MACHINE FOR LOADING ARTICLES FROM THE TO AND FOR TRANSFERRING SAD ARTICLES

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This invention relates to improvements in machines for transferring small articles, and in particular relates to improvements in machines of the type wherein articles are picked up from one conveyor and are transferred to another conveyor, such as a moving conveyor.

Without limitation thereto, the principle of my invention is particularly suited to use in connection with apparatus employing a suction cup which is operative under vacuum to pick up the article from a first stationary conveyor and which is then moved to a point at which the vacuum is relieved and the suction cup releases the article to a moving conveyor.

My improved machine is particularly useful in the solution of the following problem, although its use is not limited to the solution of such problem. It is desired to transfer a relatively bulky and soft or fragile article such as a package of dry goods or a package of crackers. The package can be transferred from a first position in which it is substantially at rest. However, it is desired to transfer the article to a receptacle which is located on a moving conveyor, and it is desired to permit this conveyor to move at maximum speed and to transfer maximum number of articles to said conveyor per given unit of time.

It has been found particularly desirable that such articles be picked up by suction from above, since there are problems in connection with having an inverted suction cup receive such an article from below. This means that the suction cup should be travelling substantially vertically and downwardly just before, during the time when, and just after it picks up the article from the first position. If the suction cup is turning out of the vertical or moving in a horizontal plane at the moment of pick up, the article may be damaged or may not be picked up at all. Furthermore, if the moving conveyor is located in a horizontal plane, the suction cup should be travelling substantially horizontally at the moment of release of the article, to permit maximum speed of the conveyor and to ensure smooth transfer of the article.

In accordance with a preferred embodiment of the invention, the path of movement of the suction cup is in the form of a cardioid, while at the same time an additional movement is imparted to the suction cup which causes its axis to remain always vertical.

The cardioid is defined as the curve generated by a point on the circumference of a circle which rolls without slipping on the outside of a fixed circle of the same diameter. Mechanical Engineers’ Handbook, edited by Lionel S. Marks (4th edition, 1941). FIG. 72 on page 153 of this book shows such a curve. This curve is heart-shaped. It will be apparent that the point which generates this curve also rotates about its own axis.

While I am not limited to any particular orientation of the cardioid path of movement of the suction cup, I prefer that the axis of the cardioid extends substantially vertically. As a result, when the suction cup is at its lowest point, it is travelling substantially horizontally and with the horizontal component of its speed maximum, which is best for unloading an article on a horizontally moving conveyor. On the other hand, when the suction cup is 180 degrees opposed to its unloading point, it first travels substantially vertically downwardly and then abruptly changes direction and travels substantially vertically upwardly, the suction cup being substantially at rest at the point of change of direction. This is the best condition for pick up of a stationary article by the suction cup.

As an important feature of the invention, the particular preferred mechanism by means of which the desired movements are imparted to the suction cup is compact and of relatively simple construction, and can operate a plurality of suction cups on a common head.

Other objects and advantages of this invention will become apparent from the following description, in conjunction with the annexed drawings, in which a preferred embodiment of the invention is disclosed.

In the drawings:

FIG. 1 is a somewhat diagrammatic vertical cross-section on line 1—1 of FIG. 2, showing the movement of the suction cup in the desired cardioid, and also showing the manner in which the suction cup remains in vertical position throughout the operation of the machine. Various selected positions of the suction cup support, during movement of the apparatus, are shown in phantom. Three suction cup units are shown, although the invention is not limited to this precise number.

FIG. 2 is a longitudinal vertical section on line 2—2 of FIG. 1.

FIG. 3 is a section on line 3—3 of FIG. 2.

FIG. 4 is a section on line 4—4 of FIG. 2.

FIG. 5 is a section on line 5—5 of FIG. 2.

FIG. 6 is a section on line 6—6 of FIG. 2.

FIG. 7 is a section on line 7—7 of FIG. 2, with the parts in position for discharge by the lowermost suction cup of its load.

