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A REVIEW OF CENTRIFUGAL FEEDER PARTS DESIGN FOR SMALL COMPONENTS

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ABSTRACT

Material handling is the process concerned with the movement, protection, storage and control of materials and products throughout manufacturing, warehousing, distribution, consumption and disposal. As a process, material handling incorporates a wide range of manual, semi-automated and automated filling equipment and systems that support logistics and make the supply chain work. It has been found in open literature surveythat centrifugal feeder is most suitable option used for feeding, counting and high speed orientation of small components such as candy, pins, pills, mechanical screws, nuts, ammunition for small arms etc. Main parts of Centrifugal feeder are disc, rim, bowl and shaft with driving mechanism. Present review mainly focuses on conceptual designing of the centrifugal feeder parts for small components.

KEYWORDS- Centrifugal Feeder, Conceptual Design, Inclined Disc, Material Handling, Small Components

1. INTRODUCTION

The centrifugal feeder is most suitable option for feeding, counting and high speed orientation of small parts such as candy, pins, pills, mechanical screws, nuts, ammunition for small armsetc. Simple arrangement and design of two rotating components of feeder namely the inner tilt disc and an outer turning flange of the bowl which as shown in Figure 1is used to arrange the object in a single file stream for counting and feeding process. The parts are moved from the inner disc to the outer periphery of disc where objects create a single file stream. The parts are then allowed to leave the rim at a predetermined exit point and are then actuated by an additional mechanism to orient the parts for further processing or to separate the counting pieces[1].

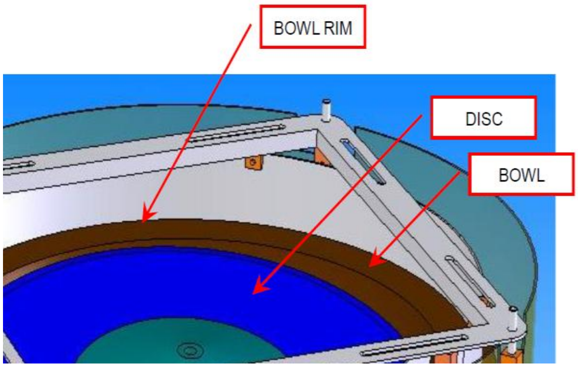

Figure 1.Main components of centrifugal feeder [2]

The primary objective of the centrifugal feeder is to improve the feeding of objects in series from a bulk feed specificallyfeeding and aligning objects with reduced abrasion andimpact damage. Secondary objective is to increase the range of permissible flow rates of a serial feeding device of improved anti-jamming character[3].

The main components of centrifugal feederwhich are describedin open literature are listed below.

(1) Disc
(2) Bowl
(3) Shaft
(4) Driving Mechanism

2. DISC

Edmunds et. al. [1] developed the centrifugal feeder with flat disc and wide bowl rim as shown in Figure 2 where disc rotate inside the bowl and their rotation plans are parallel. Disc rotating inside the bowl create reservoir and adjustable guide wall and changeable bowl rim gave freedom to use same feeder for different size and shape objects orientation. The objects centrifuge by high speed rotating disc to create single stream near periphery of disc where steady ramp took out the objects from the reservoir and deliver to the rim. The rim and the disc are either rotated with same or different speed, about their own axes of revolution.

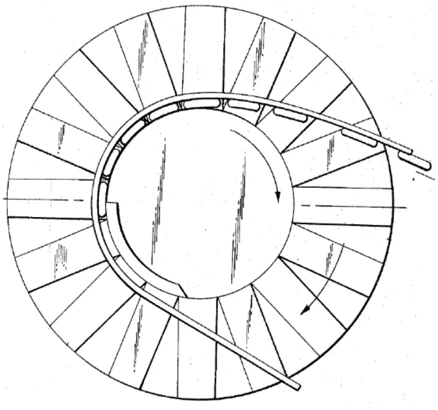

Figure 2. Flat Disc and Wide Bowl Rime with Adjustable Guide Wall [1]

Objects are sorted by centrifugal distributing action while accelerating them upon a rotating inner plane, discharging the accelerating objects in alignment upon an inclined stationary ramp at the periphery of the rotating inner plane, centrifugally carrying the objects in single file alignment away from the top of said ramp and upon a rotating outer rim; and guiding the objects across the rim so as to separate longitudinally orient and exit from the predefine exit point [1].

