(54) Title: APPARATUS FOR DESTACKING ARTICLES

(57) Abstract: An apparatus for destacking articles (1) such as nested containers comprises a lead-screw (3; 11; 25) and a drive means (4; 30), typically a motor. The lead-screw (3; 11; 25) comprises a spiral flight (5) of at least one revolution mounted on a shaft (6). A means (7; 25) for supporting a stack of the articles (1) in a predetermined orientation relative to the lead-screw (3; 11; 25) is also provided. It will be appreciated that when the shaft (6) is rotated by the motor (4; 30) an edge (8) of the flight (5) is inserted in a gap (2) defined between two of the articles (1) at one end of the stack so that on rotation of the shaft (6), the lead-screw (3; 11; 25) will act to separate the end article from the rest of stack. The lead-screw (3) may be a mono-pitch lead-screw or the lead-screw (11; 25) may be a variable pitch lead-screw.
Published:
with international search report

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APPARATUS FOR DESTACKING ARTICLES

The present invention relates to an apparatus for destacking articles, in particular but not exclusively nested containers.

Apparatus used to destack articles, such as nested containers, usually forms part of a handling system integrated into a production process wherein empty containers are to be filled or articles are to be packed. In the food industry, for example, empty ice-cream or margarine tubs and the like are usually positioned on a conveyor and moved sequentially under a filling nozzle. Conveniently, the empty containers nest and are supplied in stacks. Hence, the destacking apparatus conventionally comprises a plurality of vacuum grippers which move between a retracted or rest position, an unloading position wherein the grippers engage the lowermost or the uppermost container within a stack, and a loading position, wherein the grippers pull the engaged container from the stack and place it in a required location, such as on a conveyor. Often additional means are required to hold the stack and to ensure that the grippers only remove one container at a time.

It will be appreciated that such apparatus operates relatively slowly, which has an affect on the speed of operations further down a production line.

The object of the present invention is to overcome or substantially mitigate the aforementioned disadvantage.

According to the present invention there is provided an apparatus for destacking articles comprising a lead-screw comprising a spiral flight of at least one revolution on a shaft, drive means for the rotating the shaft, and means for supporting a stack of the articles in a predetermined orientation relative to the lead-screw in order that, on rotation of the shaft, an edge of the flight is inserted in a gap defined between two of the articles at one end of
the stack so that on rotation of the shaft, the lead-screw will act to separate the end article from the rest of stack.

 Preferably, the edge of the flight is tapered to facilitate its insertion into the gap between the articles.

 Preferably also, the spiral flight comprises at least three revolutions.

 Preferably also, the pitch of the spiral flight is equal to the spacing of the gaps between adjacent articles in the stack.

 Alternatively, the pitch of the spiral flight is variable. In this circumstance, preferably the pitch of the spiral flight increases gradually along the length of the lead-screw. In this way, differences in the spacing of the gaps between adjacent articles and between different stacks of articles can be accommodated without needing to change the lead-screw. Preferably also, the lead-screw is orientated vertically with the pitch of the spiral flight increasing gradually in a downwards direction and the lead-screw is adapted initially to engage the bottom of a stack of articles at its uppermost end where the pitch of the flight is at its smallest.

 Preferably also, the end article is located at the bottom of the stack and after separation therefrom falls under the influence of gravity on to the conveyor.

 Alternatively, the lead-screw extends the full length of the stack and rotates such that the uppermost article in the stack is separated therefrom.

 Preferably also, the uppermost revolution of the spiral flight has a pitch which is greater than the height of the articles in order that the uppermost article can be completely detached from the stack by rotation of the lead-screw.
Preferably also, a plurality of lead-screws is provided which are linked to a common drive means. In such an embodiment a pair of lead-screws of opposite hand is preferably linked to a common drive means.

Preferably also, two pairs of lead-screws are provided and located on opposite sides of the stack in order that each pair of lead-screws can provide the means for supporting the stack for the other pair of lead-screws.

