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Design and Fabrication of Pneumatic Rubber Stamping Machine

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ABSTRACT
Pneumatic applications are increasing day to day. Nowadays most of the systems are rehabilitated into Pneumatic. This is due to the speed, accuracy and safety of Pneumatic systems, when compared to the rest. Till date the rubber stamping is done manually. It is for the reason that the content, size and shape of Rubber stamp may vary depending on the particular application. But no research is carried out for large measure of similar rubber stamping. In order to save the man power and to reduce the processing time the Pneumatic Rubber Stamping Machine is designed and fabricated.

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Introduction

Nowadays the science and technology growth rate is extremely high. Many innovations are arising these days. Most of the innovations are to enhance the speed, accuracy and safety of the existing model. Even though there are many methods to function the machines faster but pneumatic plays a major role. Greater accuracy can be achieved by using pneumatic systems. Unlike in hydraulics, here only the atmospheric air is used. Since the air is an inflammable medium, the safety of the system is ensured.

In this project electric solenoid valve is used. So there is no need to change the air direction manually. Also the electronic cyclic timer is used. By using this timer, the pneumatic cylinder can be operated from 0.6 seconds to 60 minutes. For paper removing process the simple rubber friction concept is used. The Pneumatic Rubber Stamping Machine will reduce the time delay and it will increase the accuracy.

Literature review

Pneumatic was used for many commercial as well as industrial applications. During literature review it is observed that many studies have been carried out to make the process automation using the Pneumatics like Pneumatic punching machine. But no study has conducted for design and fabrication of Pneumatic Rubber Stamping Machine. From the journal reviews, the procedure for design calculation and the data for fabrication were obtained.

Materials and methods

A. Pneumatic Cylinder

All Pneumatic cylinders uses the stored potential energy of a fluid, in this case compressed air, and convert it into kinetic energy as the air expands in an attempt to reach atmospheric pressure. This air expansion forces a piston to move in the desired direction. The piston is a disc or cylinder, and the piston rod transfers the force it develops to the object to be moved. Engineers prefer to use pneumatics sometime because they are quieter, cleaner, and do not require large amounts or space for fluid storage.

Because the operating fluid is a gas, leakage from a pneumatic cylinder will not drip out and contaminate the surroundings, making pneumatics more desirable where cleanliness is a requirement. Here, the double acting type pneumatic cylinder is used. In double-acting cylinders, air is used to push the piston one way and to return the cylinder to its default position, air is applied on the opposite side of the piston while on the original side, the air is allowed to exhaust.

B. Solenoid Valve

The solenoid valve is an electromechanical valve for use with liquid or gas. The valve is controlled by an electric current through a solenoid: in the case of a two-port valve the flow is switched on or off; in the case of a three-port valve, the outflow is switched between the two outlet ports.

Table I
Specifications of Solenoid Valve

Valve Type	2 Positions, 5 Ports
Applicable Medium	Air
Applicable Pressure Range	0.15 –0.18 MPa
Operating Method	Direct Action type
Maximum Frequency	5 Cycles / sec
Applicable Temperature	5 – 60^{o}c

Multiple solenoid valves can be placed together on a manifold. Solenoid valves are the most frequently used control elements in fluidics. Their tasks are to shut off, release, dose, distribute or mix fluids. A solenoid valve is normally closed if there is no flow across the valve in its resting position solenoid valve is said to be normally open when it enables fluid to pass in its resting position.

They are found in many application areas. Solenoids offer fast and safe switching, high reliability, long service life, good medium compatibility of the materials used, low control power and compact design. It may use metal seals or rubber seals, and may also have electrical interfaces to allow for easy control. A spring may be used to hold the valve opened or closed while the valve is not activated.

C. Electronic Cyclic Timer

The Electronic Cyclic Timer is an analog circuit which is basically provided with two conditions. One is Normally Open

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condition and the other is Normally Closed condition (i.e. NO and NC condition.)

The Electronic Cyclic Timers are used to control the process/operation with specified time interval of repetitive nature. It is basically a time-clock with an arrangement for on/off operation/process at predetermined specified time-intervals. They find applications in the control of sequential functions of industrial machinery at varying time intervals for plastic industries, pharmaceutical industries, petro-chemical industries, steel industries, power plants etc.

