbuttons. When one button is pressed, a single cut is produced, and when the other button is struck, automated cutting occurs at one-second intervals and the machine keeps running until the first button is pressed again to stop it. This pneumatic cutting machine demo automates industrial cutting [2]. Shear forces separate materials in the shearing process. This method removes material along a line or plane. Applying two opposing forces perpendicularly or nearly perpendicularly achieves this. Metal sheets are crucial to industry due to their many uses. Large enterprises employ inefficient hydraulic machinery to fulfil these operations [3]. Smaller and medium-sized firms often hand-operate sheet metal equipment. This situation benefits from pneumatics theory. This innovation cuts and punches metal sheets using compressed air-driven shearing blades and punches. It cuts and punches pneumatically. Machines cut 1 mm aluminium and 0.5 mm copper sheets [4]. Compressors, pipes, double-acting cylinders, actuators, and flow control valves are the main components of the developed pneumatic system. Aluminium is used in the automotive, packaging, and medical industries because it is durable and easy to make. Small and medium-sized firms cannot afford hydraulic machines [5]. This article discusses pneumatic sheet cutting machine design and construction. This equipment cuts and punches metal sheets with compressed air. This article discusses machine design and construction. Pneumatic sheet cutting machines are ideal for small firms in hazardous situations like oil and gas refineries and chemical industries [6]. These increase output, accuracy, and efficiency compared to non-automated sheet cutting machines. This study examines pneumatic sheet cutting machines' dependability, performance, and design simplification. Pneumatic shearing machines are essential for cutting materials in hazardous situations including oil refineries, chemical plants, and oil rigs [7]. Using a switch, these devices cut metal sheets quickly. Pneumatic sheet metal cutting machines are ideal for medium and small organizations due to their portability and small size. They slice aluminium sheets faster and safer than human cutting. Pneumatic sheet metal cutting machines are essential in the automotive, packaging, and medical industries due to their low-noise, easy-to-use, and reliable nature [8]. Hydraulic equipment is too expensive for small and medium-sized firms to maintain and operate. This pneumatically controlled cutting and punching machine uses pressurized air to drive a shearing blade and punch to cut and punch metal sheets. Introduce the machine. The new pneumatic system has compressors, pipes, a double-acting cylinder, an actuator, and flow control valves [9]. This machine's ability to perform two operations on one platform increases production efficiency and lowers costs. Aluminium is increasingly used in automotive, packaging, and medical industries. This enables mass-producing high-quality goods easier and cheaper. Smaller firms with limited workspace can employ pneumatic systems to cut sheet metal [10]. Pneumatic systems are more accurate, faster, and more productive than non-automated sheet cutting machines. Numerical models for sheet metal grades and shear parameter settings can accurately predict forces and sheared edge shape.

2. Motivation

The development of low-cost devices that are capable of running real-time applications has been made possible by recent advances in technology. Using low-cost pneumatic, sensor, and micro-controller technology, this article demonstrates a straightforward method for developing and constructing an automatic sheet metal cutting machine. The sheet metal cutting machine, which consists of straightforward hand cutters for the actual cutting operations, is the heart and soul of small-scale sheet manufacturers. Sheets of metal are necessary for several processes, including slicing, punching, blanking, bending, and trimming. The machinery used in large-scale businesses is often operated hydraulically, whereas the machinery used in small-scale industries is typically operated by hand. These devices can only be operated manually, thus they move at a snail's pace, and they can't be mechanized. Modern technology in the form of pneumatic sheet cutting machines has made the process of bending and cutting sheet metal much more time and labor efficient. It is crucial for technicians and engineers to have expertise on pneumatic systems, air-operated valves, and accessories. They are made up of a system for cutting blades, a double-acting pneumatic cylinder, an air compressor, a pneumatic valve to control the flow of air, and a frame to hold the machine in place in its working position. Sheet metal cutters that are pneumatic have a wide range of applications in industry as a result of their simple and straightforward operation, low cost, high level of safety, and good degree of dimensional precision. The primary objective of this investigation is to investigate and develop a method that is both secure and effective for cutting aluminium sheets at a rapid and consistent rate utilizing a pneumatic system. This will cut the costs of manufacturing and minimize the issues associated with industrial labor, which are the most significant concerns facing mankind. Pneumatic shearing machines have limitations in power, cutting capacity, noise, and vibration compared to hydraulic or electric alternatives. Regular maintenance, air supply requirements, and safety precautions are crucial to ensure optimal performance and minimize potential hazards. Insufficient or inconsistent air supply can negatively impact the machine's performance. Proper maintenance and operator training are essential to minimize risks and ensure the safety of workers. By utilizing a machine that is powered by pneumatics, the primary purpose of this project is to successfully carry out job holding operations while expending a reduced amount of human labor.

