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Design of Real Time Multistationed Table

N. Lenin Rakes* and A. Ashok Kumar

Department of Mechanical Engineering, Bharath University, Chennai – 600073, Tamil Nadu, India;
leninrakesh.mech@bharathuniv.ac.in, ashokkumar.mech@bharathuniv.ac.in

Abstract

This project describes a real time multi stationed INTERMITTENT FEEDING ROTARY INDEXING TABLE which can be used for drilling, tapping and inspecting a standard block of size 10 X 65 mm. The positioning of the component, part transfers are done using pneumatics. The total logic of the system is based on low cost automation with pneumatics.

Keywords:

1. Introduction

Rotary indexing tables are used to index parts and components in defined, angular increments so that they can be machined, worked or assembled in multiple operations. Tables consist of a circular steel plate, one or more spindles, a drive system and pins that hold parts and components in place. Rotary indexing tables have either fixed or adjustable indexing angles. During each revolution, the table stops for a specified period of time so that an operation can be performed at each station. The bearings that support rotary indexing tables determine both the load capacity and accuracy. Angular contact bearings are more expensive than recirculating ball bearings, but provide better load capacity and axial stiffness. Cross-roller bearings are also commonly available. Rotary indexing tables are powered by pneumatics. Drive mechanisms can be located above, below, behind or to the side of the table surface. Pneumatic rotary indexing tables are suitable for small and medium loads. They are powered by one of more pneumatic cylinders, each of which represents an index. During the return stroke, a pawl locks the table in place. With some devices, the pawl can be adjusted to change the number of indexes.

2. Experimental Setup

A real time multi stationed INTERMITTENT FEEDING ROTARY INDEXING TABLE working setup was being fabricated. Loading and unloading of a standard block of size of 10 X 65mm was performed using above set up[1]. The setup consists of four-stationed body fabricated using mild steel. The rotating disc is fitted to a stepped shaft which is supported by bearings held in a bearing housing. It is centrally fitted to the axle. The pawl and ratchet mechanism was used for rotating the indexing table, where four stations are arranged[4,5]. The indexing mechanism is achieved through limit switches for every 90°. The positioning of the component, part transfer is done using pneumatic actuators. The total logic of the system is based on low cost automation using pneumatics[2]. Rotary indexing tables are the main type of carriers that can pass through at least two and up to more than 20 machining operations, reduce the overall feeding functions of the production sequence to the minimum. Loading and ejection are limited to the first and last stations respectively.

The drive for the rotary table motion is through an actuator – pneumatic cylinder which rotates the ratchet through a lever. Flow control valves are connected to the

* *Author for correspondence*

actuator to reduce the speed of the actuator[6–8]. Based upon the following design calculations, the rotary indexing table is fabricated.

Mass of the disc	= 12.32 Kg
Force acting on the ratchet	= 6.29 N
Torque acting on the shaft	= 1.57 Nm
Peripheral force	=19.62 N
Width of the ratchet	= 3.92 mm

3. Working

The work piece is initially stacked in the hopper. The operation starts with the feeding of blank from the hopper to the indexing table and being placed at the slot. When the start button is pressed, it actuates a two way Direction Control valve (DC) which actuates a single acting cylinder that releases the indexing lock. At the end of the unlocking stroke, a limit switch is triggered which then actuates double acting cylinder (1) that rotates the ratchet through a lever. Now the indexing occurs and at the end of the forward stroke of double acting cylinder (1), a limit switch (L2) is actuated with which double acting cylinder (1) comes to its return stroke and it triggers limit switch (L3) which actuates another double acting cylinder (2) which unloads the component on the indexing table. While unloading, a limit switch (L4) is triggered and double acting cylinder (2) comes for a return stroke. A single sequence of operation is finished.

Similarly, start button is pressed for every sequence of operation. Automation can be done on the rotary indexing table by adding a shuttle and timer valve to the pneumatic circuit.

