

Parts Transfer System

Field of the Invention

[0001] The present invention relates to a part transfer system. In particular, the invention relates to a feeding apparatus for a parts transfer system for feeding thin flat panel, such as semiconductor packages during operation of the parts transfer system.

Background

[0002] Automation machines with a pick and place mechanism commonly adopt vacuum suction cups for picking up parts and pneumatic air cylinders to transfer the parts to another location. Typically, the pick and place mechanism consists of a vertical stroke cylinder coupling with a horizontal transferring cylinder that perform the pickup stroke to engage and disengage parts and transferring parts. The speed of part transfer is controlled by adjusting throttle valves of the pneumatic air cylinders.

[0003] There are setbacks of using the pick and place mechanism. Firstly, the return stroke of the pick and place process does not carry any part and therefore the actual work done is only half the duty cycle, resulting in loss of overall working efficiency. Secondly the throttle valves are required to be opened up fully to allow more sufficient air into the slide before it operates the pick and place process at high speed. This would result in large impact exerted at the end of each the cylinder stroke. Though shock absorbers are provided at each end of the cylinder, prolong high impact will nevertheless reduces the life of the cylinder and the Mean Time Between Failure (MTBF) rate. Thirdly, the sudden impact experienced at the end of each stroke translates to the picked up parts which will affect the part negatively.

[0004] One known method is the use of a computer-aided manufacturing (CAM) system driven mechanism. Vacuum suction cups are also used for picking and transferring the parts. The transfer speed of this CAM system driven mechanism

depends on the speed of a motor driving the CAM system. However, the work done in transferring a part is also half the duty cycle as return stroke does not carry any parts.

[0005] The aforementioned setbacks are concerns when the parts to be transferred are rigid and thin, such as encapsulated semiconductor packages that often require to be picked and placed during the singulation process. Such parts are generally made in a form of a thin panel having a flat top surface, and they are susceptible to impact and external force exerted thereto.

[0006] US patent number US 6,733,006 relates to a rotatable pneumatic feeding head for picking up envelopes via negative pressure. The feeding head provides an air valve which can turn on or off the negative air pressure when the air pressure is no longer needed. However, it is understood to the skilled persons that such configuration is used for transferring flexible sheet.

Summary

[0007] In accordance with one aspect, there is provided a feeding apparatus for feeding rigid parts, the feeding apparatus comprises a pulley arm; a driver pulley mounting on the pulley arm, the driver pulley operable to rotate about an axis; and a sleeve rotatably mounting on the pulley arm via a hollow shaft, the sleeve defines a plurality of through holes to provide air path for continuous suction through the hollow shaft, wherein the sleeve is driven to rotate by the driver pulley, wherein the pulley arm is pivotable about the axis co-axial with the driver pulley, thereby the rotation of the driver pulley is independent of the rotation of the pulley arm.

[0008] In accordance with one embodiment, the driver pulley may be driven by a driver motor. It is possible that the driver pulley drives the sleeve to rotate via a belt. The belt may be a timing belt having integral gears. The timing belt may have a plurality of holes, each corresponds to a through hole of the sleeve and the sleeve may be a pulley having the plurality of through holes defined thereon. It is also possible that the belt defines a plurality of holes correspond to the through holes of the pulley.

In this embodiment, the sleeve may be attached with a pulley operable to be driven to rotate by the driver pulley via the belt.

[0009] In accordance with another embodiment, the air path for continuous suctions may be adapted to face the rigid parts. Also, the hollow shaft may be statically attached to the pulley arm.

[0010] In accordance with yet another embodiment, the hollow shaft is connecting to a vacuum pump for providing suction.

[0011] In accordance with another aspect of the present invention , there is provided a parts transfer system for transferring rigid parts from one location to another, the apparatus comprises a parts loader for loading the rigid parts to be transferred; a conveyer for conveying the rigid parts to be transferred to the another location; and a feeding assembly for feeding the parts to be transferred from the parts loader to the conveyer. The feeding apparatus comprises a pulley arm; a driver pulley mounting on pulley arm, the driver pulley operable to rotate about an axis; and a sleeve rotatably mounting on the pulley arm via a hollow shaft, the sleeve defines a plurality of through holes to provide air path for continuous suctions through the hollow shaft, wherein the sleeve is driven to rotate by the driver pulley; wherein the pulley arm is pivotable about the axis co-axial with the driver pulley, thereby the rotation of the driver pulley is independent of the rotation of the pulley arm.