3. Methodology

Material Preparation: Before shearing, the material must be well cleaned, flat, and properly positioned in the machine.

The blade clearance—the distance between the upper and lower blades—is calibrated during shearing machine setup. The composition and thickness of the sheared material determine blade clearance.

Material Placement: The material must be carefully placed between the shearing machine's top and lower blades to align it with the shearing line.

Blade Motion: The upper blade descends while the lower blade remains stationary or ascends. To shear down the line, the blades are often inclined. The higher blade shears the material as it descends, while the lower blade stabilizes. When exposed to external forces, a material deforms and fractures along a shearing line. Shearing causes material separation. The waste or scrap material is underneath the blank or work piece. Depending on machine arrangement, shearing machine waste is removed manually or automatically.

Iterative Process: Shearing can be repeated to cut the workpiece to the desired size or configuration.

4. Construction

The following are diverse constituents associated with a pneumatic system utilized in machinery or industrial contexts. The following is a concise overview of each individual component:

The pneumatic actuator is a mechanism that transforms the potential energy stored in compressed air into kinetic energy, resulting in the generation of mechanical motion. Pneumatic actuators are frequently employed for the purpose of regulating or facilitating the movement of diverse mechanisms within a machine.

A crank is a mechanical apparatus comprising of an arm affixed at a perpendicular angle to a rotating shaft. This mechanism is employed for the purpose of transforming rotary motion into reciprocating motion, or conversely, reciprocating motion into rotary motion.

A shaft is a cylindrical metal rod of considerable length that facilitates the transmission of rotational motion or torque between different components. Within the context of a pneumatic system, it is possible to employ a shaft as a means of transmitting motion from the actuator to various components of the machinery.

A cutter blade refers to a tool characterized by a sharp edge, primarily employed for the purpose of cutting or shearing various types of materials. Within the context of a pneumatic system, it is possible to affix a cutter blade onto a mobile mechanism or activate it through the utilisation of a pneumatic actuator, thereby facilitating the execution of cutting operations.

A supporting bed serves the purpose of offering a stable foundation upon which different machine components can be mounted and supported. The primary objective of this mechanism is to guarantee optimal alignment and stability throughout the operational process.

Pneumatic pipes refer to conduits or tubing utilised for the conveyance of compressed air between different components within a pneumatic system. These components facilitate the necessary airflow for the activation of pneumatic actuators or control devices.

Pneumatic fittings serve as connectors that facilitate the joining of pneumatic pipes or hoses. Pneumatic system components are effectively interconnected through the utilisation of secure and impermeable connections.

Pneumatic valves are responsible for regulating the movement of pressurised air in a pneumatic system. The ability to initiate, cease, or modulate the flow of air is employed to govern the movement of actuators or alternative pneumatic apparatus.

