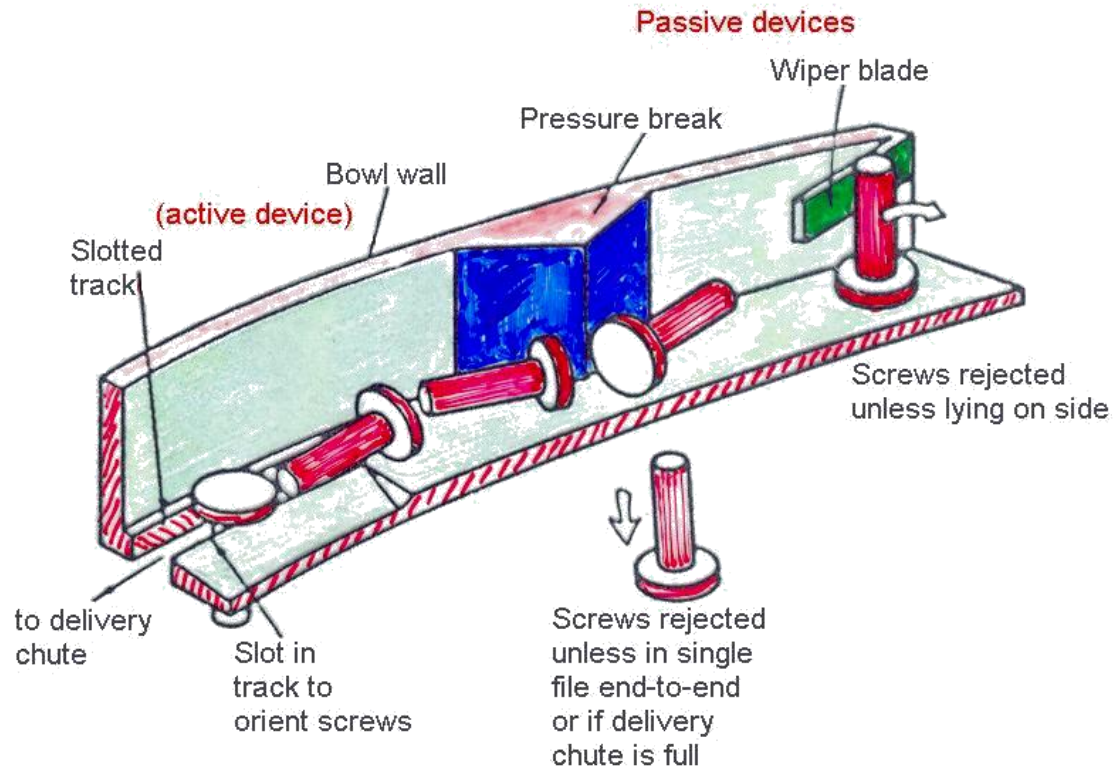


Part Orientation



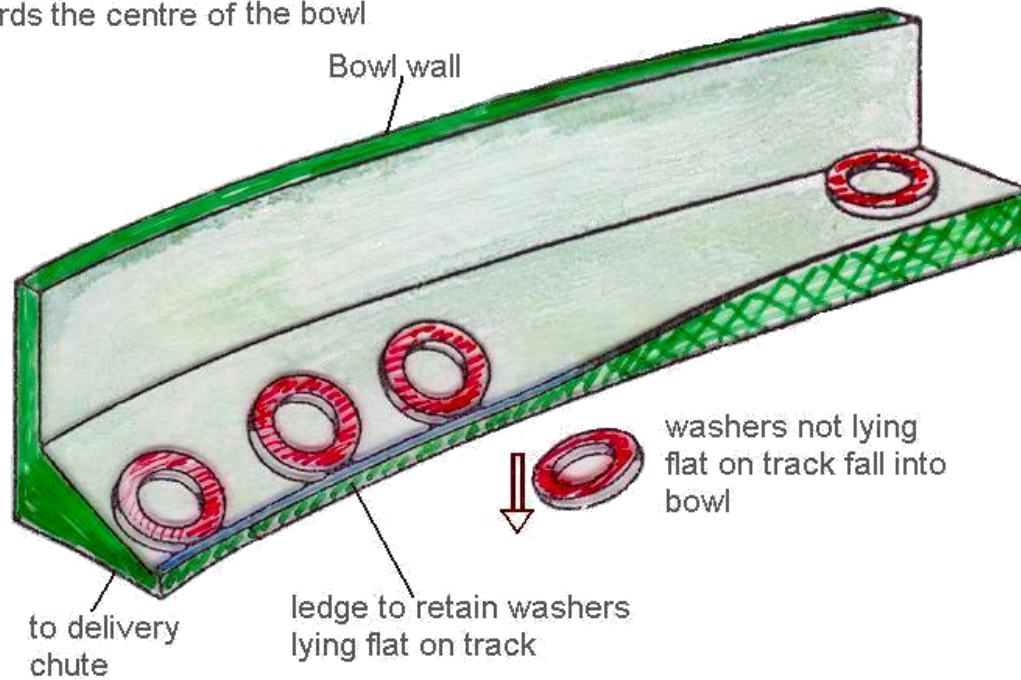
To feed the parts to the workheads in correct orientation

TYPES :

- a) In-bowl Tooling (active and passive)
- b) Out-of-bowl Tooling (active)

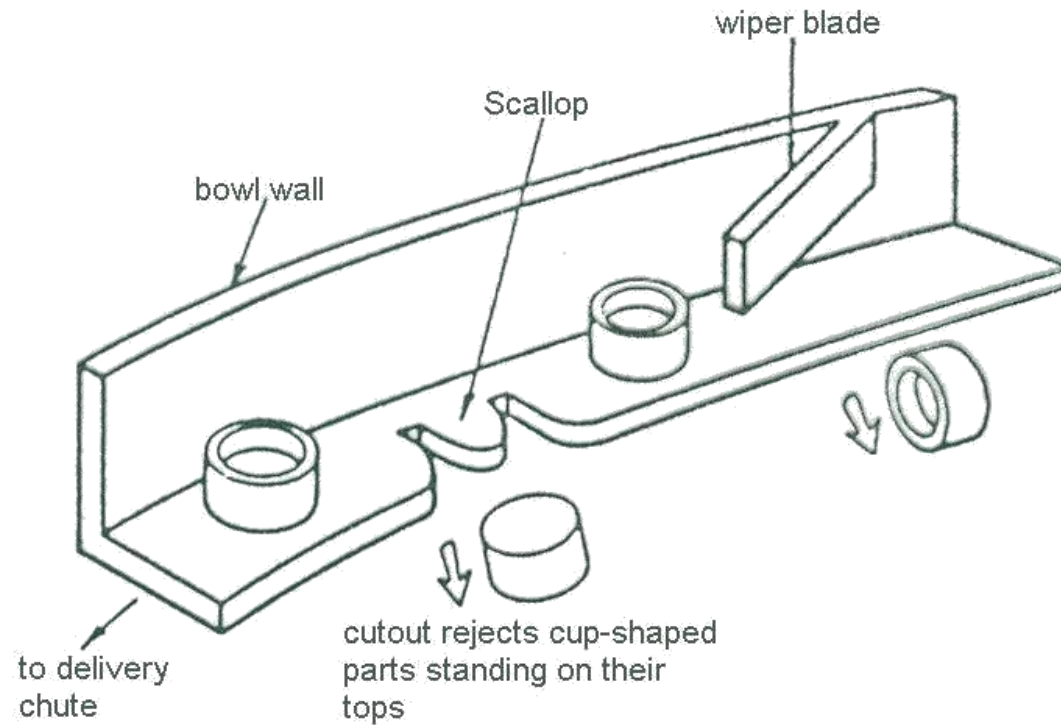
Part Orientation

A portion of the track is arranged to slope sideways and down towards the centre of the bowl



Commonly employed to orient washers

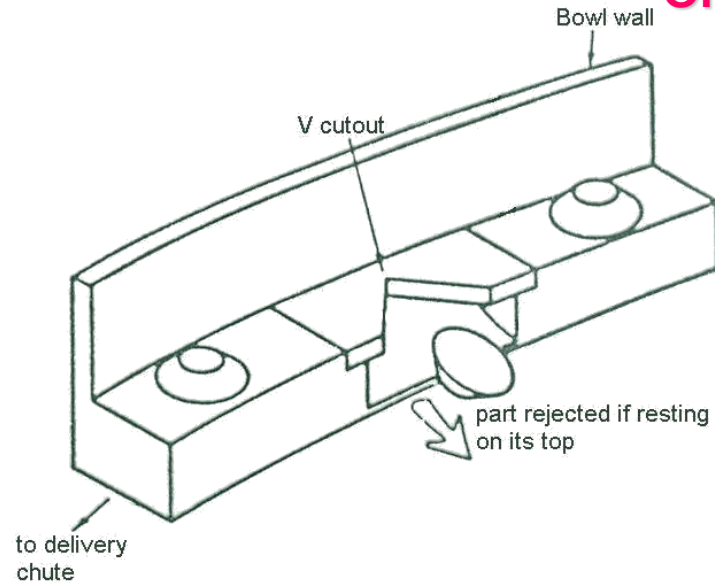
Orienting Device : Cut out



This device makes use of the difference in shape between the top and the base of the part to be fed