FIG. 8 is a view similar to FIG. 7, with the parts in position just prior to pick-up of another article by the uppermost suction cup.

FIG. 9 is a view similar to FIGS. 7 and 8, showing the parts in position for pick-up of an article by the uppermost suction cup.

FIG. 10 is a perspective and diagrammatic view of the apparatus as a whole, showing only the main working parts, and is intended to illustrate the relationships of such main operating parts.

General Description

The general arrangement of the machine will best become apparent from FIG. 10.

A fixed gear 11 is mounted upon fixed longitudinal shaft 10. Three gears 13 are respectively fixedly mounted on the rear ends of longitudinal sleeves 14, and these sleeves 14 are turnably mounted on respective longitudinal shafts 16. Each gear 13 meshes with and is of the same diameter as gear 11. The three shafts 16 are respectively turnably received in the extremities of spider 26 (FIG. 6) which is fixedly mounted on sleeve 24. Sleeve 24 is turnably mounted on shaft 10 behind gear 11 and is driven by means of sprocket 25 on sleeve 24 (FIG. 2) and any suitable drive means (not shown) for sprocket 25.

It will be apparent that a given point on the circumference of any gear 13 will generate a cardioid when such gear 13 is rotated around gear 11 without slipping.

Each sleeve 14 has a front radially outwardly extending link portion 29, and longitudinal shaft 30 is turnably mounted on the radially outer end of link 29 and extends forwardly thereof. Suction cups 37 are fixed to shaft 30 so that their axes extend radially thereto. Shaft 30 is longitudinally substantially aligned with the periphery of gear 13, so that it generates substantially a cardioid curve.

The point which generates a cardioid also turns around its own axis, therefore sleeve 14 turns around as indicated by the arrow 14a. The suction cups, if desired to remain vertical, can therefore not be mounted on sleeve
As compensation for the undesired rotation of shaft 30, to which the suction cups are mounted, a further fixed gear 33 is mounted upon shaft 10 between gear 11 and spider 26. Gear 33 meshes with gears 34 respectively fixedly mounted upon shafts 16. Gear 32 on the rear end of the shaft 16 is accordingly turned in the same direction as gear 34 on the same shaft 16, so that gear 31 and shaft 30 is turned in the opposite direction to the direction of the rotation imparted hereto by gear 13. The gear ratios are such as to make the resultant rotation of shaft 30 zero, so that the axis of suction cup 37 remains vertical, when the suction cup is simultaneously to the curve 40b (FIG. 1) of shaft 30.

Stationary article 40 is picked up by suction cups 37 from conveyor 39 when suction cups 37 are at point 37c of curve 37b. At this point, suction cups 37 are substantially at rest; and their movement is substantially vertically downward just before reaching point 37c and substantially vertically upward just after leaving point 37d. Article 40 is released by suction cups 37 to horizontal conveyor 44 moving in the direction of arrow 45 when suction cups 37 are at point 37d of curve 37c. Suction cups 37 are then moving substantially entirely in the direction of arrow 45; and their horizontal component of speed is maximum.

Detailed Description

The machine is supported by a frame consisting of a base 17 and an upright 18. Sleeve bearing 19a extends through an opening in upright 18 in a direction which may be taken as the longitudinal direction of the machine. Sleeve bearing 19a has a head 19b of enlarged diameter which abuts a face of upright 18 which may be taken to be the rear face thereof. Sleeve bearing 19a extends turbulently through the bore of bearing 19a and extends both forwardly and rearwardly thereof. The portion 24e of sleeve 24 located just behind bearing head 19 is of increased diameter and serves as the rotary member of a valve. The fixed valve element 47 is annular and extends around the movable element 24c. Annular bracket 60 bears against the rear face of fixed valve member 47 and against the rear face of rotary valve member 24e; and the assembly is secured in place by means of bolts 48 which pass through brackets 60, fixed valve member 47 and into head 19. Bracket 60 has a rearwardly extending central annular flange 67 which serves as a further bearing for sleeve 24. Drive sprocket 25 is fixedly mounted on the rear end of sleeve 24 and is adapted to be driven by any suitable means (not shown).