Ervine and Albert WG [3] designed centrifugal feeder with an idea of conical surface on disc as shown in Figure 3. The disc was mounted in inclined position in such meaner that its highest periphery point and the rim upper surface kept in one plan and work as transfer station for object which reduced the requirement of steady ramp for delivering the object from disc to rim. Another side is at lower elevation, forming a reservoir for objects to be fed. The upper work surface of the disc has created a non-planar surface such as a cone, spheroid or parabolic.The axis of the disc is inclined at an angle to the vertical, while that of the rim is preferably substantially vertical. These axes intersect at a point near the upper surface of the disc, so that the parts rotate substantially concentrically, although not coaxially.

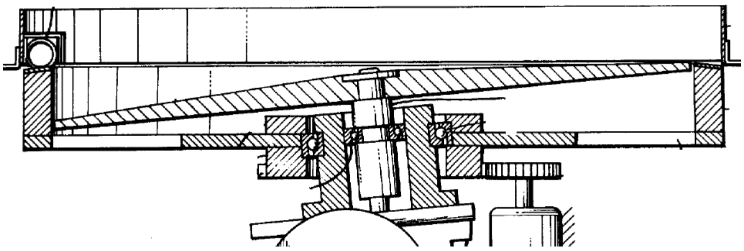

Figure 3. Centrifugal Feeder with Non- Planner Disc and Rim Surface [3]

These non-planer surfaces were formed upwards convex where their peaks were directed upwards and were symmetrical about their axes of revolution. The inclination of the axis of conical or curved disc causes a variation in the inclination or slope of its upper working surface and the rim. The slope is minimum at the point of delivery from disc to rim and maximum at the reservoir.This surface helps to sort the objects of the reservoir to distribute them externally against the rim mainly by gravity without requiring little or no aid by centrifugal force. The surface of the disc might become flat at the transfer station to allow an uncertain centrifugal force to roll or slide the objects out on the rim without gravity opposition [3].

A non-planar upwardly-convex form permits the disc to be rotated relatively at slower speed and thereby reduce impact and abrasion damage to the objects being fed. Distribution against the rim is induced primarily by gravity, since the disc has its maximum downward slope in the area of the reservoir, and this is aided by whatever centrifugal force is generated at the selected speed of rotation. The outward slope of the disc, assisted by centrifugal force, holds the objects in frictional engagement against the rim and the disc to prevent backsliding as the parts are elevated by rotation toward the discharge station. The surfaces of the disc or rim may have coatings of friction material if needed to prevent slipping of low-friction objects [3].

Clark and Ralph R. [4] were manufactured centrifugal feeder as shown in Figure 4 with coaxial rotating disk and conveying ring in the same horizontal plane which is covered by a large wall that provide guidance to objects when the feeder was functionally operated. In the initial stage of design, feeder had single disk which was rotating at high speed because of which it was difficult to fillthe objects. Researchers have tried to reduce this problem by increasing frictional contacts between objects and disc by using a high friction cork disc. But,high speed rotating objects were striking to each other or exit the path and get back force which resists their motion. So,the author added conveying ring. Conveying ring could rotate at any desired speed for getting desire feed rate perminute. High speed rotating disc convey bottle closure or gaskets to the conveying ring and ring took those object to the exit port.