[0012] In accordance with one embodiment, the driver pulley may be driven by a driver motor. It is possible that the driver pulley drives the sleeve to rotate via a belt. The belt may be a timing belt having integral gears. The timing belt may have a plurality of holes, each corresponds to a through hole of the sleeve and the sleeve may be a pulley having the plurality of through holes defined thereon. It is also possible that the belt defines a plurality of holes correspond to the through holes of the pulley. In this embodiment, the sleeve may be attached with a pulley operable to be driven to rotate by the driver pulley via the belt.

[0013] In accordance with another embodiment, the air path for continuous suction may be adapted to face the rigid parts. Also, the hollow shaft may be statically attached to the pulley arm.

[0014] In accordance with yet another embodiment, the hollow shaft is connecting to a vacuum pump for providing suction.

Brief Description of the Drawings

[0015] This invention will be described by way of non-limiting embodiments of the present invention, with reference to the accompanying drawings, in which:

[0016] FIG.1 illustrates a cross sectional side view of a parts transfer system in accordance with an embodiment of the present invention; and

[0017] FIG. 2 illustrates an enlarged view of portion of the parts transfer system of FIG. 1.

Detailed Description

[0018] In line with the above summary, the following description of a number of specific and alternative embodiments are provided to understand the inventive features of the present invention. It shall be apparent to one skilled in the art, however that this invention may be practiced without such specific details. Some of the details may not be described at length so as not to obscure the invention. For ease of reference, common reference numerals will be used throughout the figures when referring to the same or similar features common to the figures.

[0019] The present invention provides a feeding apparatus for a part transfer apparatus. The feeding apparatus includes a pivotable arm for mounting a driver pulley and a vacuum pulley. Operationally, the driver pulley drives the vacuum pulley to rotate. The vacuum pulley provides a continuous vacuum suction for lifting parts to be transferred against itself, and the rotations of the vacuum pulley draw the parts from one location to another. In operation, the arm remains pivotable on the feeding apparatus. The present invention is suitably used for feeding rigid parts that are susceptible to impact.

[0020] FIG. 1 illustrates a cross sectional view of a parts transfer system **100** in accordance with one embodiment of the present invention. The feeding apparatus is adapted for conveying encapsulated semiconductor packages **101** to a cutting device (not shown) for singulation. For easy reference, the encapsulated semiconductor packages **101** may also refer to as “the part” hereinafter. The parts transfer system **100** comprises a parts loader **110**, a conveyer **120** and a feeding assembly **130**. The parts loader **110** includes a chamber **112** for loading a stack of semiconductor packages **101**, and a lifter **114** for lifting the semiconductor packages **101** to eject from the chamber **112**. The chamber **112** has a top opening **113** and one of the edges of the top opening **113** defines a channel **115** for allowing the semiconductor packages **101** to be ejected therefrom by way of a generally horizontal sliding movement relative to the chamber **112**. The lifter **114** is movable vertically within the chamber **112** in a predetermined speed controlled by a controller (not shown). As the lifter **114** is moving upward, the

loaded semiconductor packages **101** are lifted up towards the opening **113** for ejecting from the chamber **112**. The semiconductor packages **101** are re-loaded onto the parts loader **110** by replacing another chamber **112** loaded with semiconductor packages **101**. The conveyer **120** is located by the parts loader **110**, where one end of the conveyer **120** precedes the channel **115** of the chamber **112**, from which, the semiconductor packages **101** ejected from the chamber **112** through the channel **115** are conveyed to another end of the conveyer **120**. The conveyer **120** comprises two pulleys **122** operationally rotate in a same direction and a conveying belt **121** forming a continuous loop rotates about the pulleys **122**. When the conveyer **120** is powered, rotating the pulleys **122** (and conveying belt **121**) in a clockwise direction, articles (i.e. the semiconductor packages **101** for the present embodiment) on the conveying belt **121** move forward (from left to right in FIG. 1).