Rear end plate 21 is spaced from head 19 by means of spacer sleeves 22. Longitudinally extending fastening bolts 20e extend through appropriate longitudinal apertures in plate 21, through sleeves 22, in head 19 and in upright 18 and are secured at their ends by nuts 20, thereby holding secure the assembly of plate 21, head 19 and frame upright 18. A conventional support assembly 23 is received in the opening of plate 21 and fixedly supports the rear end of shaft 10.

Spider 26 is fixedly mounted upon sleeve 24, in front of sleeve bearing 19a, by means of key 62. Spider 26 has a generally cylindrical core or center portion, and has three equally spaced, radially extending arms 63. Each arm 63 terminates in an end 64 of generally cylindrical shape and having a longitudinal axis. Said heads 63a support a transverse rear casing wall 64 which extends radially outwardly of heads 63a and also extends radially inwardly thereof toward sleeve 24. Plate 64 has a central opening, and is integral at said central opening with a longitudinally extending sleeve bearing 64a which is fixedly mounted to sleeve 24 by means of key 62. At its outer end, casing wall 64 connects with a cylindrical and forwardly extending casing wall 65. The front end of casing wall 65 is sealed by plate 66, which is secured to wall 65 by means of wardly extending cylindrical flange 66a of plate 66 and bolts 67.

In the case of each head 63a of spider 26, a sleeve bearing 27 extends through the longitudinal bore thereof. This sleeve bearing 27 is forwardly spaced from the rear end thereof and spaced within the bore thereof. Said bearing 27 extends outwardly from the bore of head 63a and forwardly from the bore of sleeve 24, when the sleeve 24 is sealed to casing wall 65. The front end of casing wall 65 is sealed by plate assembly 28, leaving a space or chamfer 52 between plane 28 and bearing 27.

Shaft 16 extends turbulently within sleeve bearing 27 and also extends forwardly thereof. The usual retaining ring 67 on shaft 16 behind sleeve bearing 27 retains the shaft from前进到 the bore thereof. Said shaft 16 is forwardly spaced from the bore of sleeve bearing 27. Sleeve 14 is turbulently mounted on shaft 16 forwardly of gear 34, and sleeve 14 and shaft 16 extend forwardly through the longitudinal opening of boss 66b on plate 66. Said boss 66b serves as a sleeve bearing for turnable sleeve 14, and shaft 14 is turnable within sleeve 14. Gear 13 is mounted on sleeve 14 rearwardly of plate 66 by means of gear hub 13a and spline 15 (FIG. 4).

Fixed gear 33 is fixedly mounted on shaft 10 forwardly of wall 64, and is spaced from sleeve 24 by means of washer 8. Gear 33 meshes with gear 34. Gear 11 is fixedly mounted on shaft 10 forwardly of gear 33 and chambered plate 66 by means of gear hub 11a and spline 18a, and meshes with gear 13. Shaft 16 and bearing 14 extend forwardly of boss 66b. The front end portion of sleeve 14 has a radially outwardly extending portion 29 which may be considered to be a rigid link. At rigidly elongated casing 63 is formed as a front extension of sleeve 15 at its link extension 29, said casing 63 having a front wall 35. Shaft 16 extends forwardly of sleeve 14 into casing 68, and gear 32 is fixedly mounted upon shaft 16 within said casing 68. Sleeve portion 29 is formed with a longitudinally extending boss 35a, which serves as a sleeve bearing, and shaft 30 is turnably received within said bearing bore 29a. Shaft 30 extends forwardly of sleeve extension 29, through casing 68, and through a sleeve bearing 36 received within the longitudinal bore of forwardly extending boss 35a on wall 35. Gear 31 is fixedly mounted on shaft 30 within casing 68 and meshes with gear 32. Forwardly of boss 35a, a pair of coplanar and longitudinally spaced shafts 30 extend radially outwardly from shaft 30. Each said shaft 30 is externally screw-threaded at 35b and has a hollow through bore 35a and is threaded into an appropriate recess within shaft 30, shaft 35 being held in place by means of nut 36c screwed onto shaft 35. A suction cup 37 is fixed upon the outer end of shaft 38 with the hollow interior of suction cup 37 in communication with bore 38a.