Table II
Specifications of Electronic Cyclic Timer

Operating Range	-20% to +10% of rated Voltage
Rated Frequency	50 Hz ± 5%
Control Output	5A @ 250V AC / 28V DC
Setting Accuracy	±10%max. ±100mSec
Repeat Accuracy	±1% max. ±100mSec
Recovery Time	100mSecs min
Variation due to Voltage Change	±2%max ±100mSec
Humidity	Max 85% RH@ 40°C
Electrical Connection	Screw type terminals with self-lifting clamps

The on time and off time parameters are settable. These can be adjusted and set simultaneously for both outputs or they can be set individually. The unit can be energized from external pulse or directly from power-on as the case may be. The outputs can be relay or solid state. Here the Electronic Cyclic Timer used can be operated from 0.6s to 60 minute. This timer can be used for 24V to 220V for both AC and DC current. Normally Open condition for the circuit connection is preferred.

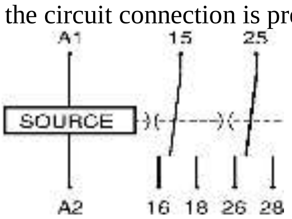

Figure I. Connection Diagram for Electronic Cyclic Timer

D. Air Compressor

An air compressor is a device that converts power (usually from an electric motor, a diesel engine or a gasoline engine) into kinetic energy by compressing and pressurizing air, which, on command, can be released in quick bursts. There are numerous methods of air compression, divided into either positive-displacement or negative-displacement types based on various requirements such as design and principle of operation, number of stages, pressure limits, capacity and method of cooling.

The Rotary compressor is used here. The piston is made up of automotive type low expansion aluminium alloy. The cylinder is made up of special cast iron, deep finned for quick heat dissipation.

Value plates are made up of special stainless steel material for high resistance and efficiency and also for self-floating. Inter cooler is made up of deep finned aluminium alloy to keep the temperature low and to minimize the formation of carbon. Crank shaft is made up of carbon steel and dynamically balanced with the roller bearing.

Design Calculation

Measured Values

Atmospheric air pressure, P_1=101kPa (absolute)
Pressure at pneumatic cylinder, P_2= 687kPa (gauge)
Piston diameter, d= 0.0445 m
Piston stroke, L= 0.152m
Available flow rate, Q_1= 0.18444 m^3/min

Calculation of Flow Rate Consumed By the Cylinder, Q_2

$Q_2/Q_1 = (P_1/P_2)*(T_2/T_1)$ -------------------------- (i)
where,
P_1= 101kPa (absolute)
P_2= 687 + 101
P_2= 788kPa (absolute)
Assume temperature is constant.
$T_1=T_2$
Q_1 = 0.18444 m^3/min
Substitute the above values in equation (i),
$Q_2/0.18444 = (101/788)*(T_1/T_1)$
Q_2 =0.1844 x (101/788)
Q_2 =0.1844 x 0.12817
Q_2 =0.02364 m^3/min
Flow rate consumed by the cylinder,
Q_2 =0.02364 m^3/min.

Calculation of Reciprocating Rate of Piston

Flow rate consumed by the cylinder =Area of Piston x Piston Stroke x Reciprocating Rate
i.e., Q_2 = A x L x Reciprocating Rate------------- (ii)
where,
Flow rate consumed by the cylinder,
Q_2 =0.02364 m^3/min
Piston stroke, L= 0.152m
Piston diameter, d= 0.0445 m
Piston area, A= (π/4) x d^2
= (π/4) x 0.04452 = 0.00156 m^2
Substitute the above values in equation (ii),
Q_2 = A x L x Reciprocating Rate
0.02364 = 0.00156 x 0.152 x Reciprocating Rate
Reciprocating Rate = 0.02364 / (0.00156 x 0.152)
= 0.02364 / 2.3712 x 10^{-4}
= 99.696 cycles/min
Reciprocating Rate = 1.667 cycles/sec