4. Pneumatic Circuit

The pneumatic circuit comprises of a single acting and two double acting cylinders, a two way DC valve and two 5 port DC valves, flow control valves, pressure relief valve and compressors. Double acting cylinders are used for rotating the ratchet and unloading the block on the work table. Single acting cylinder is used for indexing the rotary table. 5/2 valves are used for controlling double acting cylinders and 3/2 valves are used for single acting cylinders. Flow control valves are used to control the speed of actuation of cylinders responsible for rotating the ratchet. Other accessories such as pressure relief valves are used for specific purposes[3].

5. Design Calculation

5.1 Calculation for Mass of the Disc

Mass of the disc = $(\pi d^2 * t * gravity) / 4$

Where Diameter (d) = 500mm

Thickness (t) = 8mm

Mass of the disc = 12.32 Kg

5.2 Calculation for Force Acting on the Ratchet

Kinetic energy:

$\frac{1}{2} I\omega^2 = f * d$

$\omega = V / r$

Where V= linear velocity

$f = (\frac{1}{2} I \omega^2) / d$

Where, ω –Angular velocity (rad/sec),

d – Distance (mm),

I – moment of inertia (Kgm^2).

$f = \frac{1}{2}\ 1.25 * 0.8 / 0.127$

f = 6.29 N

5.3 Calculation for Torque Acting on Shaft

$T = r_* f$

Where T– Torque (Nm),

r – Radius of the rotary table (mm),

f – Force (N).

T = 0.25 * 6.29

T = 1.57 Nm

5.4 Calculation for Width of the Ratchet Teeth

b = P / p

Where b – width,

P – Peripheral force (N),

p – Permissible linear unit pressure (N/mm).

$P = 2M_t / zm$

Where m – module,

M_t – transmitted torque (Nm),

Z – Number of teeth.

$m = D/z$

Where D- tip circle diameter of ratchet (mm).

