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PNEUMATIC CIRCUIT DESIGN FOR BUSH FITTING OF HANDBRAKE

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Abstract — *Every hand brake lever has a bush on its end for perfect grip. This paper focuses on the project which tries to eliminate the problem related to the damage to the lever by introducing a Pneumatic Circuit for Bush Fitting.*

Keywords- *Automation, Pneumatics, Bush, Handbrake, Pneumatic cylinder*

I. INTRODUCTION

A fluid system that uses gas as a working fluid is known as pneumatic system. Energy is stored in gas in form of pressure energy. This gas is then used to transmit energy to various parts of system. By controlling the pressure and discharge, the speed, power output, direction of motion of the devices such as pneumatic motor, cylinder or actuators can be controlled. The working, performance and design of pneumatic system is based on the behavior of air under the working parameters of the system. Pneumatic systems also use a variety of valves for controlling direction, pressure, and speed of actuators. The direction control valves can be solenoid operated for easier operation. [13] The paper gives a good idea regarding the design of the Pneumatic Circuit for Bush fitting of the Handbrake. The dimensioning and calculations are done for the Handbrake of Mahindra Bolero.

II. CALCULATIONS AND SELECTION OF COMPONENTS

Force required to fit bush by analytical method. The maximum value of force to press fit the bush into the handbrake lever is given by the formula:

Force F = P x μ x d x l x 3.14

Where $P = \dfrac{I}{\frac{d}{E_o}+\left[\frac{do^2+d^2}{do^2-d^2}+v_o\right]+\frac{d}{E_i}\times\left[\frac{do^2+d^2}{do^2-d^2}-v_o\right]}$

where: P: Means pressure of contacts expressed in N/mm^2
I: Means interference between the hub and shaft expressed in mm
d: Nominal rim diameter expressed in mm
Eo: Hub Young's modulus expressed in N/mm^2
do: Hub outer diameter expressed in mm
vo: Hub Poisson's Modulus
Ei: shaft Young's modulus expressed in N/mm^2
di: shaft internal diameter expressed in mm vi: shaft Poisson's Modulus

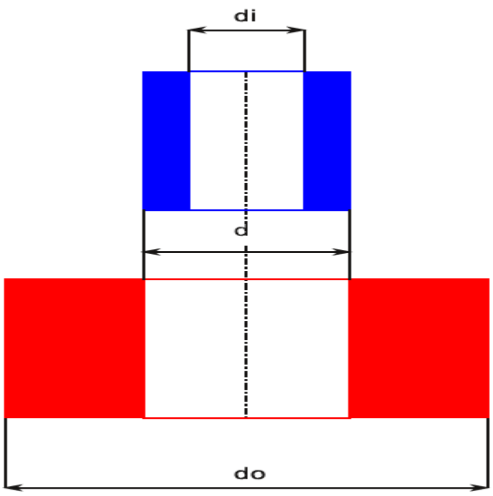

Figure 1: Interference Interference fit Taking H7n5

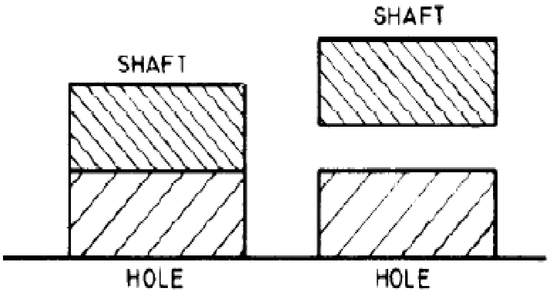

Figure 2: Interference fit

The Bush outer diameter (for which the circuit is being designed), d0= 28mm ,Bush (for which the circuit is being designed) inner diameter and Lever outer diameter,d = 20.2mm

Lever inner diameter,di= 17.6mm
Dmax = $\sqrt{d0 \times d}$ = 23.23 mm
i = $0.45\sqrt[3]{D} + 0.001D$ = 0.001303 mm
Tolerance of hole for IT grade6 = IT6=10i=0.01303 mm
Tolerance of shaft for IT grade5 = IT5 = 7i = 0.00915 mm
Fundamental deviation for hole (H7) = 0
Fundamental deviation for shaft (n5) = $5D^{0.34}$ = 0.01456 mm
Lower limit of hole, LLH = Basic size + Fundamental Deviation = 20.2 + 0 = 20.2 mm
Upper limit of hole, ULH = Basic size + Fundamental Deviation + Std. Tolerance
= 20.2 + 0.01303 = 20.21303 mm
Upper limit of shaft, ULS = Basic size + Fundamental Deviation + Std. Tolerance
= 20.2 + 0.01456 + 0.00915 = 20.22371 mm
Lower limit of shaft, LLS = Basic size + Fundamental deviation = 20.2 + 0.01456
= 20.21456 mm
Maximum interference I = ULS – LLH= 0.02371 mm
Minimum Interference = LLS – ULH= 0.00153 mm
Considering maximum interference I=0.02371 mm
Elastic Modulus of bush(polyurethane) : E0 = 1300 N/mm^2
Elastic Modulus of lever (CRCST Steel) :Ei = 180000 N/mm^2
Poissoin's ratio of bush(polyurethane) : µ0 = 0.42
Poissions ratio of lever (CRCST Steel) :µi = 0.28
By calculation, P = 0.419N/mm^2
Force F = P x µ x d x l x 3.14
= 0.419 x 0.28 x 20.2 x 3.14 x 85
= 633.012 N

2.2 Calculation of cylinder forward and return stroke

Forward stroke: -
Load = 600 N
Piston diameter = 63 mm = 0.063 m, Rod diameter = 20 mm = 0.020 m
Velocity (V) = S / t = $\frac{0.180}{2} = 0.09\ m/sec$
Q = $\text{Area} \times \text{velocity}$
= $\frac{\pi}{4} \times d^2 \times v$
= $\frac{\pi}{4} \times (0.063)^2 \times 0.09 = 2.804 \times 10^{-4}\ m^3/sec$

$$\text{Pressure} = \frac{\text{force}}{\text{area}} = \frac{f}{\frac{\pi}{4} \times d^2} = \frac{600}{0.785 \times (0.063)^2} = 192575.26\frac{N}{m^2} = 1.92\ bar$$

Return Stroke: -
Flow rate is same for both forward and return stroke

$$Q = (A_p - A_r) \times v_{return}$$
$$2.804 \times 10^{-4} = 0.785\ [(0.063)^2 - (0.020)^2] \times v_{return}$$
$$v_{return} = 0.100\ m/sec$$

Time for retraction: -

$$v_{return} = \frac{stroke}{time}$$

$$0.100 = 0.180/time$$

$$T_{return} = 1.8\ sec$$

2.3 Selection of Pneumatic Components

On the basis of the calculations and the results obtained pneumatic components are selected.

List of Components:

-Pneumatic cylinder
-Direction Control Valve
-Filter + Regulator + Lubricator
-Flow Control Valve
-Muffler
-Tubes and Connectors

III. CONCLUSION

As on finalizing the pneumatic circuit components and complete designing of fixture, the complete automation set is assembled with whole circuit as part 1 and the fixture as the other. The automation set is ready and installed where the handbrake bush can be fixed. Manual work is replaced by automation which in turn saves the total cycle time. As the process is fully automated it ensures safety to the operator. The failures occurring in the previous manual method is reduced which in turn improves the productivity. Also the bush fits accurately into the hand brake lever. The aesthetics of the hand brake lever assembly is not disturbed. As the process is simplified it does not requires skilled worker. From the above statements, we conclude that the objectives stated at earlier stages are almost satisfied. Still there is some advancement that can be done in this system.

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