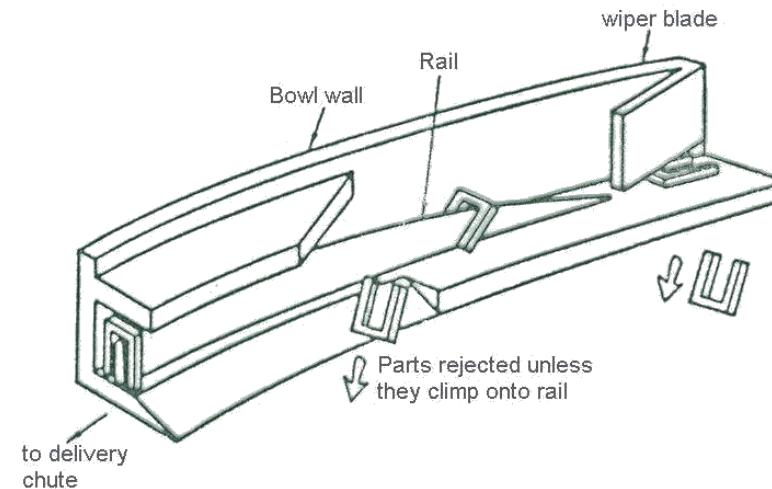
Orienting Device : Cut out



Area covered by the top of the part is very much smaller than the area covered by its base

Orientation of U-shaped Parts

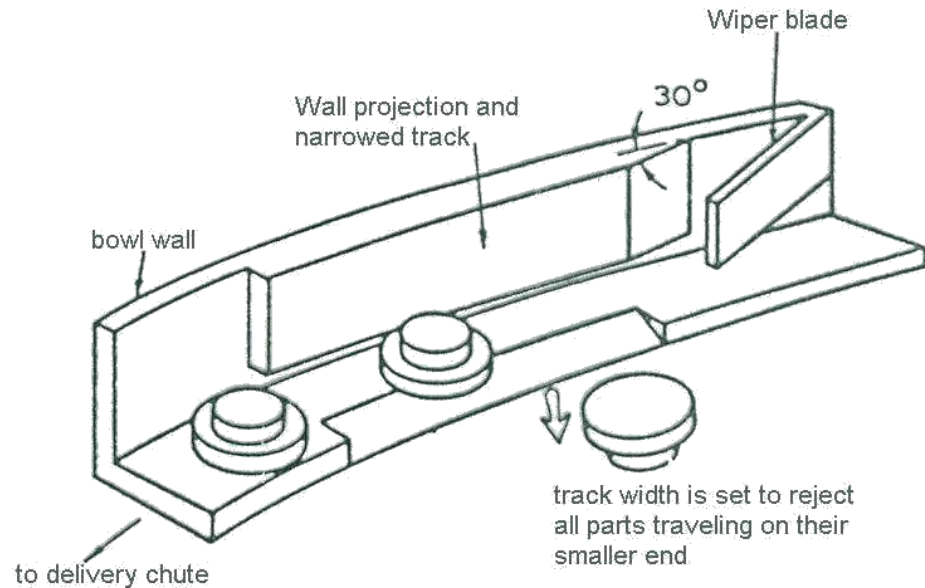
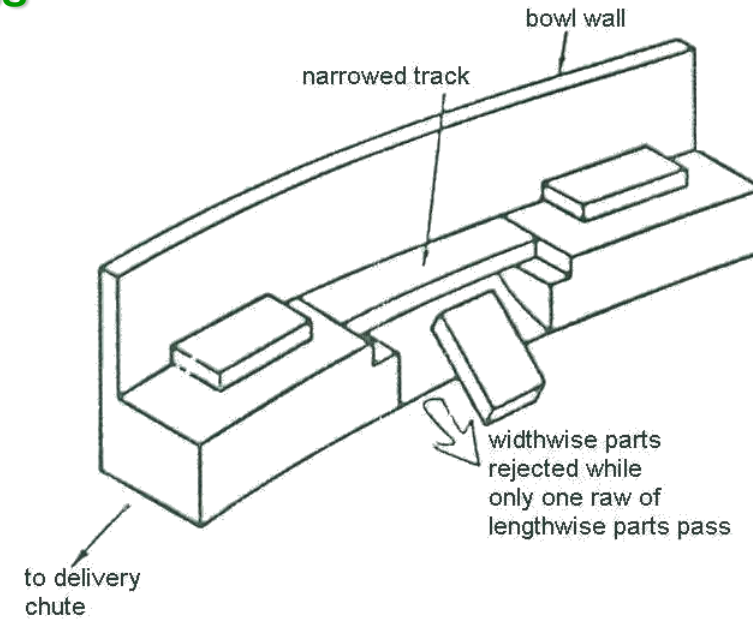
Convenient to feed them supported on a rail





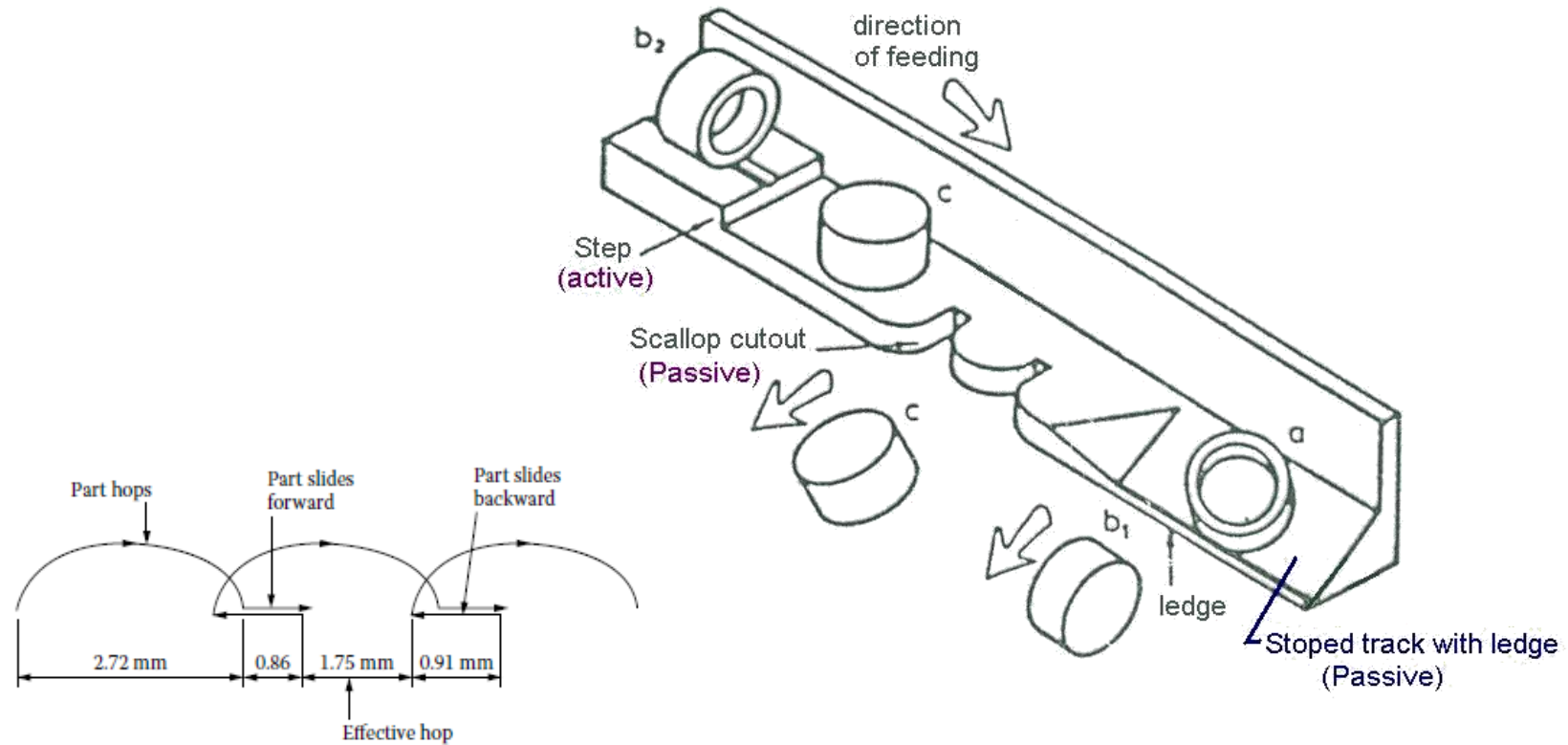
Orienting Device : Narrowed Track

Employed to orient parts lengthwise end to end while permitting only one row of pass



