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Chapter Two

WEIGHING SYSTEM

2.1 Introduction

Measuring load is an important and essential part of many industrial and commercial operations. It is crucial to have accurate measurements of the load, as small errors, occurring repeatedly, and lead to substantial loss of revenue. Therefore, weighing systems have an important device; it is denoted as load cell. A load cell is uncontrollable weighing device capable of weighing an article. It is used in a variety of industrial weighing applications.

2.2 Checkweigher System

A checkweigher is a system that weighs items as they pass through a production line, classifies the items by preset weight zones, and ejects or sorts the items based on their classification. Checkweighers weigh 100% of the items on a production line. Typically, an infeed section, scale section, discharge section, rejecter or line divider, and computerized control comprise the physical checkweighing system. Checkweighers and their components vary greatly according to how they are used, the items being weighed, and the environment surrounding them.

2.2.1 Checkweigher System Components

❖ **Conveyor System**

Conveyors are used to transport product between two or more locations. The variety of products a conveyor system transports is ranges from bolts to pallets and everything in between for distribution and manufacturing systems. See the figure 2.1

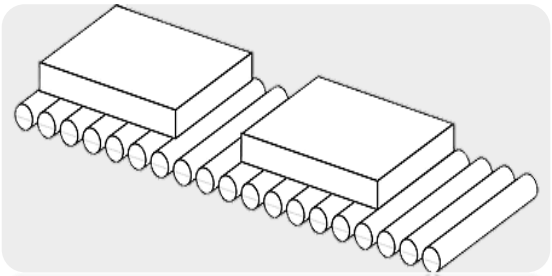


Figure 2.1: Conveyor System

❖ **Conveyor System Description**

A conveyor moves cardboard boxes, wood boxes, metal boxes and plastic boxes. It can also move bags, components, pallets or other components. Many kinds of conveying systems are available, and are used according to the various needs of different industries. [1]

The most famous types of conveyors systems are:

- ✓ Vibrating Conveyor Systems.
- ✓ Roller Conveyor Systems.
- ✓ Vertical Conveyor Systems.
- ✓ Belt Conveyor Systems.

The following figure shows the types of conveyors:

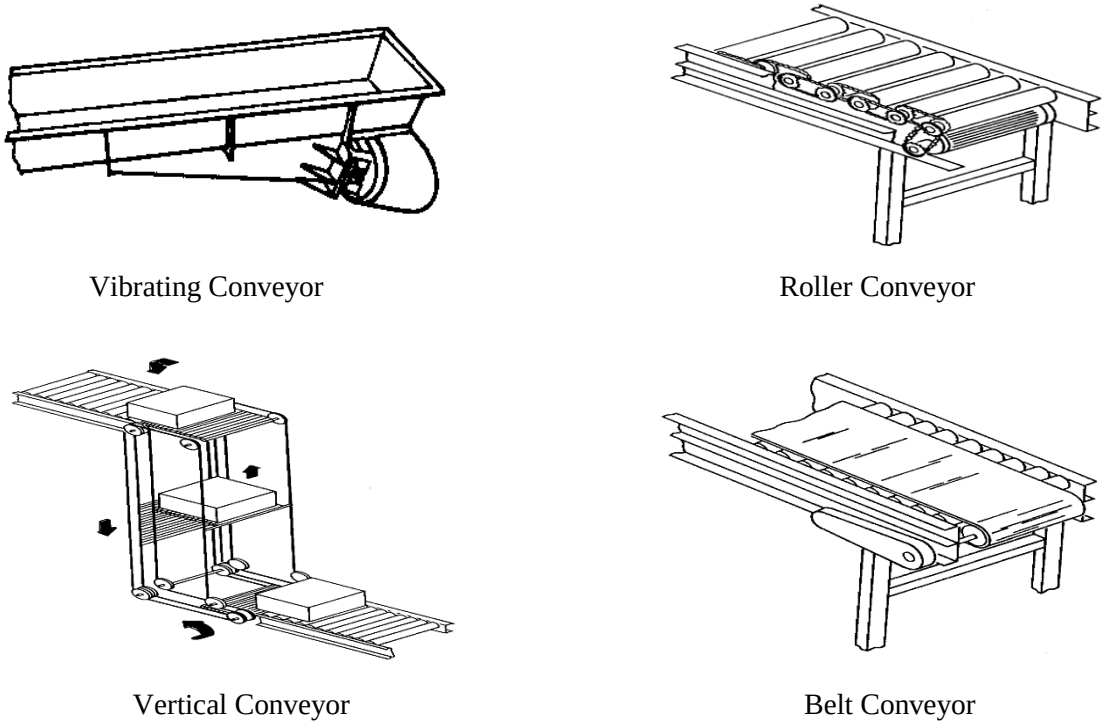


Figure 2.2: Conveyor System Types

2.3 Sensors

A sensor is a device that detects and responds to some type of input from the physical environment. The specific input could be light, heat, motion, moisture, pressure, or any one of a great number of other environmental phenomena. The output is generally a signal that is converted to human-readable display at the sensor location or transmitted electronically over a network for reading or further processing.