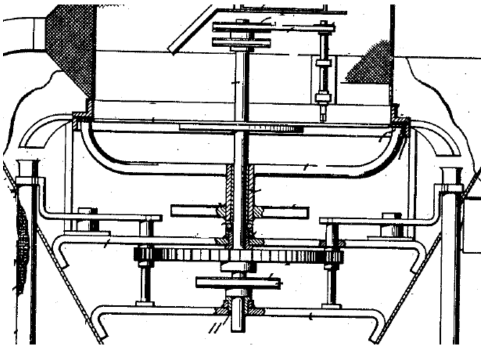

Figure 4. Horizontal Disc and Conveying Ring Design of Centrifugal[4]

Kelly and Leonard[5] developed the centrifugal feeder with single rotating member which had the conical surface to create a single row of the uneven object which was delivered by the conveyor belt to the feeder as shown in Figure 5. Over the conical surface, tangential bracket in the spiral configuration was mounted to give the direction to the objects. The inclination of the surface of the cone and the gravitational force gave rolling effect to the objects. Thus, when the objects are deposited on the rotating conical surface, the centrifugal force tends to slide it towards its outer periphery. Since bracketwas in a spiral configuration, it drives the objects in progressively increasing radial paths, effectively increasing their speed and spacing. This separation leaves room for objects deposited closer to the central part of the surface to slide in place against the guide strip and form a single row. This way, the objects are ejected into the bucket in a single row and thenonto the conveyor belt in a single row aligned approximately along the center line thereof.

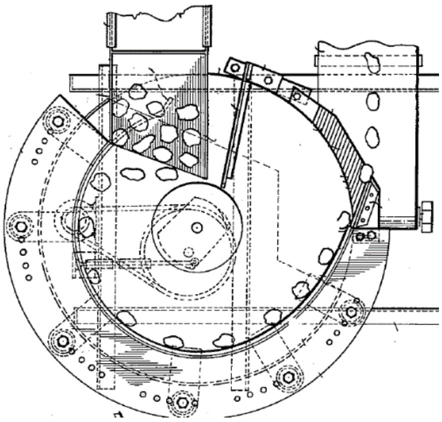

Figure 5. Single Conical Rotating Surface for Uneven Objects Orientation[5]

Boling and Monte J. [6] were worked to design the rotary feeder as shown in Figure 6 which had a disk installed inside the bin and rotated by the help of the pulley which is mounted on the disk. The pulley was connected to the external motor via an endless O-ring. The smaller pulley compared to the disk, space was created between the periphery of the pulley and the guide wall on the disk. The entire design is placed on the tilt bracket so that the disc is set in the tilting position. This tilting of the disc creates a reservoir at the underside and an upper side outlet is made. When the disc is rotated, the rings are centrifuged and slide into the wall of the guide and the ring jammed into space. The rings move with the disk and pass through the exit for the output. The extract of the guide wall at the outlet is designed such that the ring can reach the conveyor belt and the movement for that given by O-ring.

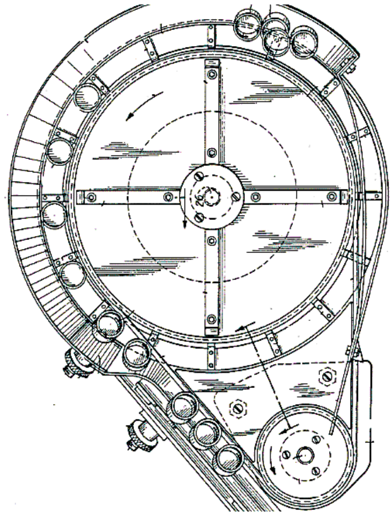

Figure 6. Rotary Feeder with Single Rotating Disc Which Rotate By Pulley and O-Ring [6]

Hilton and Sydney [7] worked on the centrifugal feeder which gave different shape of the inclined disc and bowl design of feeder. As shown in Figure 7, the tangential flanged central conical surface was specially designed for ring object and made of elastomer polymer to reduce the weight of the structure. The conical surface and gravitation force increase the downward force whereas the centrifugal force increases the force towards the outside simultaneously. Therefore, the ring moves rapidly downwards and rests near to the surface of the flange. Ring transfer to the flange edge by the spiral stationary ramp design which gave the direction to the rings and lifted from the bottom of the conical bowl and delivered to the edge of the flange. Conical surfaces with the tangent flange mounted on a shaft rotating by the unique drive mechanism thereby reduce the need for two different drive mechanisms for the rotation of disc and bowl assembly.