[0021] Still referring to FIG. 1, the feeding assembly **130** comprises a pulley arm body **131**, a driver pulley **132**, a tensioner **133**, a timing belt **134** and a vacuum pulley **150**. The feeding assembly **130** is mounted generally above the conveyer **120** having a portion extended slightly over the channel **115** of the opening **133** for allowing contact with the semiconductor packages **101**. The pulley arm body **131** serves as a mounting frame for supporting the driver pulley **132**, the tensioner **133** and the vacuum pulley **150** on the parts transfer system **100**. The pulley arm body **131** is pivoted on the parts transfer system **100** for allowing the extended portion of the feeding assembly **130** swivels about a pivot axis. The driver pulley **132** is rotatably mounted co-axially with the pivot axis the pulley arm body **131**, whereby rotations of the pulley arm body **131** is independent of rotations of the driver pulley **132**. The driver pulley **132** is connected to a driver motor (not shown). A stopper **136** is provided at the bottom of the pulley arm body **131** for limiting the rotations of the pulley arm **130** so that the pulley arm **130** may rest at a suitable position for the operation of the parts transfer system **100**. The stopper **136** would also prevent the pulley arm **130** is not overly swung. The vacuum pulley **150** is pivoted, away from the driver pulley **132**, at the extended portion of the pulley arm **130** (and the pulley arm body **131**) via a hollow shaft **152**. Rotations of the vacuum pulley **150** are remotely driven by the driver pulley **132** via the timing belt **134**. A tensioner **133**, mounting

between the driver pulley 132 and vacuum pulley 150, is further provided for tightening the timing belt 134. It is understood to a skilled person that the driver pulley 132 and the vacuum pulley 150 have integral teeth 138, 154 with profiles for coupling with the timing belt 134.

[0022] FIG. 2 shows an enlarged cross sectional view of the vacuum pulley 150 of FIG. 1. The vacuum pulley 150 is pivoted on the pulley arm body 131 with part of its body exposes from the pulley arm body 131 so that when the feeding assembly 130 is in a rested position, the vacuum pulley 150 (the timing belt 134) is in contact with the semiconductor packages 101. The hollow shaft 152 pivoting the vacuum pulley 150 has an air passage 155 downwardly facing the chamber 112. The direction, to which the air passage 155 is facing, is also facing the exposed part of vacuum pulley 150. Each cut 156 between the integral teeth 154 of the vacuum pulley 150 defines a through hole 157 for aligning with the air passage 155. Depending on the size of the air passage 155, there may be more than one through holes 157 aligning with the air passage 155 at any one time. Correspondingly, a hole at each integral tooth 139 of the timing belt 134 is provided so that when the integral teeth 154 are gearing with the integral teeth 139, it forms an air path from the hollow shaft 152, through the air passage 155, through the aligned through holes 157 and the holes of the timing belt 134. The hollow shaft 152 is directly connected to a vacuum generator (not shown) through a flexible tube.

[0023] Still referring to FIG. 2, the semiconductor packages 101 fully loaded in the chamber 112 are loaded at the parts loader 110. When the parts transfer system 100 is powered up, the driver pulley 132 rotates to drive the vacuum pulley 150 via the timing belt 134. The vacuum generator creates a negative pressure by withdrawing the outside air through the air path of the vacuum pulley 150. Concurrently, the lifter 114 lifts the stack of semiconductor packages 101 towards the opening 113 of the chamber 112. When the top most semiconductor packages 101 is raised to a level where the channel 115 is defined, the rotating vacuum pulley 150 is in contact with the top most semiconductor packages 101. The vacuum pulley 150 starts to feed the semiconductor packages 101 to the conveyer 120 onwards to another side of the conveyer 120 for

singulation. While the vacuum pulley **150** is rotating, the timing belt **134** feeds the semiconductor package **101** by friction force to bring the semiconductor package **101** to the conveyer **120**. The negative pressure (suction force) further lifts the semiconductor package **101** against the timing belt **134** for providing a better grip during the parts transferring. It is to be noted that during the operation, the feeding assembly **130** remains rotatable about the pivot axis co-axial with the drive pulley **132**.

[0024] Still referring to FIG. 2, the vacuum pulley **150** is adapted to provide continuous suction throughout the operation. Accordingly, the air passage **155** of the hollow shaft **152** requires a large opening relative to the through holes **157** caters for continuous air paths while the vacuum pulley **150** is rotating. As illustrated, the perimeter of the air passage **155** covers about four through holes **157** at any one time, i.e. when the vacuum pulley **150** is rotating and when the vacuum pulley **150** is staying still. To maintain continuous suction for lifting up the parts **101** to be transferred throughout the operation, the hollow shaft **152** is statically attached to the pulley arm body **131**, thereby the air passage **155** of the hollow shaft **152** is generally facing downward, i.e. towards the parts loader **110**. Further, it is required that feeding speed by the vacuum pulley **150** and the lifting speed by the lifter **114** are controlled to provide a smooth transition.