2.3.1 Photo Sensors

A Light Sensor generates an output signal indicating the intensity of light by measuring the radiant energy that exists in a very narrow range of frequencies basically called “light”, and which ranges in frequency from “Infra-red” to “Visible” up to “Ultraviolet” light spectrum. See the figure 2.3

Figure 2.3: Light Sensor

The light sensor is a passive devices that convert this “light energy” whether visible or in the infra-red parts of the spectrum into an electrical signal output. Light sensors are more commonly known as “Photoelectric Devices” or “Photo Sensors” because the convert light energy (photons) into electricity (electrons).

2.3.2 Load Cells

Load cell is an electromechanical device. It can be called a transducer as it converts one form of energy to another mechanical force or stress to electrical energy. A load cell has various characteristics that are measurable. These characteristics are determined by the type of metal used, shape of the load cell and how well it is protected from its environment. To understand load cells better (you can see the reference [2]) there are terms that you need to become familiar with so you can better match the load cell to your application.

Load Cell Description

An electronic weighing system is the electronic system used for dynamic weighing. A weighing system consists of one or more sensors and an intelligent module. The sensor is usually called a load cell and is available in several different types. In industrial weighing systems, there are three types of load cell: Magnetic transducer which measures change in magnetic permeability, oscillating string transducer which measures changes in frequency and the third one is the strain gauge transducer which measure changes in resistance. The three types of load cell are called transducers because it converts the force into a measurable data. In the weighing system used in this thesis we will use the third type.

Majority of the industrial weighing systems use the strain gauge load cell in various types such as traditional canister, s beam, single ended beam, platform load cell, etc., as shown in figure 2.4 it is considered the most common type of load cells in industry due to their low price and great loads area. In addition, it is suitable to be used in the dusty and moist workshop environments.

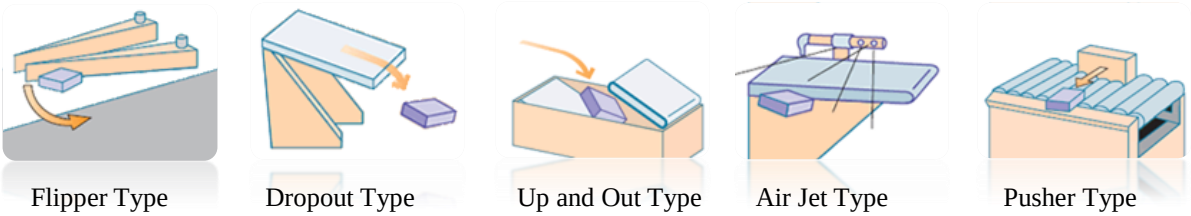
Traditional Canister S-Beam Load Cell Single Ended Beam Platform Load Cell

Figure 2.4: Load Cell Types

2.4 Rejecters

A reject signal is sent from the checkweigher control to a rejecter on the checkweigher or further downstream. Typically the reject signal consists of a solid state relay with high or low voltage output or a mechanical contact. [3]

A mechanism which removes items from the line flow upon receiving a signal from a control system. The rejecter often consists of a solenoid operated valve, air cylinder, and associated mechanical parts. Majority of the industrial weighing systems use the rejecters various types such as: flipper, dropout, up and out, air jet, and pusher rejecter, etc., as shown in figure 2.5.



Flipper Type | Dropout Type | Up and Out Type | Air Jet Type | Pusher Type

Figure 2.5: Rejecters Types

2.5 PLC (Programmable Logic Control)

A central control system from which one can operate and program functions of several independent or dependent systems. The PLC consists of a user interface, central processor, links to subsidiary system controls, and an electrical control interface.

PLCs have become more and more standard in manufacturing and packaging industries. Some checkweigher manufacturers have designed PLC interfaces to common PLC formats and can now fit into your lines seamlessly. Ask checkweigher manufacturers what level of integration they provide for PLC support.

The most common type of PLC in industry as shown in figure 2.6

Fatek PLC | Siemens PLC | Delta PLC

Figure 2.6: PLC Types

2.6 HMI (Human Machine Interface)

A Human Machine Interface (HMI) is the user interface that connects an operator to the controller for an industrial system.