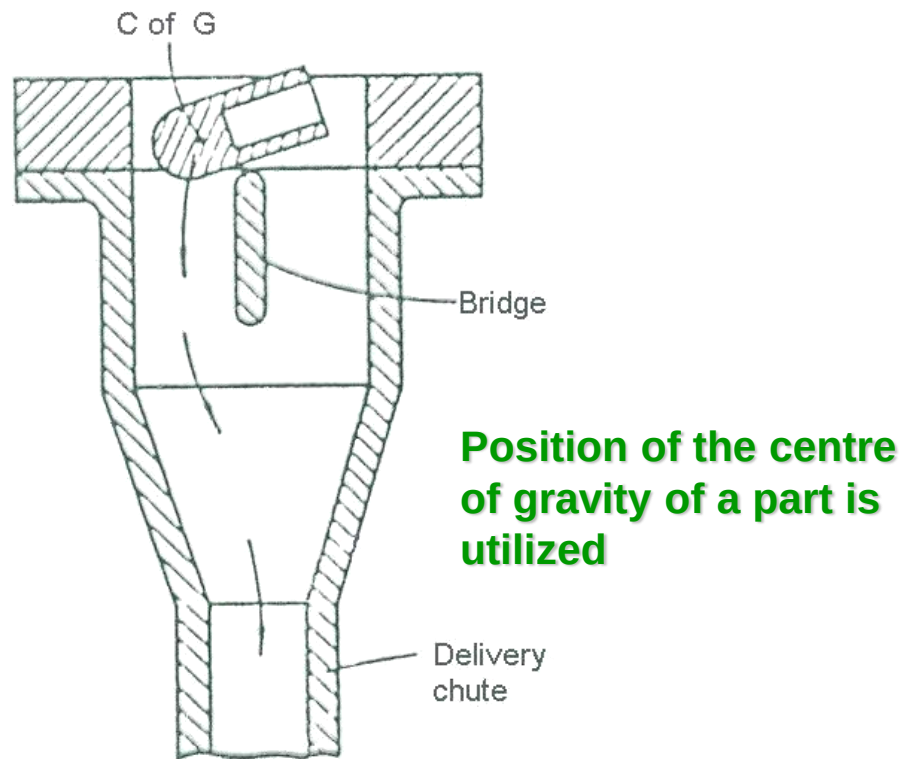
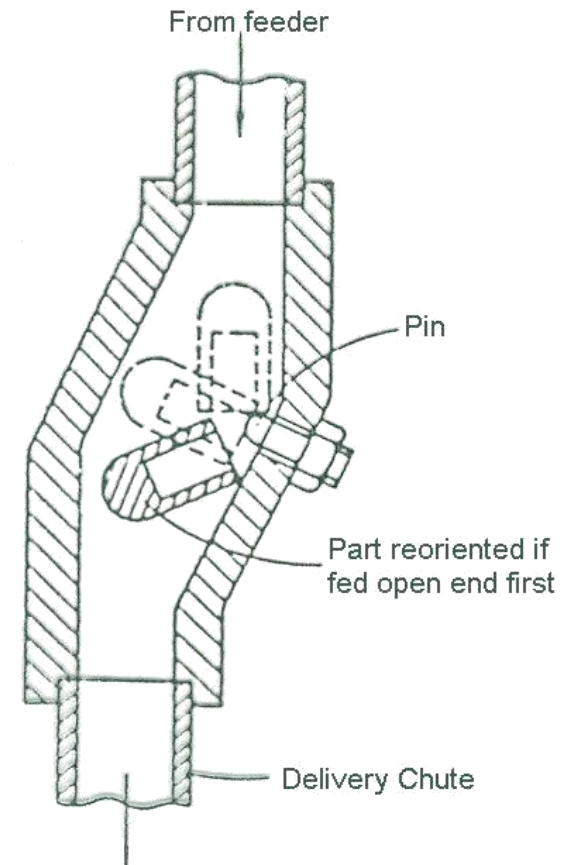
Employed to orient parts lengthwise end to end while permitting only one row of pass

Analysis of Orienting Systems



Out-of-Bowl Reorienting Devices

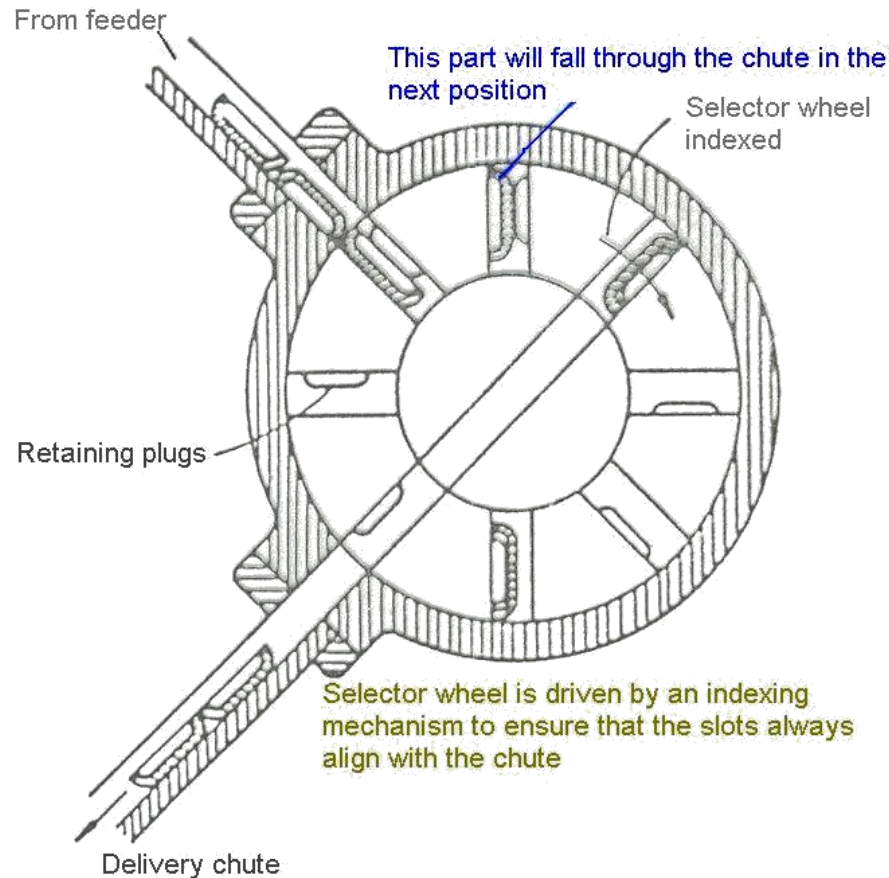
These types of orienting devices are situated between the feeder and the workhead. They are usually of active types.





Out-of-Bowl Reorienting Devices

Reorientation of shallow-drawn parts

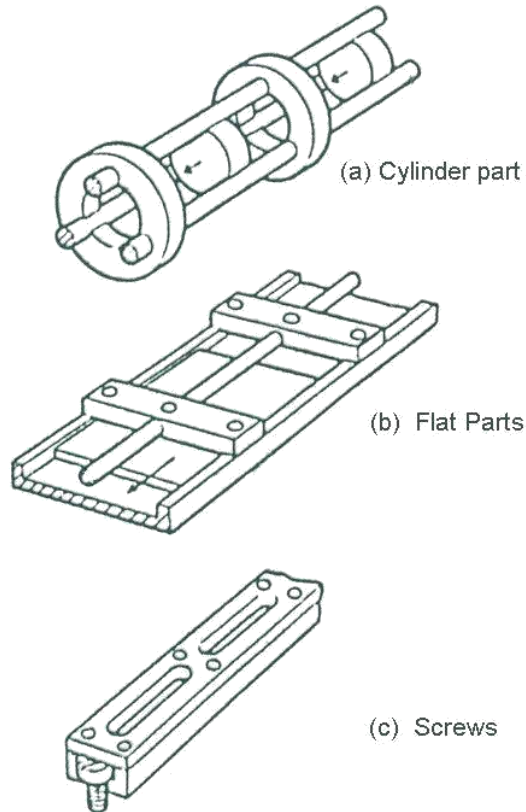


Consists of a stationary container in which a wheel is mounted with radial slots. This wheel is driven by an indexing mechanism to ensure that slots always align with the chute

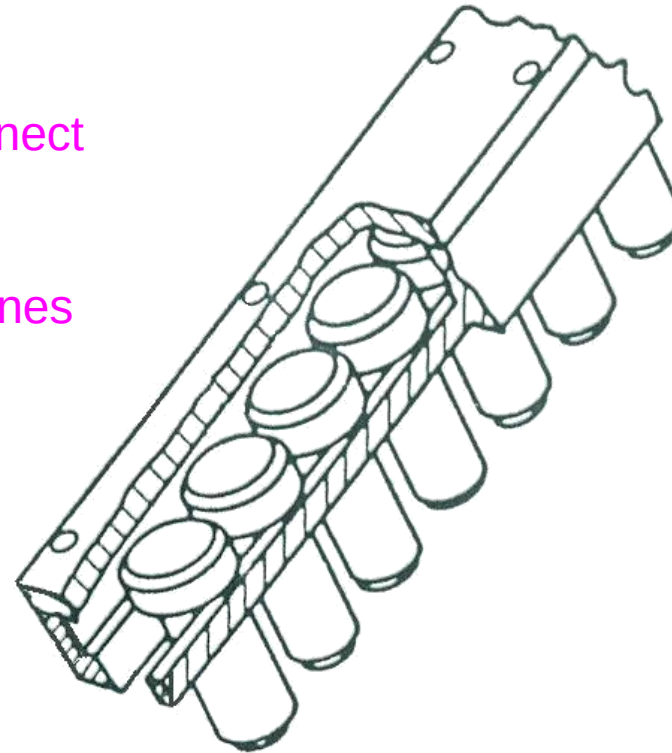


Feed Tracks

To provide easy access to automatic workheads and the assembly machines, part feeders are usually placed some distance away from the workhead