Preferably also, each pair of lead-screws is mounted on a height-adjustable carriage and can be moved horizontally relative to the carriage to accommodate differently sized articles.

Preferably also, the means supporting the stack comprises a guide means which retains the stack at such an angle relative to the lead-screw that gravity alone is sufficient to maintain the stack in contact with the flight of the lead-screw.

Preferably also, the drive means for rotating the stack comprises either a constant-run motor or a stepper motor.

Preferably also, the apparatus is mounted on a conveyor in order that the articles can be separated from the stack and sequentially located at different predetermined positions.

Alternatively, the apparatus is mounted adjacent to a conveyor which moves relative to the apparatus in order that the articles can be separated from the stack an sequentially located at the same position on the conveyor.

Preferably also, the apparatus is combined with an automatic feeding mechanism. In such an embodiment preferably operation of the automatic feeding mechanism is controlled by at least one detector that detects when the height of the stack has been reduced to a critical height and thereafter
causes operation of the automatic feeding mechanism to add an additional stack of articles to the end of the first stack.

The present invention will now be described by way of example with reference to the accompanying drawings, in which:-

Fig. 1 is a schematic representation of an apparatus in accordance with the invention adapted for destacking plastics tubs;

Fig. 2 is a view of an apparatus similar to that shown in Fig. 1 but with the stack retained in a cradle at a different angle;

Fig. 3 is a schematic representation of a stack of articles retained by a different form of cradle;

Fig. 4 is a schematic representation of a second embodiment of apparatus adapted to destack articles from the top of a stack;

Fig. 5 is a schematic representation of a variable pitch lead-screw for use in an apparatus as shown in any of Figs. 1 to 4;

Fig. 6 is a schematic side view of an automatic feed mechanism for use with an apparatus in accordance with the present invention;

Fig. 7 is a view similar to Fig. 6. but showing the feed mechanism in operation; and

Fig. 8 is a plan view of the feed mechanism as shown in Fig. 6 in combination with a third embodiment of apparatus in accordance with the present invention.

In this description and as shown in all of the drawings, the articles 1 to be destacked all comprise tubs, such as are used for margarine, ice cream,
confectionery and the like. However, it will be appreciated that the articles could comprise any articles which stack such that a small gap 2 is defined between adjacent articles. Typically such articles will nest but, again, this is not a requirement of the invention provided that the appropriate gap 2, as aforesaid, is defined such that it appears at a regular interval along the length of the stack and allows purchase for an edge of a lead-screw of the apparatus as will now be described. As such, therefore, the articles 1 will usually comprise articles of identical shape and size.

With reference to Figs. 1 to 3, an apparatus for destacking the articles 1 comprises a lead-screw 3 and a drive means 4, typically a motor. The lead-screw 3 comprises a spiral flight 5 of at least one revolution mounted on a shaft 6. A cradle or similar guide means 7 for supporting a stack of the articles 1 in a predetermined orientation relative to the lead-screw 3 is also provided. It will be appreciated that when the shaft 6 is rotated by the motor 4 an edge 8 of the flight 5 is inserted in the gap 2 defined between two of the articles 1 at one end of the stack so that on rotation of the shaft 6, the lead-screw 3 will act to separate the end article from the rest of stack.

The edge 8 of the flight 5 is preferably tapered to facilitate its insertion into the gap 2 between the two end articles 1. In this way, the edge 8 can be inserted even into an extremely small gap 8, the increase in taper thickness itself being sufficient to start drawing the articles 1 apart even before the completion of one full revolution of the lead-screw 3. Also, the spiral flight 5 comprises at least three revolutions and has a pitch that is comparable to the spacing of the gaps 2 between adjacent articles 1 in the stack. Hence, one full revolution of the lead-screw 3 drives the end article 1 off the stack yet arrests movement of the remainder of the articles 1 in the stack.

