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Pneumatic Foot Step in Buses

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Abstract:- The idea is to help senior citizens and children to board and/or get down from busses, by providing an extra step at the end of the bus staircase, such that it can be extended and retracted as and when required. The step is required to be in extended (downward) position when senior citizens and/or children want to get down or climb up in any bus stop, and should be in retracted (upward) position when the bus is in moving condition. The step extends and retracts with the help of the same pneumatic system and actuation mechanism, which are employed to operate the automatic doors in a bus. Therefore, the same air compressor and storage tank, which are already used in the busses, can be used for our project simultaneously. However, only a prototype working model is being fabricated to demonstrate the working and feasibility of the project. Upon positive reception, the project can be further fabricated to be mounted on a running bus without altering the basics used in the prototype.

Keywords:- pneumatic system, actuating mechanism, compressor and storage tank.

I. INTRODUCTION

A. General Overview

Busses are the most popular mode of public transportation. It is affordable to all classes of people and age, and is appreciably frequent. They may not the fastest means to reach our destination, but they are definitely cheaper, safer and reduce overall fuel consumption. Apart from government run busses, we also find private busses like travels busses, company and college busses commuting most of the city's population. But due to Indian road conditions, the steps on a bus used to board or a bus are high, in order to maintain safe clearance. This makes it difficult for small children and senior citizens and injured passengers to climb into or get down from a bus. This may lead to choosing other modes of travel. Also, it increases the time taken for the passengers to board/get down from the bus.

Our project aims at eliminating this issue using simplest & safest methods possible. The idea is to design and fabricate a step that can bemounted right beneath the currently existing step, without crossing the safe clearance required, and operate this step pneumatically such that it can be extended diagonally downwards, forming a staircase that is lower and easier for Senior citizens to commute through, and can be retracted diagonally back to a position where it is safe and doesn't hinder the ground clearance to a great degree.

The use of pneumatics is justified by the fact the almost all the busses have air braking and automatic (pneumatic) doors, which means that almost all the busses already have an Air Compressor and Storage Tank built into it. Also, pneumatics can be actuated with ease, and repairs and maintenance is easy. Plus, drivers are already used to pneumatics, so this makes it easier and friendlier to teach the methods of operation and maintenance.

II. COMPONENTS OF A PNEUMATIC SYSTEM

The following are the essential components of a pneumatic system

- Air Compressor
- Storage Tank
- Pneumatic Cylinders
- Valves
- Tubes and fittings.

A. Air Compressors

An air compressor is a specific type of gas compressor. A gas compressor is a mechanical device that increases the pressure of a gas by reducing its volume.

Fig. 1:- Air Compressor[1]

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Compressors are similar to pumps: both increase the pressure on a fluid and both can transport the fluid through a pipe. As gases are compressible, the compressor also reduces the volume of a gas. [4]

There are many options for the "prime mover" or motor that powers the compressor

- Gas turbines power the axial and centrifugal flow compressors that are part of jet engines.
- Steam turbines or water turbines are possible for large compressors.
- Electric motors are cheap and quiet for static compressors. Small motors suitable for domestic electrical supplies use single-phase alternating current. Larger motors can only be used where an industrial electrical three phase alternating current supply is available.
- Diesel engines or petrol engines are suitable for portable compressors and support compressors. They help in producing energy by according their given liquids and gases. It can power the compressor by using the power produced in the crankshaft in it. In addition to power produced by using exhaust gases once again circulated in it.

B. Storage Tank

Compressed air energy storage (CAES) is a way to store the gases when machine operates at low loads. It delivers the saved energy when machine runs at peak loads. At the time of compression thus more heat produced thus it attacks the efficiency of the machine. maintaining the heat efficiency of the compressor thus get raised. There are three ways in which a Compressed Air energy Storage system can deal with the heat. Air storage can beadiabatic, diabatic, or isothermal.[4]

Fig: 2:- Storage Tank[1]

- *Adiabatic*

Adiabatic process defined as which transmits energy to its surroundings from the system but mass remains the same. Thus many researches had gone by insulating the air tank thus leaving out heat energy from the system can be reduced.thus heat can be stored in solids up to 300 °C .