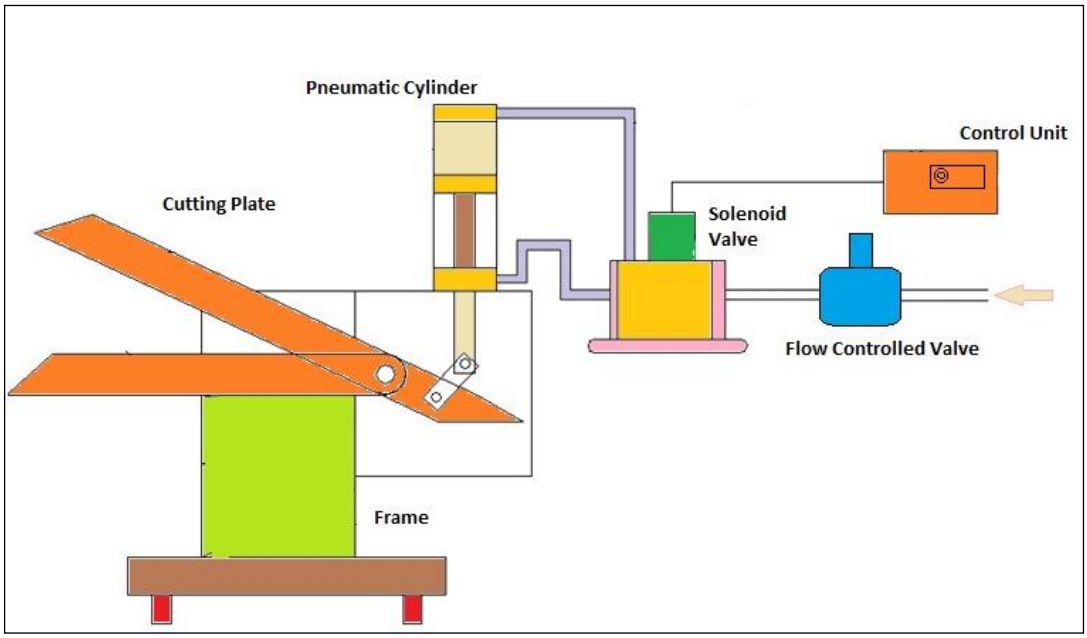
An electronic circuit can be defined as a complex arrangement of various electronic components, including resistors, capacitors, transistors, and integrated circuits, which are interconnected in a systematic manner to fulfil specific tasks or functions. Electronic circuits can be employed in pneumatic systems to regulate the functioning of pneumatic valves and other electrical elements.

Support and mounts refer to supplementary structures or components that serve the purpose of providing support and facilitating appropriate mounting for different components within a machine or pneumatic system. One of their primary functions is to maintain stability and reduce vibrations while in operation.

The integration of these various components results in the establishment of a functional pneumatic system, wherein the pneumatic actuator assumes the responsibility of regulating the movement of the crank, shaft, cutter blade, or any other associated mechanisms. The infrastructure and control required for the effective operation of the system are provided by the supporting bed, pipes, fittings, valves, electronic circuit, and support mounts.

5. Specification

A pneumatic cylinder is a mechanical device that utilizes compressed air to generate linear motion. The stroke length is equal to 150 millimeters. The diameter of the object is 50 millimeters. The pressure is equal to 10 bar. The sheet cutter has a length of 8 inches.



5.1 Operations

A table with support arms, stops or guides, upper and lower straight-edge blades, and a gauging device hold the sheet in the pneumatic machine. The table includes the two-way directional valve. Compressor-connected two-way directional valve. Compressor pistons move. A crankshaft connects the piston to a prime mover (electric motor, internal combustion engine). Air enters and leaves the chamber using valves. When the compressor starts, compressed air flows to the pneumatic cylinder inlet. The blades are separated by the sheet. The upper blade descends while the bottom blade stays put. 5–10% of sheet thickness separates the upper and lower blades. The upper blade is oriented to cut from end to end, decreasing force. The piston moves forward when the pneumatic hand lever is moved forward. The higher blade then cuts the sheet. When the pneumatic hand controlled lever is moved backward, the upper blade rises to its original position. After cutting, set the pneumatic hand lever to mid-position and turn off the compressor.

6. Conclusions

Shearing machines that are pneumatic offer a number of benefits, including adaptability, speed, precision, cost-effectiveness, and ease of use. Because they are able to cut through a wide variety of materials, including metals, plastics, textiles, and composites, they are useful in a number of different

industries. In addition to being faster, more accurate, and requiring fewer components, these versions are also more cost-effective than their hydraulic and electric counterparts. In addition to this, they call for a low level of operator training and can be utilised easily in a variety of environments.

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