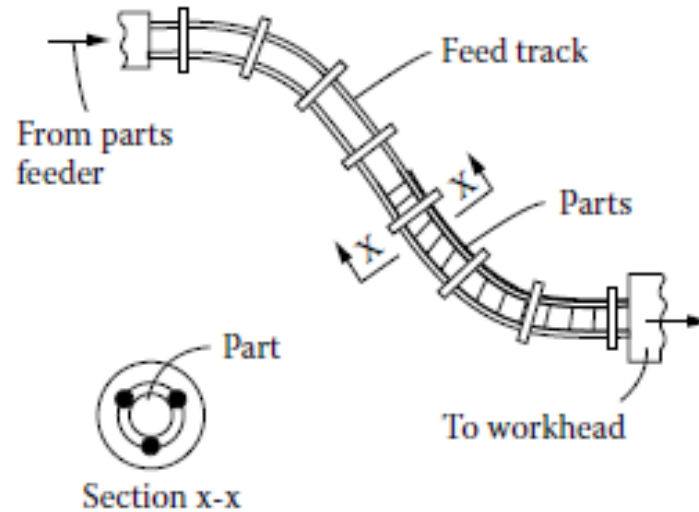


Feed tracks connect part feeders to workheads of assembly machines





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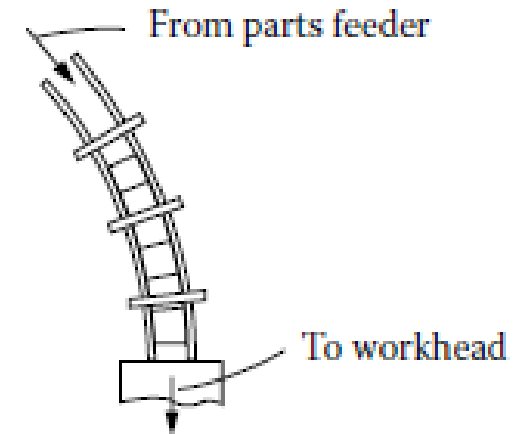
(a) Horizontal delivery of parts

For the vertical design, the time of delivery, t_p will be given by the time taken for a part to fall a distance equals to its own length:

$$t_p = \left(\frac{2L}{g} \right)^{0.5}$$

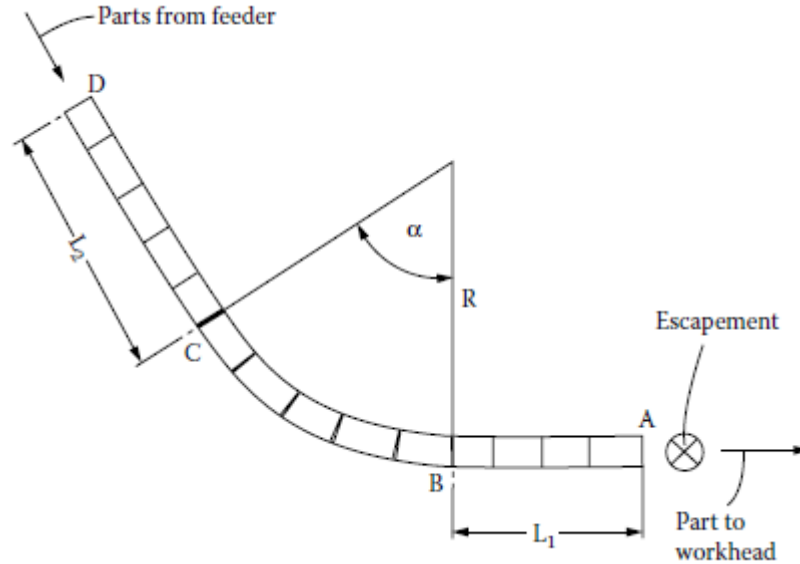
L – part length, g - acceleration due to gravity= 9.81 m/s²

(b) Vertical delivery of parts





Analysis of Horizontal Delivery Feed Track



This portion consists of a horizontal section AB of length L_1 , preceded by a curved portion BC of constant radius R , which, in turn, is preceded by a straight portion inclined at an angle α to the horizontal.

It is assumed in the following analysis that a certain fixed number of parts are maintained in the track above the delivery point.



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If the length of the straight inclined portion of the track containing parts is denoted by L_2 , the number of parts N_p is given by

$$N_p = \frac{L_2 + R\alpha + L_1}{L}$$

The weight of the section AB = $m_1 L_1 g$

The total frictional resistance in this region is: $\mu_d m_1 L_1 g$

μ_d is the coefficient of friction (dynamic) between the parts and the track

The equation of motion for section AB is given by

$$F_1 - \mu_d m_1 L_1 g = m_1 L_1 a$$

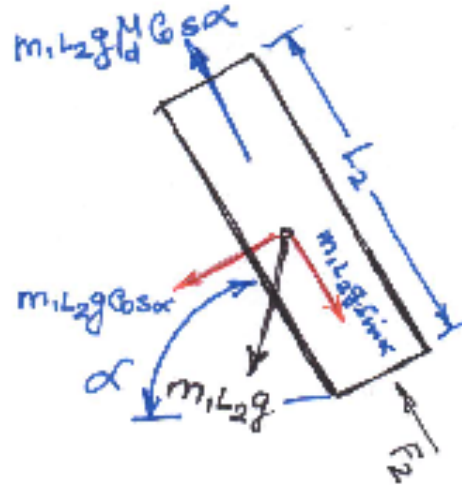
$$F_1 = m_1 L_1 (\mu_d g + a)$$

where F_1 is the force exerted on the parts in section AB by the remainder of the parts in the feed track, and a is the initial acceleration of all the parts.



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Similarly, the column of parts in the straight inclined portion *CD* of the feed track is partly restrained by a force F_2 , given by

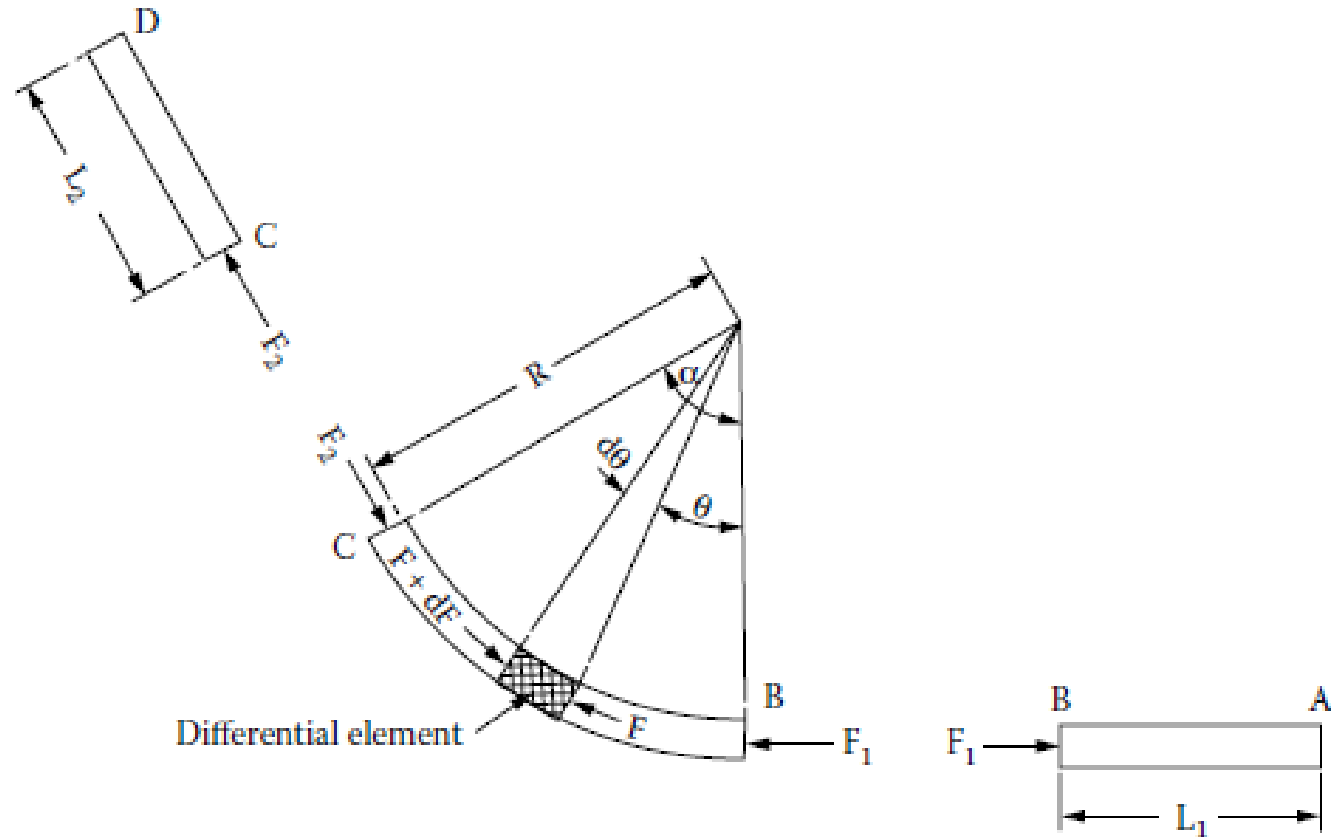


$$F_2 - m_1 L_2 g \sin \alpha + m_1 L_2 \mu_d g \cos \alpha = m_1 L_2 a$$

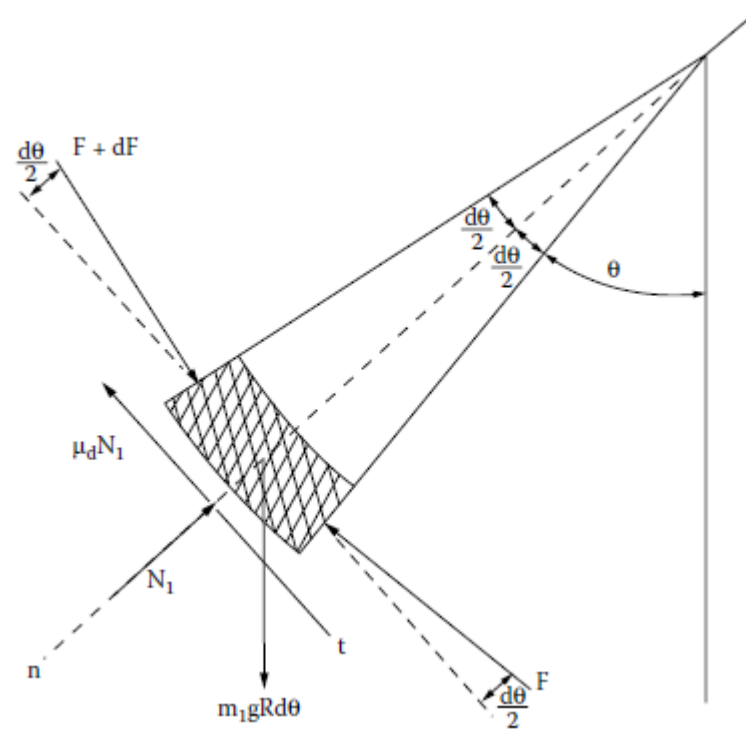
$$F_2 = m_1 L_2 (g \sin \alpha - \mu_d g \cos \alpha + a)$$



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To analyze the motion of the parts in the curved section *BC* of the feed track, it is necessary to consider an element of length $Rd\theta$ on a portion of the track that is inclined at an angle θ to the horizontal.