$m = 162/40$

$m = 4$

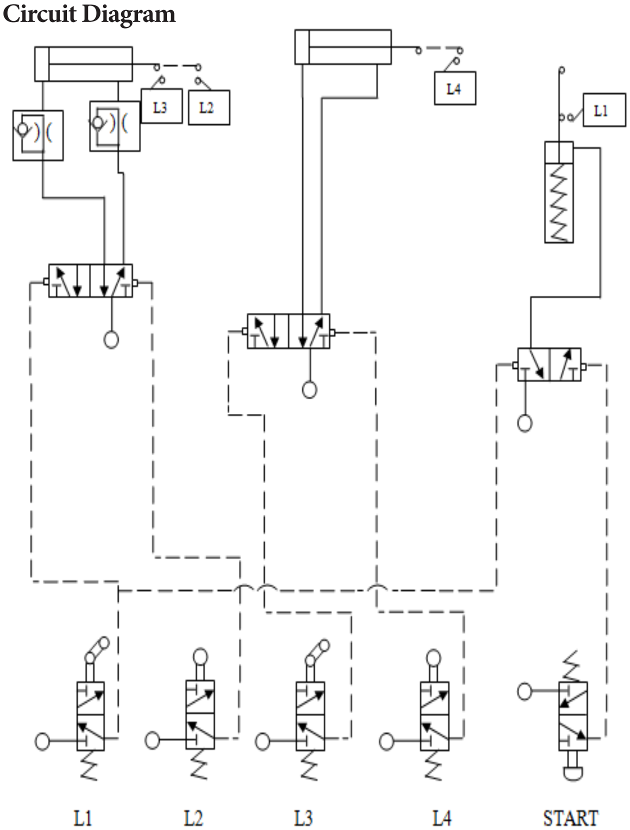
$P = 2*1.57*10^3/40*4$

P =19.62 N

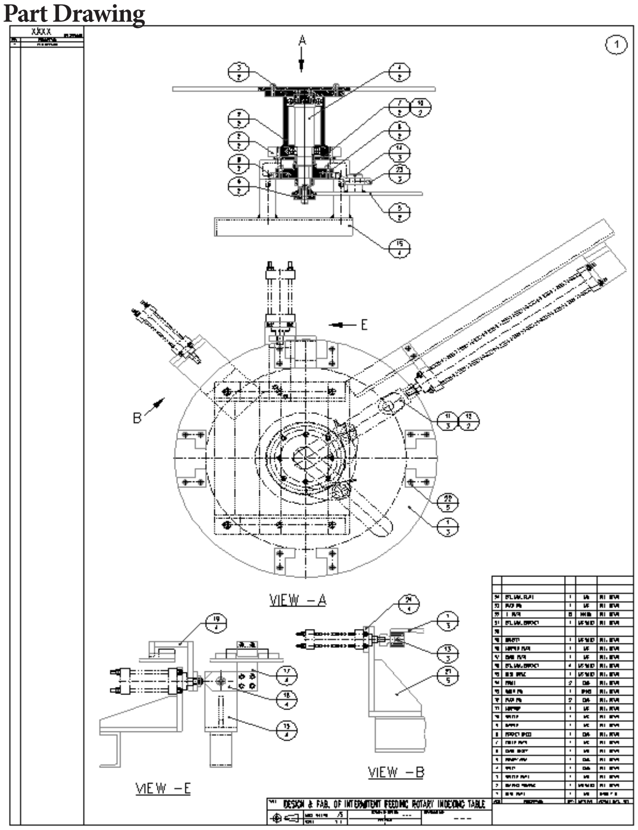
b = 19.62/50

b = 3.92 mm

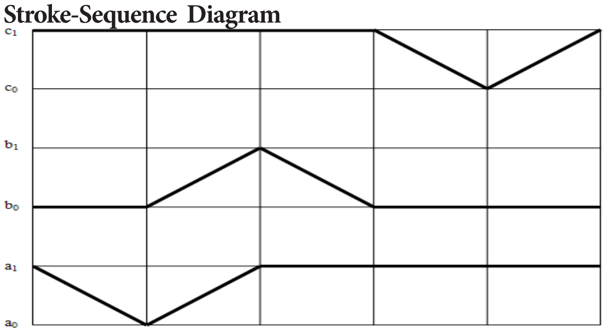
Circuit Diagram



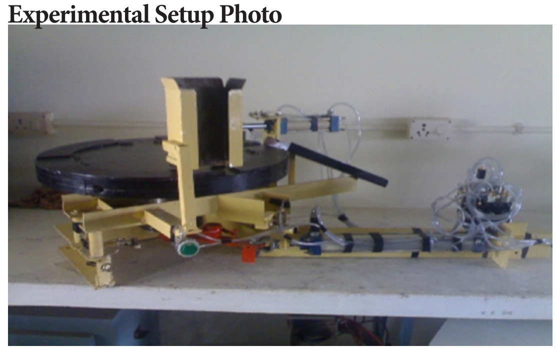
Part Drawing



Stroke-Sequence Diagram



Experimental Setup Photo



5.5 Specification of Bearings

5.5.1 Single Thrust Ball Bearing

Inner diameter = 30mm, outer diameter = 52mm

Thickness= 16mm

Bearing number SKF= 51206

Static load Co = 4800 Kg

Dynamic load C = 2280 Kg

Maximum permissible speed = 3800 rpm

5.5.2 Single Deep Groove Ball Bearing

Inner diameter = 25mm, outer diameter = 52mm

Thickness = 15mm

Bearing number SKF = 6205

Static load Co = 710 Kg

Dynamic load C = 1100 Kg

Maximum permissible speed = 12000 rpm

6. Conclusion

Here the design of the circuit was successfully done and the model was fabricated according to the designed circuit. The model was tested successfully for various work pieces. This fabricated model which uses pneumatics is used for loading and unloading components. The intermittent feeding rotary indexing table which was fabricated requires less man power and effort. The accuracy was high.

7. Scope for Future Work

In future, a rotary indexing table can be designed by adding some operations at every station such as drilling, boring, tapping which eliminates man power and the work can be processed automatically.

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