- *Diabatic.*

In the storage tank thus during the compression stroke thus heat get raised due to the air energy were get stored and during the heavy load given it retrieved. When the energy produced during the compression stroke get waste if not perfect system used .Without the loss or gain of heat a process named as diabatic.

- *Isothermal*

It is the process which even change of a system took place thus temperature remains constant. this occurs when change in temperature accompanied managed by using thermal reservoir. A system may also be said as which does not exchanges heat to the surroundings.

C. Pneumatic Cylinders

Pneumatic cylinders are mechanical device which acted in reciprocated and linear motion by the use of compressed gas which is stored in the air tank. When the compressed gas enters the cylinder thus piston get moved and required motion is obtained.

- *Single-acting cylinders*

Single-acting cylinders which actuates when compressed air enters in to the cylinder. Thus it performs only one motion and retrieved back to its back position when only by using an external thing.

- *Double-acting cylinders*

Double-acting cylinders thus two way possible when get extracted by sending compressed air at one side then piston reaches its end. Then it get back to its position by sending air at another side thus piston get back to its original position.

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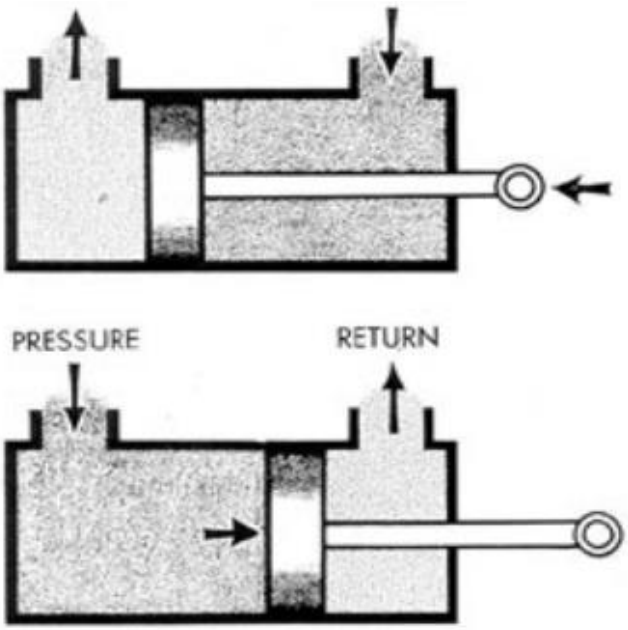

Fig. 3: A Double Acting Cylinder[1]

- *Multistage telescoping cylinders*

Telescoping cylinders, also known as telescopic cylinders. It can be either single or double-acting. The telescoping cylinder incorporates a piston rod nested within a series of hollow stages of increasing diameter. Depending up on the compressed air given at the input thus it actuate and also it varies according to its diameter.

D. Valves

A valve is a device that regulates, directs or controls the flow of a fluid (gases, liquids, fluidized solids, or slurries) by opening, closing, or partially obstructing various passageways. Here used one is hand lever valve thus when get pushed front compressed air sends from the storage tank thus piston get expanded from the cylinder.[4]

Valves are quite diverse and may be classified into a number of basic types. Valves may also be classified by how they are actuated.

- Hydraulic
- Pneumatic
- Manual
- Solenoid
- Motor

Fig. 4:-valves[1]

E. Tube and Fittings

Polyurethane tubes are used popularly for pneumatic fittings and so, easily available for purchase. So, PU pipes of 3x1m length are selected such that they can withstand a maximum pressure of 10kg/cm2. Connectors, silencers, adapters etc are also bought for the sake of pneumatic fittings

III. LITERATURE REVIEW

A. Current Applications of Pneumatics in Busses

Pneumatics is already in use in busses, majorly for

- Air Brakes
- Pneumatically operated Doors.

Therefore, current busses already have an Air compressor and Storage Tank built into them.

B. Supply System

The air compressor is driven by the engine either by crankshaft pulley via a belt or directly from the engine timing gears. Thus it lubricated and air filter is used in order to send the air without moisture. After the valve pushed front and back thus the compressed air goes in expanding and hand lever pushed back then it retains its initial position. In case already ABS it must be implemented by desired ways by it should not affect the ABS.

C. Control System

By the hand lever valve the actual motion get performed .Pushing of the lever to back and front thus expansion of the piston takes place by sending of compressed air from storage tank.