Free body diagram for an element

In this case, a force F resists the motion of the element, and a force $(F + dF)$ tends to accelerate the element. These forces have a small component $F d\theta$ that increases the reaction between the parts and the track and, consequently, increases the frictional resistance.



The equilibrium equation of forces in the radial direction n is

$$N_1 = m_1 g R \cos \theta d\theta + F d\theta$$

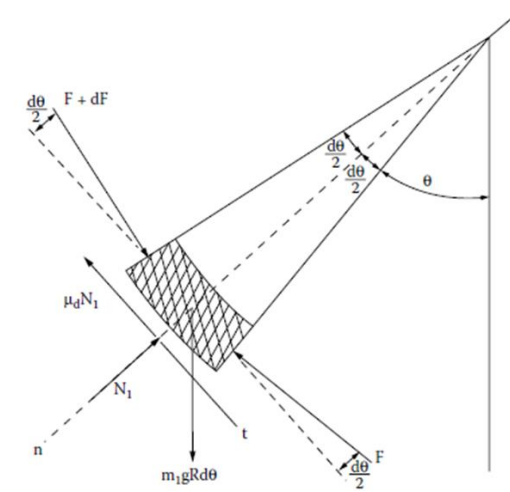
Ignoring $dF d\theta$

The equation of motion in the tangential direction t is

$$dF + m_1 g R \sin \theta d\theta - \mu_d N_1 = m_1 R a d\theta$$

rearranging the terms, the following first-order linear differential equation with constant coefficients is obtained:

$$\frac{dF}{d\theta} - \mu_d F = m_1 R (a + \mu_d g \cos \theta - g \sin \theta)$$





The general solution to Equation

$$F = Ae^{\mu_d \theta} + m_1 g R \left[\frac{(1 - \mu_d^2) \cos \theta + 2\mu_d g \sin \theta}{1 + \mu_d^2} - \frac{a}{\mu_d g} \right]$$

This equation relates the acceleration of the line of parts along the curved and horizontal sections of the track when a force F is applied to the end of the line located at an angle θ .

There are two applicable boundary conditions: $\theta = 0$, $F = F_1$, and $\theta = \alpha$, $F = F_2$. The first boundary condition gives

$$A = F_1 - m_1 g R \left(\frac{1 - \mu_d^2}{1 + \mu_d^2} - \frac{a}{\mu_d g} \right)$$



Using this second boundary condition and solving Equation 5.8 for a/g , we obtain

$$\frac{a}{g} = \frac{(L_2/R)(\sin \alpha - \mu_d \cos \alpha) - (L_1/R)\mu_d e^{\mu_d \alpha} + \{[(1 - \mu_d^2)(e^{\mu_d \alpha} - \cos \alpha) - 2\mu_d \sin \alpha]/(1 + \mu_d^2)\}}{(L_2/R) + (L_1/R)e^{\mu_d \alpha} + (e^{\mu_d \alpha} - 1)/\mu_d}$$

This equation shows the relationship between the non-dimensional acceleration a/g of the entire line of parts and the design parameters L_2/R , L_1/R , α , and μ_d .

the time t_p for one part to move into the workhead can be found from the kinematic expression

$$t_p = \left(\frac{2L}{a} \right)^{1/2}$$

Equation can be approximated as

$$\frac{a}{g} = f_1(\mu_d) + f_2\left(\frac{L_1}{R}\right) + f_3(\alpha) + f_4\left(\frac{L_2}{R}\right)$$



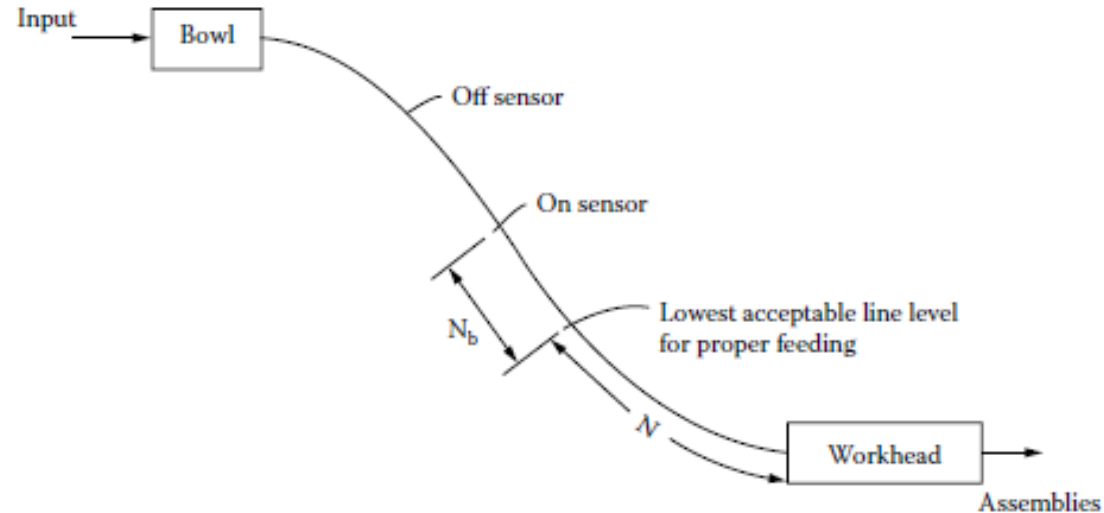
ON – OFF Sensors

- When automatic feeding devices are used on assembly machines, the mean feed rate is usually set higher than the assembly rate to ensure a continuous supply of parts at the workhead.
- Under these circumstances, the feed tracks become full, and parts back up to the feeder.
- For vibratory-bowl feeders, however, this method is not always satisfactory. With these feeders, the parts in the line in the feed track are usually prevented by a pressure brake from interfering with the orienting devices mounted on the bowl-feeder track. If a part filters past the orienting devices and arrives at the pressure break when the delivery chute is full, it is rejected back into the bowl. If this occurs too frequently, excessive wear to both the bowl and the parts can result.



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To solve the problems caused by overfeeding and, consequently, ease the problem of wear, a simple control system can be employed that incorporates sensing devices located at two positions on the feed track.



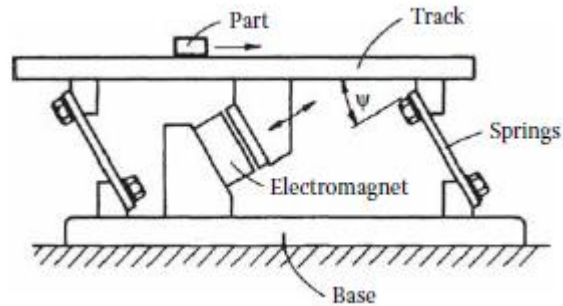


Powered Feed Tracks

Most commons are:

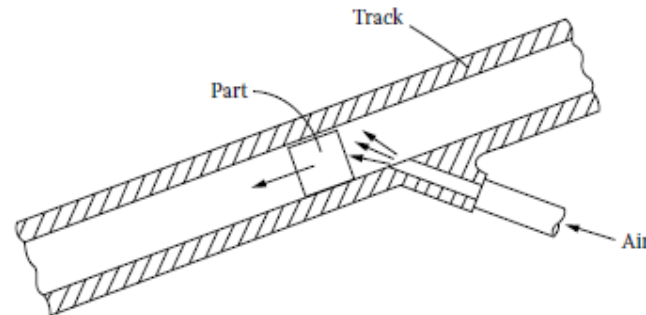
1. Vibratory Tracks
2. Air-assisted Tracks

Vibratory Tracks:



- Operates at the same principle as the vibratory bowl feeder.
- It is found that the mean conveying velocity for a wide range of μ will be given by:
$$V_m = \frac{4500}{f} \text{ mm/s, for } \psi = 20^\circ \text{ and } \frac{A_n}{g_n} = 1.2$$
 f is the frequency of vibration

Air-Assisted Tracks:



These are often gravity feed tracks with air jet suitably placed to assist the transfer of parts.