In the preferred form of the invention shown in the drawings, and corresponding to an actual working model, gears 11 and 13 are of the same diameter and hence in a 1:1 ratio. The diameter of gear 33 is one and one-half times that of gear 11 and three times the diameter of gear 24. Gears 31 and 32 have the same diameter. The diameter of gear 13 is twice that of gears 31 and 32.

For proper control of the suction of suction cups 37, three longitudinal grooves are formed in the bore of fixed valve member 47, these grooves being respectively designated by the reference numerals 47a, 47b and 47c. Optionally, these three grooves together extend around slightly more than one half of the periphery of the bore of fixed valve member 47. Preferably, the top groove 47a and intermediate groove 47b are of the same circumferential length and are of greater circumferential length than groove 47c.

Hollow radial fitting 49 communicates through a radial opening in fixed valve member 47 with groove 47a. Hollow radial fitting 50 communicates through a further radial opening in fixed valve member 47 with groove 47b. Hollow radial fitting 51 communicates through a further radial opening in fixed valve member 47 with groove 47c. Fittings 49 and 50 are adapted to be con-
nected to any suitable suction source (not shown) so as to exhaust air from grooves 47a and 47b in the direction of arrows 49a and 50a respectively. Fitting 51 is optionally adapted to be connected to any suitable source of air (not shown) so as to let air into fitting 51 in the direction of arrow 51a.

Sleeve 24 has three equally circumferentially spaced and longitudinally extending bores 24a. Radial ports 24b and 24c respectively communicate with the respective longitudinal bores 24a and extend to the periphery of sleeve 24.

A bore 26c is formed in each spider arm 63 and extends between the bore 24a of the spider and the bore formed in the outer head 63a. Radial bore 27c in sleeve bearing 27 communicates between bore 26a and the space or chamber 52 behind shaft 16. Shaft 16 has an axial bore 16c which extends from the rear end of shaft 16 to a point in radial alignment with element 29.

Alined radial bores 16c in shaft 16 and 53 in extension 29 communicate between bore 16b and an enlarged annular groove 54 in the wall of bearing bore 29a. Radial bores 54d in shaft 30 communicate between groove 54 and central axial bore 36a of shaft 30. This bore 36a communicates with bore 38a of suction cup shaft 38.

FIG. 10 shows diagrammatically and in broken lines a lower conveyor 44 and an upper conveyor 39. While these conveyors may take any appropriate form, illustratively they may be in the form of belts. Conveyor belt 44 is moved in horizontal plane by any suitable means (not shown) in the direction of arrow 45 and in position to receive articles from suction cups 37 when they are in their lowest position during their path of travel. Illustratively, FIG. 10 shows an elongated carton 46 carried upon the upper face of conveyor belt 44 and positioned and adapted to receive an elongated object 40 which is carried by the two suction cups 37. This article 40 may be any appropriate article, such as a soft bag of cocoa or a bag of fragile crackers.

Diagrammatically and for convenience of illustration, FIG. 10 shows conveyor 39 positioned for transfer of an article therefrom to suction cups 37 of one shaft 30 at the same moment that other suction cups 37 are unloading articles 40 upon conveyor 44. It will be understood, however, from the general description of the machine given above and from the summary of operation which follows, that there is an interval of one-sixth of a revolution of the spider, after an article has been unloosed onto conveyor 44, before an article is received from conveyor 39, and conveyor 39 is appropriately located for this purpose.