Calculation of Stroke Speed

Stroke speed = Stroke length / Time taken--------- (iii)
Stroke length, L= 0.152m
Time taken, t= 0.3 sec
Substitute the above values in equation (iii),
Stroke speed = 0.152 / 0.3
Stroke speed = 0.5067 m/sec

Calculation of Number of Rubber Stamping

One rubber stamp can be made from one reciprocating motion of the piston. i.e., Reciprocating rate is equal to the Number of rubber stamping. From the calculation it is observed that within five minutes the rubber stamping can be made for a ream of paper.
Reciprocating Rate = 100 cycles/min
Number of Rubber Stamping per minute = 100

Construction

The Pneumatic Rubber Stamping is constructed by using various components namely air compressor, air tank, solenoid valve, electronic cyclic timer, double acting pneumatic cylinder and electric motor and assembled as shown in the block diagram.

The air tank is mounted with the air compressor. The solenoid valve, electronic cyclic timer, double acting pneumatic cylinder are placed in a separate stand made of cast iron. To prevent the accidental electric shock, all the circuits are covered with a wooden box. The papers to be stamped can be placed in a paper tray which is also connected with the paper removal mechanism.

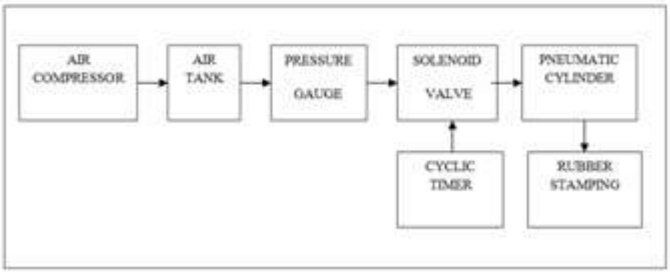

Figure II
Block Diagram of the Pneumatic Rubber Stamping Machine

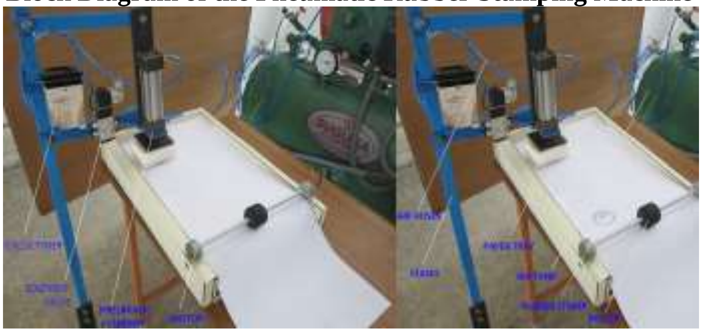

Figure III
Fabricated Model of Pneumatic Rubber Stamping Machine

E. Working Methodology

The air compressor converts power into kinetic energy by compressing and pressurizing air. The compressed air is stored in an air tank which is mounted along with the air compressor. The pressure is measured by using the pressure gauge which is fitted with the air tank. Then by using air hoses the air is allowed flow from tank to pneumatic cylinder through the solenoid valve.

A solenoid valve is an electromechanical valve for use with liquid or gas. The valve is controlled by an electric current through a solenoid. It is a two-port valve the flow is switched on or off. The Electrically operated solenoid valve is controlled by the electronic cyclic timer. In the Timer time can be varied from 0.6 seconds to 60 minutes by using cyclic timer as per our requirements.

Pneumatic cylinders use the stored potential energy of a fluid, in this case compressed air, and convert it into kinetic energy as the air expands in an attempt to reach atmospheric pressure.

At the end of the piston in pneumatic cylinder, the rubber stamp is attached by using the spring. The ink can be fed into the rubber stamp before starting the operation. Refilling the ink for the rubber stamp is very easy. The single refill can be last up to 500 stamping. The paper can be removed by using paper removal mechanism by the application of friction concept. The speed of the stamping can be adjusted by using the electronic cyclic timer and also the speed of the motor can be adjusted by using the regulator.

F. Conclusion

The Pneumatic Rubber Stamping Machine is designed and fabricated as per the calculated design procedure. The fabricated product is checked under various conditions to improve the accuracy of the product. In future, by designing a special sensing device the accuracy of the system can be improved.

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