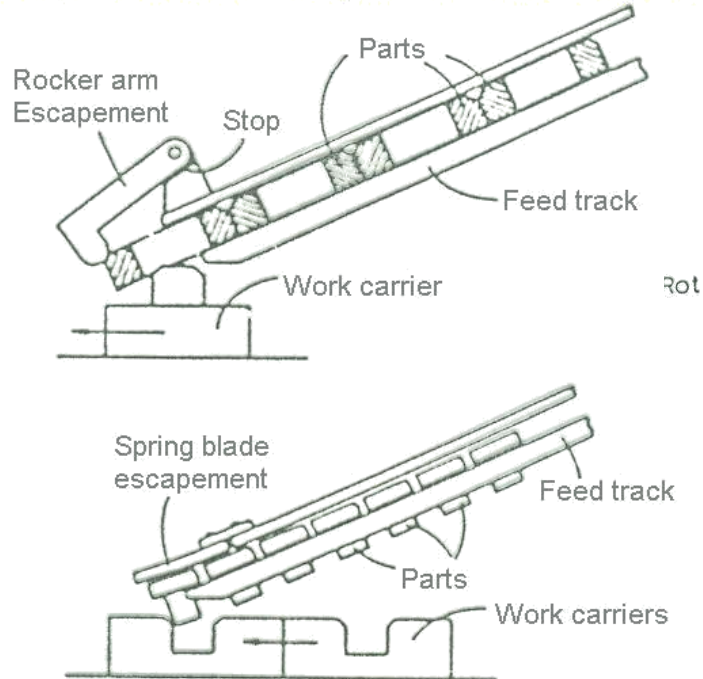


Important Points of all types of Feed Tracks

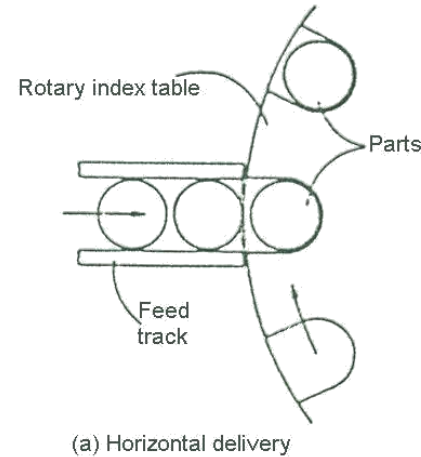
- For good space utilization a feed track should not be too long
- Feed tracks besides acting as a transfer device, provides a buffer stock of parts which, if a blockage occurs, will allow the workhead to continue operating for a limited period
- In the event of a blockage, the parts are readily accessible. For this reason, feed tracks should be designed to allow easy access to all parts of the track

Escapements

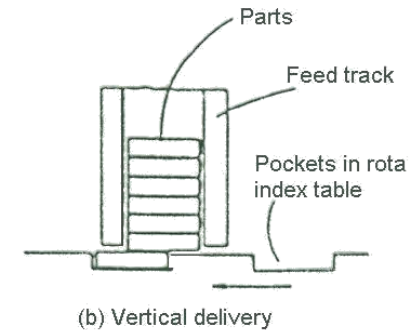
Escapements are activated by the work carrier and parts



Simplest type of escapement where parts are pulled from the feed track by the work carrier and the escapement itself consists of only a rocker arm and a spring blade

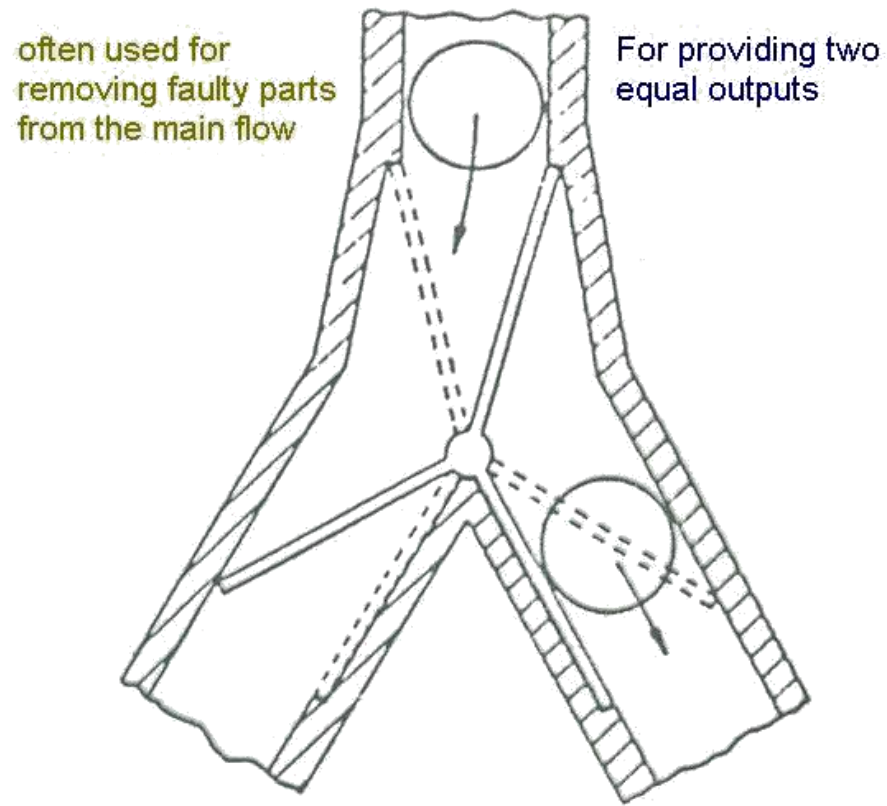


Act as part placing mechanisms



Escapements

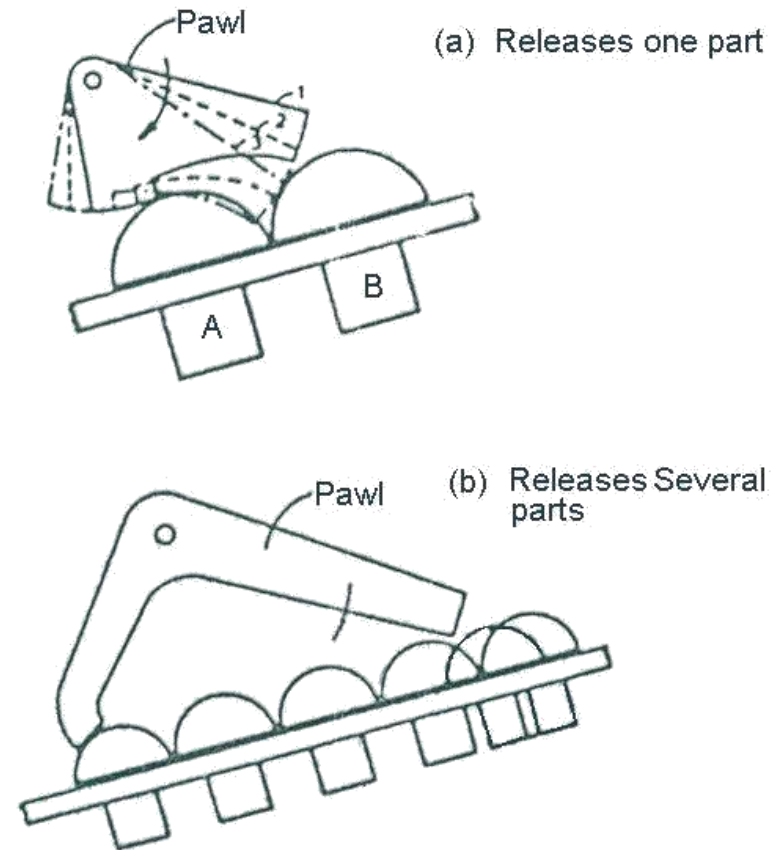
Gate Escapement



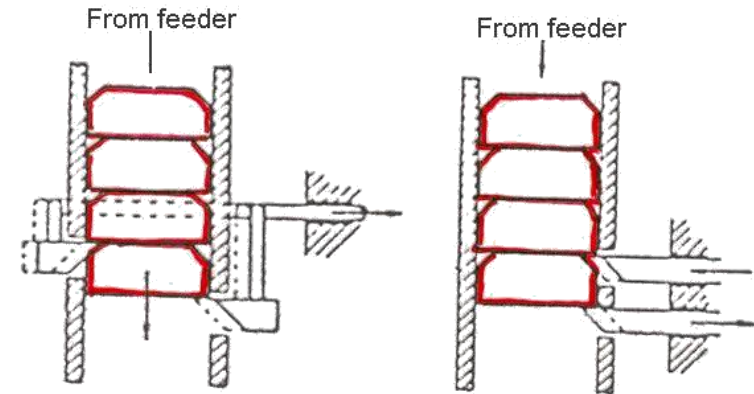
Main Use:

To provide an alternative path for parts

Ratchet Escapements



Operated by linear motion

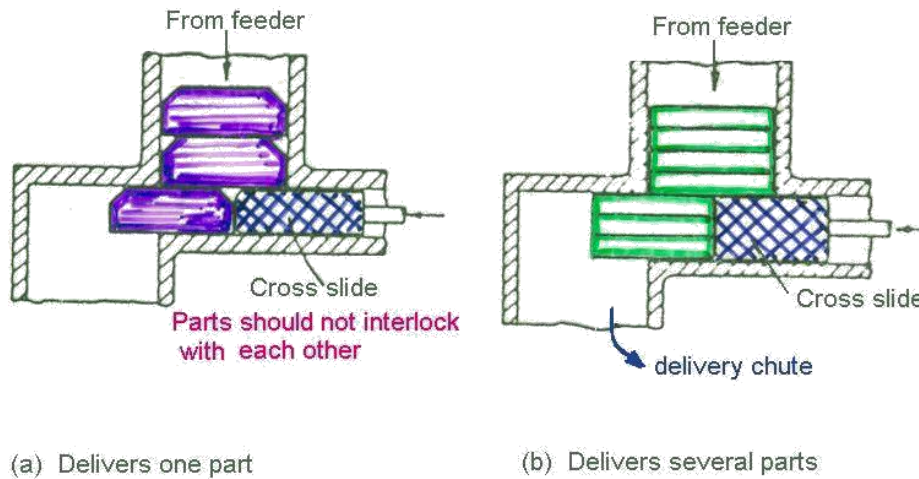


Parts should have suitable gaps between their outer edges.