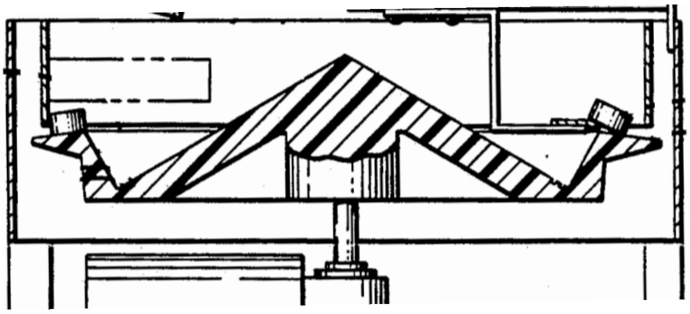

Figure 7. Rotary Feeder with Conical Surface with Tangential Flange [7]

When the disc rotated in the bowl, space was formed between the disc and the bowl, so that both rotated freely which would limit the usefulness of the centrifugal feeders in relation to very small or thin objects such as a washer, small pockets, Sweets wrapped in saran or other similar objects. Hoppmann and Kurt H. [8] solved this problem by extending the side of the disc by fixing a brush as shown in Figure 8 on the periphery of the disc to engage the side of the disc and the inner surface of the bowl for deliver the disc object to the rim so that the small object does not fall or load in the gap [8].

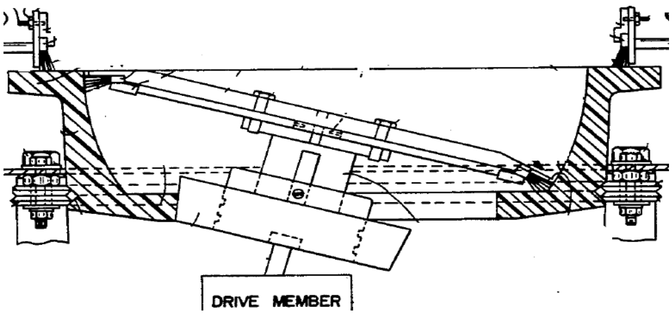

Figure 8. Disc Extension by Brush for Cover the Gap between Disc and Bowl [8]

Corbin and R. Scott [9]suggested another method for mounting the shaft in tilt position as shown in Figure 9by means of the universal union between the axis and the disc.

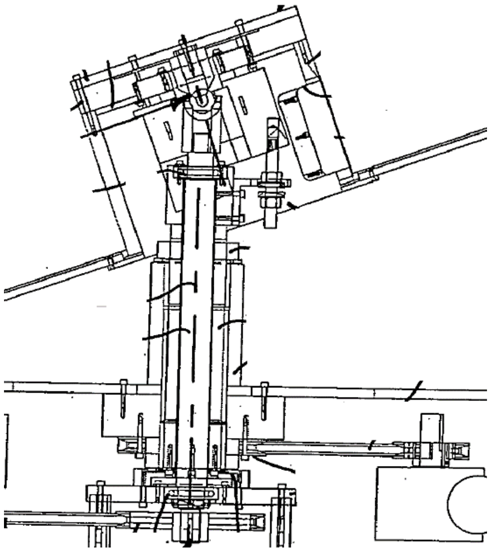

Figure 9. Rotary Feeder with Incline Disc by universal joint[9]

After having the review of all available information in open literature, it has been observed that position of the disc can be either horizontal orinclined. The disc needs high speed of rotation tocentrifugethe object. At high speed of rotation and with large centrifugal force generated in the reservoir, the objects start bumping violently against one another and against the rim. This problem can be minimized by a non-planar upwardly-convex form permits the disc to be rotated relatively at slower speed and thereby reduce impact and abrasion damage to the objects being fed.