Figure 2.7: Delta HMI

Industrial Control Systems (ICS) are integrated hardware and software designed to monitor and control the operation of machinery and associated devices in industrial environments, including those that are designated critical infrastructure. An HMI includes electronic components for signalling and controlling automation systems. See the figure 2.7

HMIs are usually deployed on Windows based machines, communicating with programmable logic controllers (PLC) and other industrial controllers. [4]

2.7 Protection System

2.7.1 Contactors

Contactors are an electrically controlled switch used for switching a power circuit similar to a relay except with higher current ratings. A contactor is controlled by a circuit which has a much lower power level than the switched circuit.

Contactors come in many forms with varying capacities and features. Unlike a circuit breaker, a contractor is not intended to interrupt a short circuit current, contactors range from several amperes to thousands of amperes. The physical size of contactors ranges from a device small enough to pick up with on hand to large device as shown in figure 2.8

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Figure 2.8: Contactor

2.7.2 Circuit Breaker (CB)

If a power surge occurs in the electrical wiring, the breaker will trip this means that a breaker that was in the on position will flip to the off position and shut down the electrical power leading from the breaker. Essentially, a circuit breaker is a safety device. When a circuit breaker is tripped it may prevent a fire to start in overloaded circuit, it can also prevent the destruction of the device that is drawing the electricity. See the figure 2.9

Figure 2.9: Circuit Breaker

2.7.3 Overload

Overload relays are intended to protect motors, controllers and branch-circuit conductors against excessive heating due to prolonged motor over currents up to and including locked rotor currents. Protection of the motor and other branch-circuit components from higher currents, due to short circuits or grounds, is a function of branch-circuit fuses, circuit breakers or motor short circuits protectors. The system needs two overloads to protect the motors. See the figure 2.10

Figure 2.10: Overload

2.7.4 Emergency Stop Button

Emergency Stop Button is shown in a figure 2.11 provides safety for humans and the machine; it offers a wide range of safety components for the protection of humans, machine and production goods in emergency situations.

It is the purpose of emergency-stop device to deflect or minimize the risk as quickly as possible and optimally in the event of an emergency arising.

Figure 2.11: Emergency Stop Button

2.7.5 Earth Leakage Circuit Breaker (ELCB)

Is a safety device used in electrical installations with high Earth impedance to prevent shock. It detects small stray voltages on the metal enclosures of electrical equipment, and interrupts the circuit if a dangerous voltage is detected. Once widely used, more recent installations instead use residual current circuit breakers which instead detect leakage current directly. See the figure 2.12

Figure 2.12: Earth Leakage Circuit Breaker

2.8 Pneumatic System

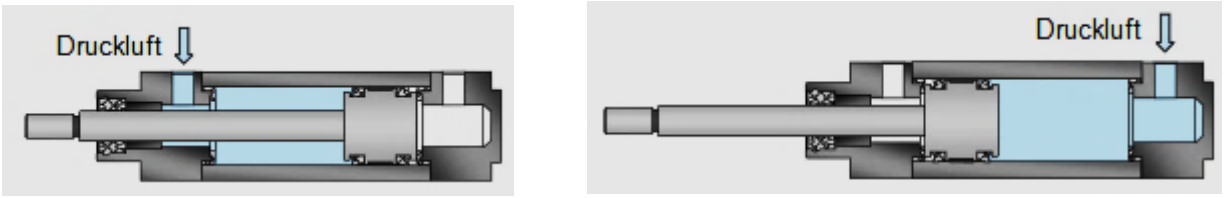
2.8.1 Magnetic Cylinder Sensors

Detecting piston positions with precision, in countless fields of automation, it is essential to monitor the motion processes in pneumatic cylinders. Magnetic cylinder sensors contactlessly detect the piston position of these cylinders and give a switching signal. They are completely maintenance-free and are mounted outside the cylinder. See the figure 2.13. [5]

Figure 2.13: Magnetic Cylinder Sensors

2.8.2 Double Acting Cylinder

The double-acting cylinder requires compressed air for every direction of movement. On this type of cylinder, the force both the advancing and retracting direction is built up using compressed air. The simplest way of actuating a double-acting cylinder is by using a 5/2-way valve. See the figure 2.14 **[**6]



Double Acting Cylinder Retracted

Double Acting Cylinder Advanced

Figure 2.14: Double Acting Cylinder

2.8.3 Solenoid Valve

Solenoid valve is an electromechanical device used for controlling liquid or gas flow. The solenoid valve is controlled by electrical current, which is run through a coil. When the coil is energized, a magnetic field is created, causing a plunger inside the coil to move. Depending on the design of the valve, the plunger will either open or close the valve. When electrical current is removed from the coil, the valve will return to its de-energized state. See the figure 2.15

Figure 2.15: Solenoid Valve