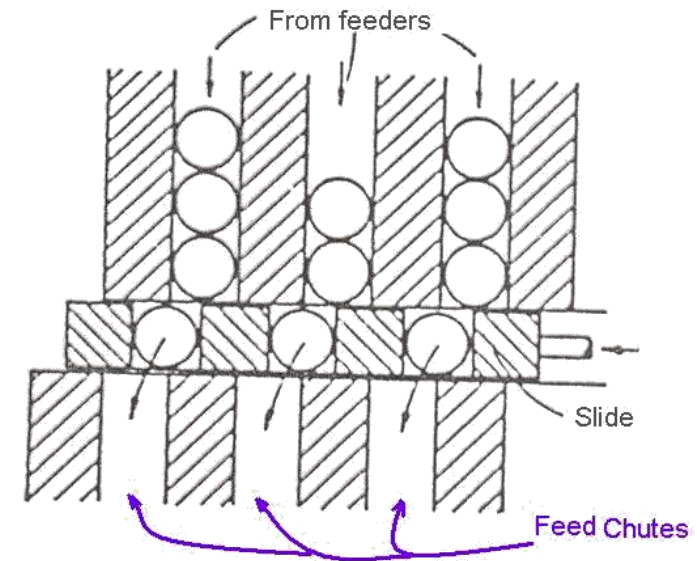
The figures of ratchet escapement may be operated together or independently by cams, solenoids or pneumatic cylinders giving a linear motion



Slide Escapements delivering into single feed chute

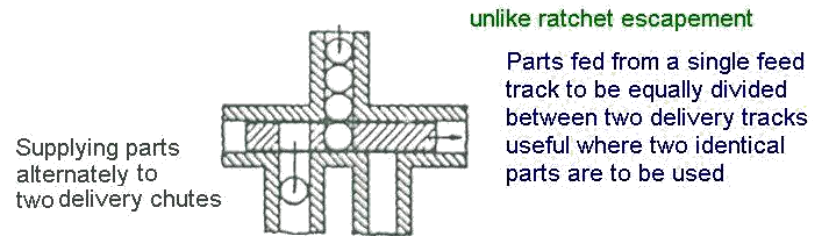
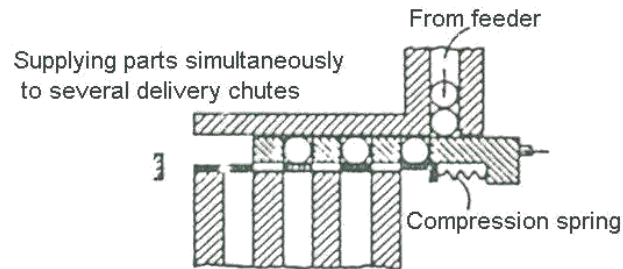


Slide Escapements operating several feed chutes

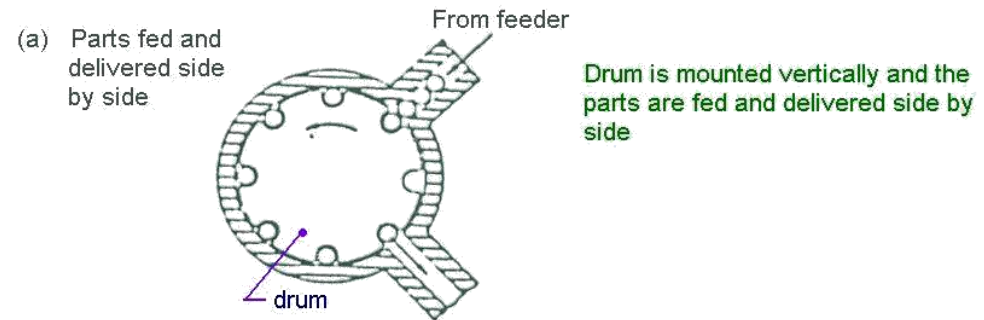


For Parts: spherical cylindrical or plates

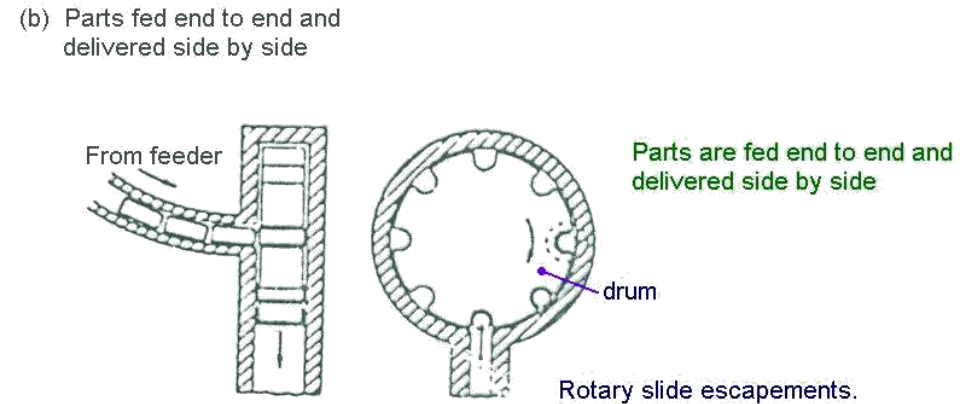
Slide Escapements supplying two or more delivery chutes from a single feed chute