3. BOWL

The bowl is second important rotating element placed around the disc found in centrifugal feeder literature. The inner surface of the bowl creates a reservoir for objects and the wide edge of the bowl allows a single conveyor to oriented and spaced apart to rely on the same rim. The spacing between the parts can be achieved at a precisely controlled speed without additional mechanism acting on the parts [1].The disc and the rim are driven at the same angular velocity, which had the effect of delivering a line of work pieces in an end-to-end stop and the advantage that the work pieces were not subjected to angular acceleration during their transfer from the disc to the rim. However, it may be desirable in some applications to space the parts along the delivery line [3].

The high friction surface of the rim has improved the efficiency of the object transport process which can be achieved by coating the surface with rubber material. The objects also slide and guide against the guide wall to reduce the sliding friction of the guide wall from a low friction surface such as polished stainless steel [1].

The invention presented by Hilton and Sydney [7] is a rotary feeder for feeding objects from a bulk storage facility to an orienting take away unit as shown in Figure 7.In presented design, the feed bowl was provided with a conical bottom surrounded by side walls extending upwardly and outwardly in communication with the bottom of the bowl. The side walls form an inclined angle of at least ninety degrees with the base or bottom of the bowl. This feeder used a bowl having vertical side walls and a stationary ramp to move objects out of the bowl. Once out of the bowl, the objects move through a flat surface by centrifugal force for ultimate distribution. This type of feeder needed sufficient centrifugal forces to move objects from the bottom of the bowl to the planner surface and to bring them to the exit point.

Fully oriented objects coming out of the feeder need to be checked for any physical damage or defects. Kenneway and Ernest K [10] made a centrifugal feeder design similar to the design made by Corbin and R. Scott [9] with inclined disc and bowl. When feeder functionally operated, objects are centrifuged by incline disc and delivered to the bowl rim from the disc at transfer station.The feeder includes a part feeding device with a perimeter track, a second track extending around the first track, a vision inspection system, and an ejector device. The part feeding device has a bowl around which the perimeter track extends for singulating, orienting and delivering oriented parts from a supply of loose non-aligned parts in the bowl along the perimeter track to a first output location. The second track is attached to the bowl feeder and includes a transparent floor extending at least partially around the bowl rim. The second track is configured to receive the oriented parts from the first output location and convey the received parts across the transparent floor to a second output location. The vision inspection system includes a controller and cameras operably connected to the controller, the cameras being oriented to look through the transparent floor and the controller being programmed to identify defective ones of the received parts based on information from the at least one camera.

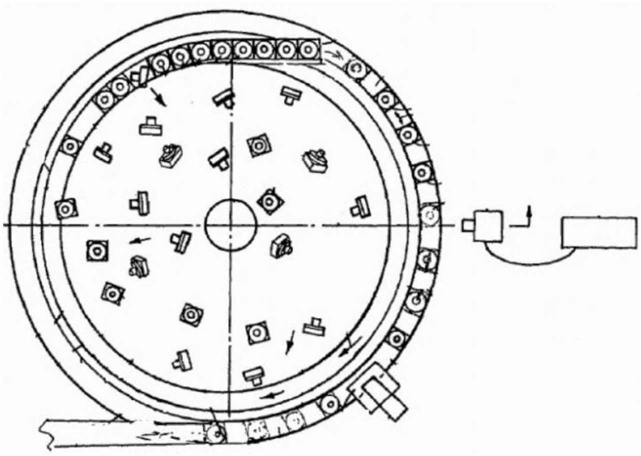

Figure 10. Second Transparent Track with the Vision Inspection System [10]

The main components of Centrifugal feedernamely the disc and bowl are usually made of metallic material either spun or cast metal. From economical and versatile view point, bowl and disc assembly are manufactured from nonmetallic material such as ultra-high molecular weight polypropylene resin which in turn reduce weight, power consumption and results in quieter operation[11].