As shown in FIG. 10, illustratively, conveyor 39 takes the form of a belt moving in the direction of arrow 41 around rollers 42a and 42b, which turn in the direction of arrow 43. Any suitable drive means for conveyor belt 39 may be employed. Conveyor belt 39 carries a plurality of spaced articles 40.

It will be further appreciated that any other suitable conveyor or storage unit may be employed for supplying articles 40 to position to be picked up by suction cup 37.

Summary of Operation

Since the operation of the machine is apparent from the above description, the operation will only be briefly summarized.

Shafts 16 are moved in circular path 9 about the axis of shaft 10, while at the same time being rotated about their own axes (arrow 16a). Sleeves 14a also are moved in circular path 9 about the axis of shaft 10, while at the same time being rotated about their own axes (arrow 14a). Arrow 15a shows the rotation of gear 13.

As a result, shaft 30 is moved in the direction of arrow 30a, and suction cup 37 describes the curve 37b shown in FIG. 1. Curve 37b is a cardioid.

The rotation of gear 32 in the direction of arrow 34a turns gear 31 in the direction of arrow 31a. The net result is zero rotation of gear 31, so that suction cups 37 always extend vertically.

Curve 37b for cup 37 is shown in FIG. 1. At the bottom point 37d of curve 37b, suction cup 37 is travelling almost entirely horizontally and with maximum speed in the horizontal direction. In this position, valve 24c, which corresponds to the then lowestmost suction cup, is in communication with groove 47c (FIG. 7). As a result, air is passed through fitting 51, groove 47c, groove 24c, bore 24d, bore 24b (FIG. 2), bore 26a, chamber 52, bore 16b, bore 16c, bore 53, bore 54b, bore 30a and bore 38a to the suction cup. As a result, this article 40 carried by suction cups 37 is released to conveyor 44 received within carton 46. At this time, the groove 24b corresponding to the suction cups which have just released an article is located as shown in FIG. 7, out of communication with any source of vacuum or of air. At this time, also, groove 24d corresponding to the suction cups 37 which have just picked up an article 40 from conveyor 39 is located opposite the bore wall portion 47d which spaces valves 47a and 47b.

FIG. 8 shows the positions of the parts approximately one-sixth of a revolution after their position of FIG. 7. Groove 24c corresponding to the suction cups which have just released an article has cleared groove 37c, so that air is no longer being supplied to said suction cups.

Groove 24d, which corresponds to the suction cups which have just picked up an article 40 from conveyor 49, now is in communication with grooves 47b, so that it still continues to be maintained under vacuum until just before it is due to release the article. However, groove 47b is spaced from groove 47a, in case for some reason the suction cups corresponding to groove 24d fail to pick up an article 40. This prevents any lowering of the vacuum to be supplied to the groove 47a to the suction cups which are to pick up the next article.

Just before suction cup 37 reaches the curved apex 37c, it is travelling substantially vertically downwardly. At point 37c, the suction cup is substantially stationary. This is the moment suction cup 37 picks up package 40. Just after suction cup 37 leaves point 37c, it travels substantially vertically upwardly.

FIG. 9 corresponds to the condition of the valve just after suction cups 37 are at point 37c. In the condition of FIG. 9, groove 24d is in communication with groove 47a, whereby suction cups 37 corresponding to groove 24d have just picked up an article 40 from conveyor 39.

While I have disclosed a preferred embodiment of this invention, and have indicated various changes, omissions and additions which may be made therein, I make it clear that it is not my object to limit the invention or the scope thereof, but that other changes, omissions and additions may be made in the invention without departing from the scope and spirit thereof.

The drawings are substantially to scale of a working model of the invention, and reference is made to the drawing to complete the disclosure herein.