Drum Escapement

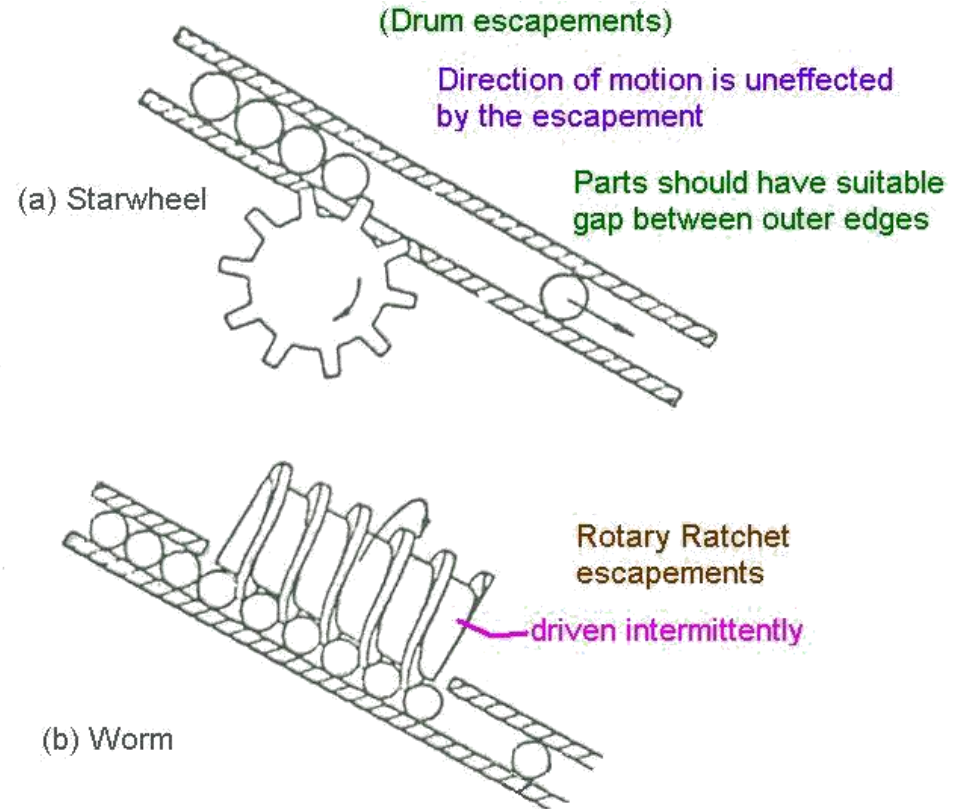


On passing through the escapement the parts can be turned through a given angle



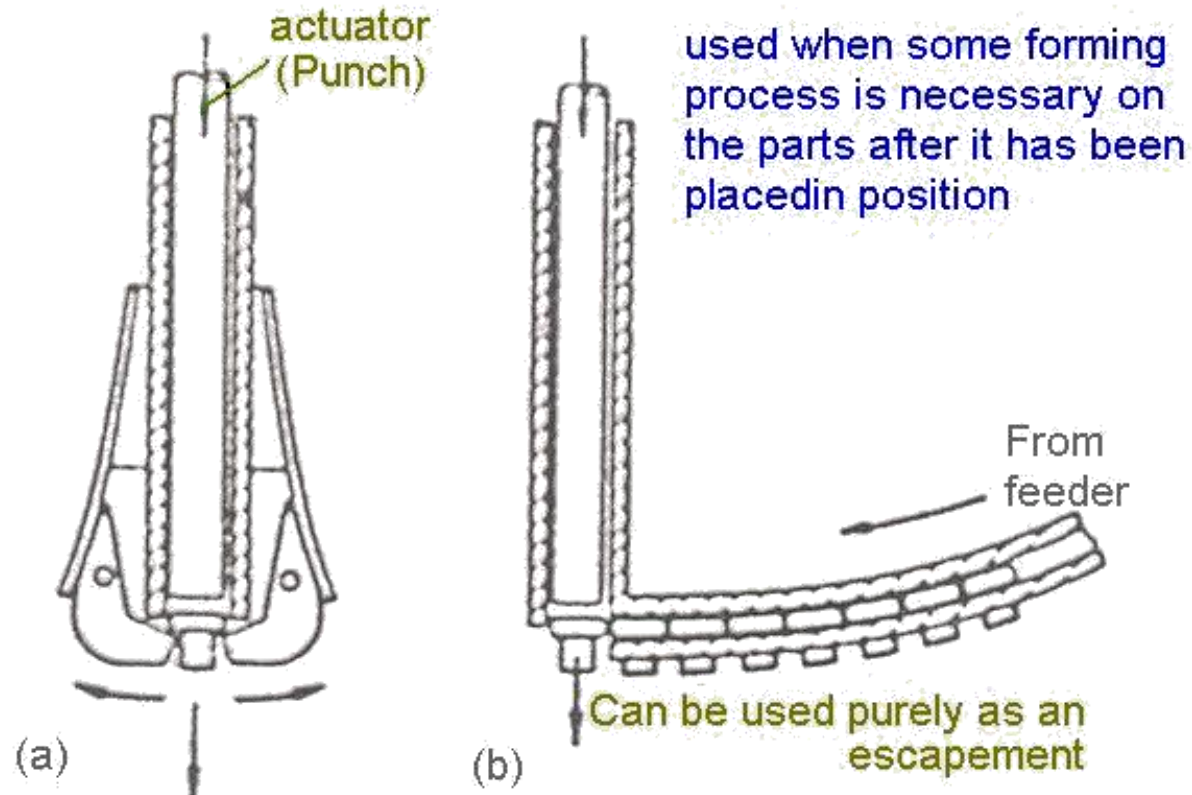


Star Wheel and Worm Escapements





Jaw Escapement





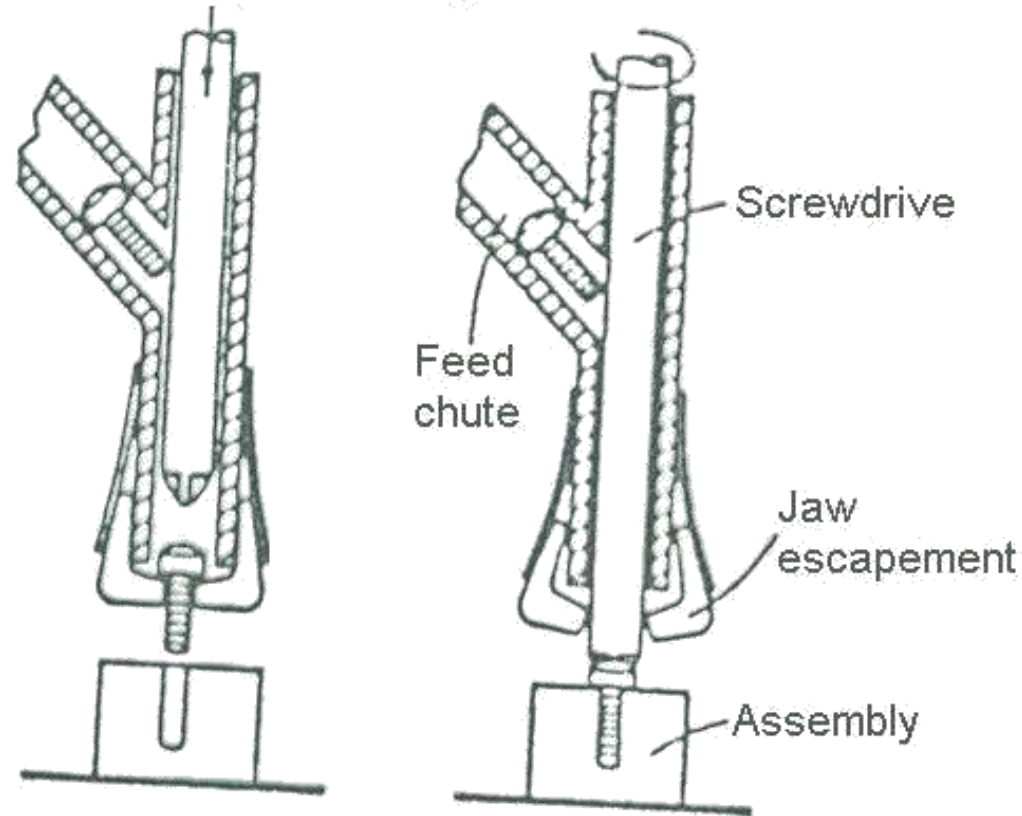
By far the most widely used parts-placing mechanism is a conventional gravity feed track working in conjunction with an escapement. This system of parts placing is probably the cheapest available, but it has certain limitations:

1. It may not be possible to place and fasten parts at the same position on the machine because of interference between the feed track and the workhead. This would necessitate a separate workstation for positioning the part, which would result in an increase in the length of the machine. It then becomes necessary to retain the part in its correct orientation in the assembly during transfer.
2. If a close fit is required between the part and the assembly, the force due to gravity may not be sufficient to ensure that the part seats properly.
3. If the part cannot be suitably chamfered, the gravity feed track may not give the precise location required.

Part Placing Mechanisms

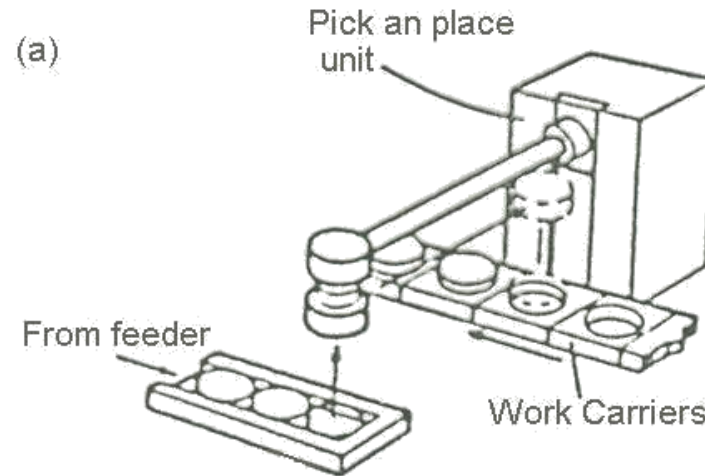
For placing of screws and rivets, which together form a large proportion of all part placing requirements, and where the tool activates the escapement and applies the required force to make assembly possible, the gravity feed track is invariably used.

Screw placing and driving



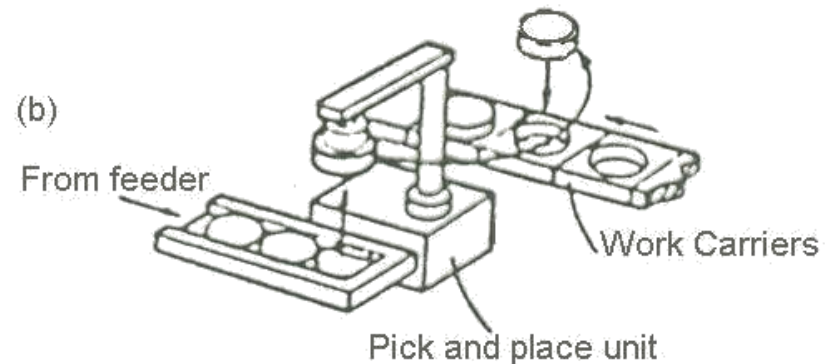


Part Placing Mechanisms



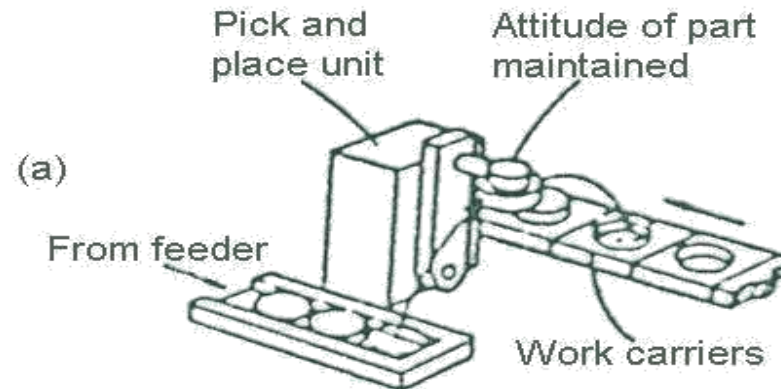
Part is picked up from the feed track by means of mech., magnetic or vacuum hand

Picks up job vertically transfers along a straight path horizontally and place vertically

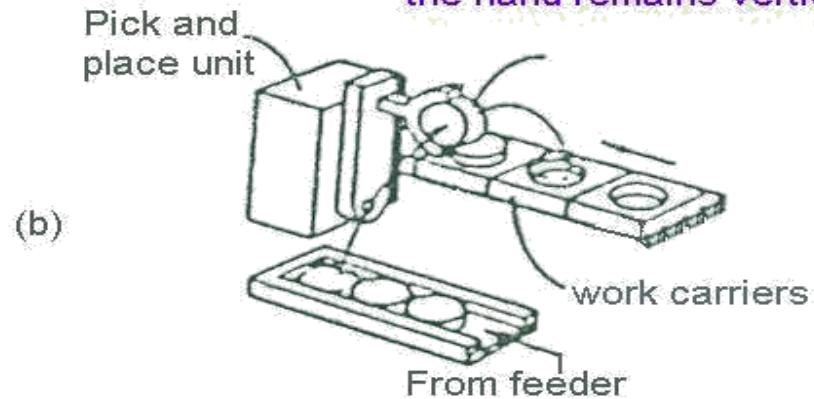


Picks up job vertically, transfers around the arc of a circle in horizontal plane and places vertically

Part Placing Mechanisms



Picks and places by rotary motion of the transfer arm in a vertical plane and throughout transfer, the hand remains vertical



The part is turned over during the operation