Papsdorf et. al. [12] havesuggested the centrifugal feeder design with object control system including a number of air nozzles that are purposefully placed for creating a single order stream of objects. A plurality of nozzles blow a stream of air through holes in the guide wall directed toward the axis of rotation of the outer bowl. The nozzles are installed above the path of a single object to blow off other objects that are vertically set on top of each other. The nozzles can direct a targeted pulsed air stream directly at an object to systematically eliminate objects and work in conjunction with sensors which detect the relative position of sequential objects and can signal when nozzles should remove an unwanted object for instance when objects are too close together in sequence. Air pulses for the nozzles may be controlled by an electrical signal to a solenoid valve. A PLC or industrial computer can interpret signals from sensors to command when an air pulse is needed. Compressed air is supplied by reservoir and pressure is adjustable by pressure regulators [12].

4. SHAFT

The disc shaft holds the entire load that is applied to the disc and transmits the torque and the rotational motion of the motor to the disc which is holed either in horizontal or in inclined potion with respect to the bowl rotating axis. The shaft is held in inner side bearings of the static hub and bowl hub mounted on outer side bearing of static hub. So bowl and disc can rotate either same or different speed. The thrust bearing is widely used to sustain the load of the plate. One end of the shaft is connected to the conical disc and another end is connected to the motor shaft by the pinion and chain, the roller and the O-ring or the mounting on the motor shaft.

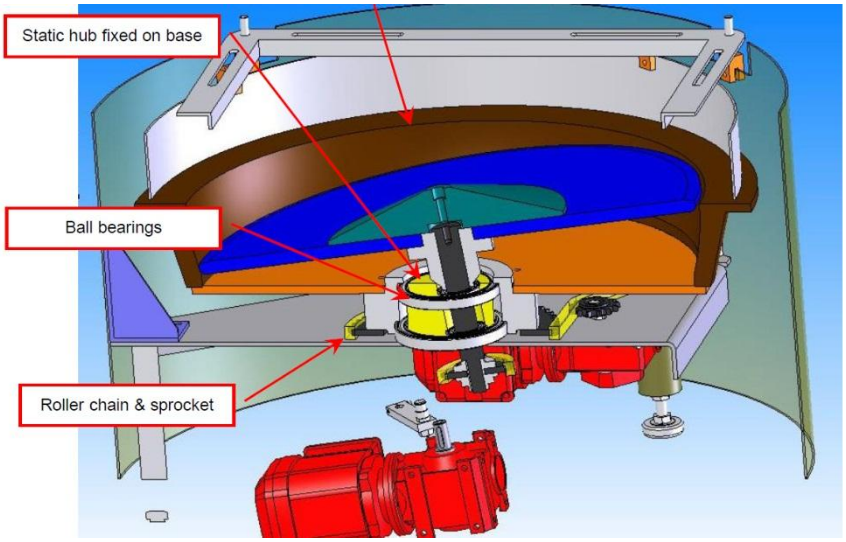

Figure 11. Disc Shaft Pass through the Fix Static Hub and Bowl Hub Mounted On Static Hub [2]

5. DRIVING MECHANISM

Power source is attached to base structure via attaching bracket. Power source may be a variable speed DC motor having output shaft with drive pulley mounted thereon. A controller mechanism may also be attached to the base structure and electrically connected to an electric power source and to the motor so as to provide power on/off and variable speed controls for the drive motor.