[0025] Referring back to FIG. 1, the parts transfer system **100** is configured to minimize the weight exerting on the semiconductor packages **101** to prevent damages to the parts. Therefore, each component of the feeding assembly **130** is made up of light material, for example, aluminum. Further, as the driver motor is not connected to the vacuum pulley **150** directly, the weight applying on the semiconductor packages **101** can also be kept minimal. In operation, the lifter **114** is configured to lift up the semiconductor packages **101** in a continuous manner. As the feeding assembly **130** is pivoted on the parts transfer system **100**, the feeding assembly **130** does not exert additional force onto the semiconductor packages **101** as the lifter **114** is lifting up the semiconductor packages **101**. In a situation when the vacuum pulley **150** fails to feed the semiconductor packages **101** to the conveyer **120**, thereby causing the semiconductor packages **101** accumulated on the parts loader **110** while the lifter **114** is

lifting the parts, the vacuum pulley **150** raises accordingly to prevent additional weights exert onto the semiconductor packages **101**. By the same token, when the lifting speed by the lifter **114** exceeds a speed required for the smooth transition, the vacuum pulley **150** raises accordingly. Likewise when the feeding speed falls below a speed required for the smooth transition.

[0026] In accordance with another embodiment, the parts transfer system **100** further includes a controller and sensors for controlling the operations of the parts transfer system **100**. The controller controls the overall operation's speed for providing a smooth transition. When the controller detects any malfunctions on the parts transfer system **100** via the sensors, the controller may cut off the operations. Taking the above example, when the vacuum pulley **150** fails to operate, and the sensor detects that the feeding assembly **130** had reached a certain height threshold, the controller cuts off the entire operation to prevent damages to the semiconductor packages **101**.

[0027] In accordance with yet another embodiment, the exposed portion of the feeding assembly **130** is adjusted to have the vacuum pulley **150** at a slightly higher level above the top most semiconductor package **101** at rest. That can easily be achieved by adjusting the position of the stopper **136** or any stopping means attached beneath the feeding assembly **130**. In operation, when the stack of semiconductor packages **101** is lifted when they are is lifted near the opening of the chamber **112**, the rotating vacuum pulley **150** lifts the top most semiconductor package **101** against itself via the vacuum suction. The top most semiconductor package **101** is then drawn towards the conveyer **120** via the rotation of the vacuum pulley **150**. In this configuration, there is substantially no weight applying on the semiconductor packages **101** during the feeding process.

[0028] In the embodiment illustrated in FIG. 1, a timing belt **134** is used as a driving belt for driving the vacuum pulley **150**. It is to be appreciated that any other driving belt with/without integral gears can also be used for the pulley driving system. For example, a v-shaped belt with a v-shaped vacuum pulley would work as good.

[0029] According to the present invention, the driving belt can be configured to drive the vacuum pulley without obstruction to the air path so as to avoid holes on the driving belt. In one embodiment, the vacuum pulley **150** includes a sleeve attaching with a v-shape pulley and, both sleeve and the v-shaped pulley are adapted to fit over a hollow shaft. The sleeve and the v-shape pulley are rotatable about a hollow shaft. The sleeve has through holes defined along its round surface. The hollow shaft also defines an air passage that aligns with the through holes. A driver pulley drives the vacuum pulley **150** via a v-shape belt that holds onto the v-shaped pulley. It is possible that the round surface of the sleeve may further wrap with suitable rubber material (with holes) for improving the feeding process. Depending on the requirements, the sleeve and the v-shape pulley may have a same diameter size.

[0030] Referring back to FIG. 1, the parts loader **110** is used for loading parts to be transferred. For easy loading and unloading, a separate chamber **112** is provided for loading the parts. It is understood that, depending on the type of parts to be transferred, any magazines, cartridges or the like may be utilized.

[0031] The above embodiments provide fast and efficient parts transfer. The single directional actuation of the motor and the presence of the vacuum through the holes help to propel the parts continuously from one position to another. The speed of part transfer can be adjusted through a variable speed controller controlling the motor driving the pulley system. As the operational speed is dependent on the rotational speed of the vacuum pulley, there will be no additional (or very little) physical impact on the parts to be transferred.