The speed of operation of the apparatus is limited only by the speed of the revolving shaft 6 of the lead-screw 3. As even a standard squirrel-cage electric motor is capable of delivering 2900 rpm, which in terms of the present apparatus would equate to the delivery of 2900 articles 1 per minute
and is far in excess of any average expected duty, it is expected that the apparatus will be able to meet any realistic demand for speed of delivery of any article 1. Yet should such a demand arise or even a demand for speeds in excess of this, the apparatus should be capable of delivering it. The motor 4 will therefore typically comprise a standard constant run motor for high-speed destacking or a stepper motor for the intermittent delivery of articles 1 on demand.

The number of articles 1 in each stack is limited only by the size of the cradle 7 which holds them. In the present example, the cradle 7 comprises a tubular casing in which the stack is located with an appropriately located slot through which the flight 8 of the lead-screw 7 can project. However, in some applications this may be impracticable and it may be more appropriate for the cradle 7 to comprise a guide and support means fashioned from metal rods 9, as shown in Fig. 3. Preferably, the cradle 7 should retain the stack at such an angle relative to the lead-screw 3 that the force of gravity alone is sufficient to maintain the stack in contact with the flight 8 of the lead-screw 3 and it will now therefore be necessary to use any additional means to exert this pressure. In most cases, it is envisaged that the force of gravity will be great enough to permit the orientation of the cradle 7 to be adjustable to suit the specific demands of each individual apparatus. For example, in Fig. 1 the cradle 7 is shown supporting the stack in a vertical orientation whereas in Figs. 2 and 3 the stack is shown supported at an angle to the vertical. In some applications, it may be appropriate for the stack to be retained horizontally.

The apparatus may be mounted on a conveyor that moves relative to the speed of the motor 4 in order that as the articles 1 are separated from the stack they fall sequentially into different predetermined positions. Alternatively, the apparatus is mounted adjacent a conveyor which moves relative to the apparatus in order that as the articles 1 are separated from the stack they fall sequentially into same position on the conveyor.
Also, the apparatus 1 may be mounted so as to be rotatable between a first repose position, wherein the apparatus is not used and the stack is retained in a different orientation, for example a horizontal orientation, to that in a second in-use position, wherein the stack may be retained at an angle to the horizontal to allow the force of gravity to assist in the delivery of articles as they fall from the stack.

As shown in Figs. 1 to 3, usually the article being driven off the stack by the apparatus is located at the bottom of the stack and after separation falls under the influence of gravity into the required location. However, in an alternative arrangement as shown in Fig. 4, the lead-screw 3 is arranged to extend the full length of the stack through a vertical gap in the cradle 7 and rotates such that the uppermost article in the stack is separated therefrom. The articles 1 are therefore driven off the stack one by one in an upwards direction for collection by other apparatus, not shown, as required. In this case, as gravity will not act to detach the article from the stack, in order to permit the uppermost article to be completely detached from the stack on rotation of the lead-screw 3, the uppermost revolution 10 of the spiral flight 8 has a pitch which is greater than the height of the articles 1.

Figs. 1 to 4 of the drawings and the above description imply that the lead-screw 3 is a mono-pitch lead-screw. This is the case in some embodiments of the invention. However, it has been found that for some applications, a variable pitch lead-screw 11, as shown in Fig. 5, operates more effectively. The use of a variable pitch lead-screw 11 means that the gap 2 between the articles 1 in a stack need not be the same along the length of the stack so that variations in nesting pitch of the stack can be accommodated. It also means that the same apparatus can be used without changing the lead-screw 3 for a wide range of different types and/or sizes of stacked articles. When using a variable pitch lead-screw, preferably the pitch of the spiral flight 12 increases gradually along the length of the lead-screw 3. With reference to Fig. 5, the variable pitch lead-screw 11 shown therein is arranged so that it initially engages the bottom of a stack of articles 1 at its uppermost
end 13 where the pitch is small. As the lead-screw 11 is rotated and the flight 12 enters the gap 2 between adjacent articles 1, a point is reached where the pitch of the lead-screw is the same as the gap 2 and the end article of the stack is then separated from the stack. The further increase in the pitch of the lead-screw 3 then operates to split the articles gradually apart whilst still in the stack as they travel down the length of the lead-screw until the end article is no longer retained by the lead-screw 3 and drops off under the influence of gravity.