I claim:

1. A transfer apparatus comprising a first longitudinally extending shaft, a suction cup support extending radially from said first longitudinal shaft, a suction cup mounted upon the outer end of said suction cup support, a second longitudinally extending shaft, a sleeve turnably mounted on said second longitudinal shaft, a lateral link fixed to said sleeve, said first longitudinal shaft extending turnably into said link, meshing first and second gears respectively mounted on said first and second longitudinal shafts, said apparatus having a main longitudinal axis which is offset from the axes of said first and second longitudinal shafts, said second longitudinal shaft being turnable about said main axis, drive means for rotating said second longitudinal shaft about said main axis, means responsive to said drive means for simultaneously turning said first longitudinal shaft about the axis of said second longitudinal shaft, and further means responsive to said
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4. Transfer apparatus comprising a first longitudinally extending shaft, a suction cup support extending laterally from said first longitudinal shaft, a suction cup mounted upon the outer end of said suction cup support, a second longitudinally extending shaft, a sleeve turnably mounted on said second longitudinal shaft, a lateral link fixed to said sleeve, said first longitudinal shaft extending turnably into said link, meshing first and second gears respectively mounted on said first and second longitudinal shafts, a fixed third longitudinally extending shaft, and second longitudinal shaft being turnable about the axis of said third longitudinal shaft, drive means for rotating said second longitudinal shaft about said axis of said third longitudinal shaft, meshing third and fourth gears respectively fixed on said third longitudinal shaft and on said second longitudinal shaft for turning said second longitudinal shaft about its axis when it is rotated about the axis of said third longitudinal shaft, and meshing fifth and sixth gears respectively fixedly mounted on said third longitudinal shaft and said sleeve for turning said sleeve about its axis when said second longitudinal shaft is rotated about the axis of said third longitudinal shaft.

5. Apparatus in accordance with claim 4, the relationship between the speed of rotation of said first longitudinal shaft relative to said lateral link and the speed of movement of said first longitudinal shaft about the axis of said second longitudinal shaft being such as to maintain said suction cup shaft always substantially vertical.

6. Apparatus according to claim 5, the relationship between the speed of rotation of said second longitudinal shaft about the axis of said third longitudinal shaft and the speed of rotation of said first longitudinal shaft about the axis of said second longitudinal shaft being such that said first longitudinal shaft turns twice about the axis of said second longitudinal shaft while said second longitudinal shaft turns once about the axis of said third longitudinal shaft.

7. Transfer apparatus operative under vacuum to pick up an article by suction and to move it to a point at which the article is released to a moving conveyor comprising a first longitudinally extending shaft, a suction cup support extending laterally from said first longitudinal shaft, a suction cup mounted upon the outer end of said suction cup support, a second longitudinally extending shaft, a first sleeve rotateably mounted on said second longitudinal shaft, a lateral link fixed to said first sleeve, said first longitudinal shaft extending rotateably into said link, meshing first and second gears respectively fixed on said first and second longitudinal shafts, a fixed third longitudinally extending shaft, a second sleeve rotateably mounted on said third longitudinal shaft, a spider fixed on said second sleeve, said second longitudinal shaft extending rotateably into said spider, a sprocket fixed on said second sleeve, driving means for rotating said sprocket, meshing third and fourth gears respectively fixed on said third and second longitudinal shafts for rotating said second longitudinal shaft about its own axis while said longitudinal shaft rotates about the axis of said third longitudinal shaft, and meshing fifth and sixth gears respectively fixed on said third longitudinal shaft and on said first sleeve for rotating said first sleeve relative to said second longitudinal shaft.

8. Apparatus in accordance with claim 7, the relative diameters of said first, second, third, fourth, fifth and sixth gears, being such as to maintain said suction cup support always substantially vertical.

9. Apparatus according to claim 8, said relative diameters of said third, fourth, fifth and sixth gears being such that said first longitudinal shaft turns twice about the axis of said second longitudinal shaft while said second longitudinal shaft turns once about the axis of said third longitudinal shaft.

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