The bowl rim and plate assembly is driven by a separate motor whose speed can be controlled independently by any conventional means.Motor drives the disc through a sleeve shaft and another motor drives bowl by sleeve shaft. By means of this, the rims can be driven at an angular velocity greater than that of the disk, which causes the work piece line to be circumferentially spaced around the rim. Under certain circumstances, however, it may be appropriate to drive the flange at a slower speed than the disc, such as when the disc feed is intermittent or delayed, but it is though desirable to ensure delivery a continuous line of adjoining portions of the rim. This can also be achieved by controlling the motor speeds and producing an appropriate speed ratio.

Baird et. al. [11] used two concentric shaftdrivesfor their centrifugal feeder, one was solid shaft and another was sleeve shaft with same rotating vertical axis as shown in Figure 9. Both were fixed in thrust bearing. A universal joint is received on the top end of the drive shaft and is physically coupled to the rotatable disc. A drive cylinder coaxially surrounds the drive shaft, the drive cylinder being provided to drive the annular rim surrounding the disc. A single motor is provided which is coupled to both drive shaft and drive cylinder. The angular velocity of the drive shaft and drive cylinder are determined by the size of toothed gears mounted on each and on the driving rotor.

6. CONCLUSION

This review paper briefly describe about the basic conceptual design of centrifugal feederparts such as disc mounting methods, effect of non-planer surface on disc, effect of horizontal and incline disc and different speed effect of disc and bowl on object deliver rate.Important conclusions drawn are;

(i) The horizontal disc or incline plane disc need high speed rotation for centrifuge the object.But the resultof high speed and large centrifugal force generated in the reservoir is bumping of objects violently against one another and against the rim. This problem can reduced by a non-planar upwardly-convex form permits the disc to be rotated relatively at slower speed and thereby reduce impact and abrasion damage to the objects being fed.

(ii) The disc and the rim are driven at the same angular velocity, which had the effect of delivering a line of work pieces in an end-to-end stop and the advantage that the work pieces were not subjected to angular acceleration during their transfer from the disc to the rim.

(iii) If the disc and bowl made fromnonmetallic material such as ultra-high molecular polypropylene resin, itreduced weight and power consumption, quieter operation, and gentler part handling are desirably achieved.

REFERENCES

[1] Edmunds, G., K. Hoppmann, and H. Schober. "Centrifugal method of sorting particulate articles" U.S. Patent No. 3,831,734. 27 Aug. 1974.

[2] “Centrifugal Feeder Design” By PackexOne [Online]. Available: www.packexone.com

[3] Ervine, Albert WG. "Apparatus for feeding articles in serial order" U.S. Patent No. 4,007,854. 15 Feb. 1977.

[4] Clark, Ralph R. "Centrifugal feeding device" U.S. Patent No. 2,108,163. 15 Feb. 1938.

[5] Kelly, Leonard. "Single row feeder" U.S. Patent No. 3,049,215. 14 Aug. 1962.

[6] Boling, Monte J. "Belt feeder for orienting and transporting round symmetrical parts" U.S. Patent No. 4,705,156. 10 Nov. 1987.

[7] Hilton, Sydney. "Rotary feeder" U.S. Patent No. 4,830,172. 16 May 1989.

[8] Hoppmann, Kurt H. "Disc for centrifugal feeder" U.S. Patent No. 5,145,051. 8 Sep. 1992.

[9] Corbin, R. Scott. "Rotary feeder" U.S. Patent No. 7,472,782. 6 Jan. 2009.

[10] Kenneway, Ernest K. "Material handling apparatus with integrated part sorter." U.S. Patent No. 7,669,707. 2 Mar. 2010.

[11] Baird, Randy K., Kenneth D. Doak, and Gary L. Schucker. "Rotary orienting feeder" U.S. Patent No. 6,578,699. 17 Jun. 2003.

[12] Papsdorf, Clifford Theodore, Michael John Mers-Kelly, and Christopher Michael Richards. "Article feed system for aligning and singulating articles." U.S. Patent Application No. 13/047,418.