D. Pneumatically Operated Doors

The Pneumatically operated doors performed by pushing the separate hand lever the compressed air sucks then

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door get opened by supplying the air it get closed In this the main thing thus doors were not maintained by lubricating it. It results in stuck of door at its corners.

IV. DESIGN OF PNEUMATIC FOOT STEP

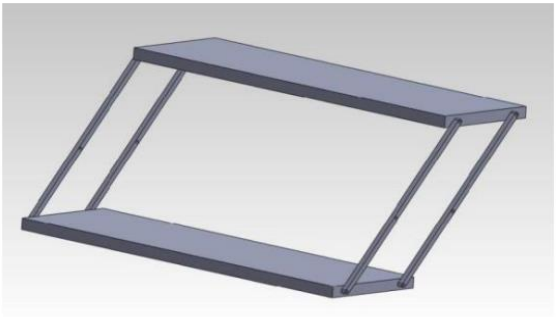

Fig: 5:- pneumatic foot step[1]

V. CALCULATION

A. Calculation of length of each link

- Vertical height up to which the step should extend is 25cm
- But in the prototype, the links are bolted at a point 2cm below the final step
- Therefore, the vertical height up to which the step should travel is 23cm
- The horizontal distance that the step should travel is 23cm
- Now, notice the right angled triangle formed as shown

By Pythagoras Theorem,

$$AB^2 + BC^2 = AC^2$$

$$\Rightarrow \quad 23^2 + 23^2 = AC^2$$

$$\Rightarrow \quad AC = 32.54\text{cm}$$

$$\Rightarrow \quad AD = AC/2 = 16.24\text{cm} \sim 16\text{cm}.$$

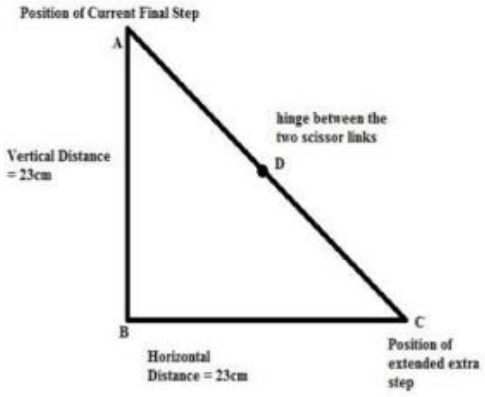

Fig. 6 :- Right Angled Triangle

Therefore, the hinge points between the links should be 16cm apart. So, let the length of each link be 20cm.

B. Calculation of the Required

- *Stroke Length of the*

It has been observed and understood that, the required stroke length is equal to the displacement of the extra step, which is equal to ~ 32cm.

C. Calculation of length and thickness of the welds

For the parallel fillet weld in shear We know that

$t = 0.707h$
$P = 2(0.707hl\tau)$
Where,
P = tensile load on plates (N),
h = leg of the weld (mm),
l = length of the weld (mm),
τ = Permissible Shear Stress(N/mm2)

For static loads, τ can be taken as 94 N/mm2, as per the code of American Welding Society (AWS).

Now, assume the tensile load of 2kN to be acting on the parallel fillet weld.

Therefore, using equation[2]

$$2 \times 10^3 = 2(0.707 \times 4 \times l \times 94)$$
$$l = 37.6\text{mm} = 3.7\text{ cm}$$

Also,

$$t = 0.707 \times 4 = 2.828\text{mm}$$

Therefore, length and thickness of the weld required is 37.6mm and 2.828mm respectively. For Transverse Fillet loading, length of the weld for 4mm leg and

$$2P = 2\text{KN}$$

$$\tau_{max} = \frac{1.21P}{hl}$$

for $\tau_{max} = 94\ \text{N/mm}^2$,

$$\Rightarrow \quad 94 = \frac{1.21 \times 1000}{4xl}$$

$$\Rightarrow \quad l \sim 1\text{mm}$$

Choosing the length of the longer side will be taken as 36.7mm [3]

Fig. 7:- Pneumatic Foot Step

VI. CONCLUSION

It can be concluded that from our project thus it is helpful for the senior citizens and children's whom were stepping in to the bus..Thus this step can hold on up to 25kg and pressure required on the foot steps for the expansion and holding on weight will be 7bar.Thus it to executed at low cost investment in all government and private buses.

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