[0032] In addition, the above embodiments provide a feeding process with almost zero idle time since there is no returning of stroke for picking the next part is involved. Parts are continuously propelled to a place position without succumbing to impact resulted from the conventional transfer mechanism.

[0033] In the above embodiments, semiconductor packages **101** are used as parts to be transferred by way of illustrations, not limitations. It is understood, from the

configurations and structures of the various embodiments, that the present invention is suitable for any rigid parts that are flat and thin, and yet it is susceptible to impact and external pressures during industrial process.

[0034] While specific embodiments have been described and illustrated, it is understood that many changes, modifications, variations and combinations thereof could be made to the present invention without departing from the scope of the invention.

Claims

1. A feeding apparatus for feeding rigid parts, the feeding apparatus comprising:
a pulley arm;
a driver pulley mounting on the pulley arm, the driver pulley operable to rotate about an axis; and
a sleeve rotatably mounting on the pulley arm via a hollow shaft, the sleeve defines a plurality of through holes to provide air path for continuous suctions through the hollow shaft, wherein the sleeve is driven to rotate by the driver pulley;
wherein the pulley arm is pivotable about the axis co-axial with the driver pulley, thereby the rotation of the driver pulley is independent of the rotation of the pulley arm.
2. The feeding apparatus according to claim 1, wherein the driver pulley is driven by a driver motor.
3. The feeding apparatus according to claim 1, wherein the driver pulley drives the sleeve to rotate via a belt.
4. The feeding apparatus according to claim 3, wherein the belt is a timing belt having integral gears.
5. The feeding apparatus according to claim 3, wherein the belt has a plurality of holes, each corresponds to a through hole of the sleeve.
6. The feeding apparatus according to claim 3, wherein the sleeve is a pulley having the plurality of through holes defined thereon.
7. The feeding apparatus according to claim 6, wherein the belt defines a plurality of holes correspond to the through holes of the pulley.

8. The feeding apparatus according to claim 3, wherein the sleeve is attached with a pulley operable to be driven to rotate by the driver pulley via the belt.
9. The feeding apparatus according to claim 1, wherein the air path for continuous suctions is adapted to face the rigid parts.
10. The feeding apparatus according to claim 1, wherein the hollow shaft is statically attached to the pulley arm.
11. The feeding apparatus according to claim 1, wherein the hollow shaft is connecting to a vacuum pump for providing suction.
12. A parts transfer system for transferring rigid parts from one location to another, the apparatus comprising:
 - a parts loader for loading the rigid parts to be transferred;
 - a conveyer for conveying the rigid parts to be transferred to the another location; and
 - a feeding assembly for feeding the parts to be transferred from the parts loader to the conveyer, the feeding apparatus comprising:
 - a pulley arm;
 - a driver pulley mounting on pulley arm, the driver pulley operable to rotate about an axis; and
 - a sleeve rotatably mounting on the pulley arm via a hollow shaft, the sleeve defines a plurality of through holes to provide air path for continuous suctions through the hollow shaft, wherein the sleeve is driven to rotate by the driver pulley;wherein the pulley arm is pivotable about the axis co-axial with the driver pulley, thereby the rotation of the driver pulley is independent of the rotation of the pulley arm.
13. The parts transfer system according to claim 12, wherein the driver pulley is driven by a driver motor.

14. The parts transfer system according to claim 12, wherein the driver pulley drives the sleeve to rotate via a belt.
15. The parts transfer system according to claim 14, wherein the belt is a timing belt having integral gears.
16. The parts transfer system according to claim 14, wherein the belt has a plurality of holes, each corresponds to a through hole of the sleeve.
17. The parts transfer system according to claim 14, wherein the sleeve is a pulley having the plurality of through holes defined thereon.
18. The parts transfer system according to claim 17, wherein the belt defines a plurality of holes correspond to the through holes of the pulley.
19. The parts transfer system according to claim 14, wherein the sleeve is attached with a pulley operable to be driven to rotate by the driver pulley via the belt.
20. The parts transfer system according to claim 12, wherein the air path for continuous suction is adapted to face the rigid parts.
21. The parts transfer system according to claim 12, wherein the hollow shaft is statically attached to the pulley arm.
22. The parts transfer system according to claim 12, wherein the hollow shaft is connecting to a vacuum pump for providing suction.