

EXHIBIT 22

PNEUMATIC SYSTEMS

Principles and

Maintenance

S. J. MAJUMDAR

Preface

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Principles and Maintenance

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Pneumatic Cylinders and Air Motors

SYNOPSIS

Pneumatic cylinders offer a straight rectilinear motion to mechanical elements. Cylinders are classified as light, medium, and heavy duty with respect to their application. Selection of materials for cylinder component depend greatly on this factor. Functionally, cylinders may be single acting and double acting. They may be further classified as diaphragm cylinder, duplex cylinder, through rod cylinder etc. End position cushioning of cylinders at certain times may be of utmost importance. However, if the cylinders do not travel up to the end of stroke, designers need not go for cushioned cylinders. The piston rod of cylinders are given special treatment as it is the highly stressed part. For cylinder lubrication, mist lubrication is most common. To generate rotary motion, air motors may also be used. Vane type motors are more popular. Air motors have certain specific advantages over electrical motors. Proper maintenance of cylinders, motors, and various air operated hand tools enhance their life expectancy to a great extent.

5.1 TYPES OF CYLINDERS

The pneumatic power is converted to straight line reciprocating motions by pneumatic cylinders. The various industrial applications for which air cylinders are used can be divided dutywise into three groups—light duty, medium duty and heavy duty. But according to the operating principle, air cylinders can be sub-divided as (i) single acting and (ii) double acting cylinders.

Single Acting Cylinder In a single acting cylinder, the compressed air is fed only in one side. Hence, this cylinder can produce work only in one direction. The return movement of the piston is effected by a built-in spring or by application of an external force. The spring is designed to return the

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