It will be appreciated that as with the mono-pitch lead-screw 3, the flight 12 of the variable pitch lead-screw 11 also has a tapered edge to facilitate its entry between two articles of a stack.

The retention of the stack in an at least partially separated condition can be further controlled by the use of a plurality of lead-screws as is described below with reference to Fig. 8, which shows four such lead-screws 11 being used in combination with an automatic feed mechanism which is also shown in Figs. 6 and 7.

With reference to Figs. 6 to 8, the automatic feed mechanism comprises a platform 14 comprising adjustable side plates 15 between which is located a central slider 16 on which can be placed individual stacks of articles for feeding by the mechanism to the destacking apparatus. The platform 14 can be tilted upwards at approximately 15° to the horizontal, as shown in Fig. 7, by a ram 17. In addition, a second ram 18 is provided to move the slider 16 relative to the side plates 15 towards a pair of gates 19. The gates 19 are opened and closed by a cam mechanism 20 that is linked to operation of the ram 18 such that on operation of the ram 18 the slider 16 moves towards the gates 19 which open to permit the end stack 21 of articles to be fed through before they close. The slider 16 can be fed with additional stacks 22 either automatically, for example via a conveyor, or manually.
After passing through the gates 19, the end stack 21 falls under gravity against one or more guide means in the form of bars 23, which may be inclined, and thence downwards. The guide bars 23 cause the stack 21 to become vertical so that it can comes to rest either by falling into the top of another stack 24 (see Fig. 7) already being destacked by an automatic destacking apparatus or, if no such stack 24 is present, at the top of the lead-screw or lead-screws 25 of such an apparatus, as shown in Fig. 8.

Operation of the rams 17 and 18 of the feed mechanism is controlled by the use of detectors such as photocells 26, 27. A light beam 28 is shone between the cells 26 and 27, which under normal operation is blocked by the stack 24 being destacked by the destacking apparatus. However, when the height of this stack 24 has been sufficiently reduced to a critical height, the light beam 28 is not blocked and this causes automatic operation of the rams 17 and 18 to feed in the end stack 21 from the platform 14. This stack 21 then falls into the end of the existing stack 24. Hence, a continuous stream of destacked articles can be supplied by the combined destacked apparatus and feed mechanism.

In order to accommodate stacks of different heights, which in turn may be affected by the size of each article 1, the height of the platform 14 and its associated mechanisms are adjustable via additional support rams 29.

With reference to Fig. 8, the destacking apparatus in combination with the automatic feed mechanism comprises four variable pitch lead-screws 25 arranged in two pairs, each of which pairs is driven by a common motorized drive means 30. The pairs of lead-screws 25 operate on opposite sides of the stack 24 and within each pair the lead-screws 25 are of opposite hand. For any given lead-screw 25, the lead-screw of the pair immediately opposite it is also of opposite hand so that all the lead-screws 25 can act in concert and the forces generated by the lead-screws 25 on the stack 24 act to retain it in position between them. In such an arrangement, each pair of lead-screws effectively acts as a means for supporting the stack 24 in a
predetermined orientation for the other pair of lead-screws so that an independent means such as the cradle 7 or rod 9 required when only one lead-screw is used is not required.

It will be appreciated that mono-pitch lead-screws such as described above with reference to Figs. 1 to 4 could also be used instead of the variable pitch lead-screws 25 in the destacking apparatus.

Each pair of lead-screws 25 and their associated drive means 30 are mounted on one of two carriages 31 that are height adjustable. Each pair of lead-screws 25 is also mounted such that they travel horizontally relative to the carriage 31 both towards and away from the other pair of lead-screws 25 along two adjustable threaded rods 32. This enables stacked articles of different diameter to be accommodated by the same apparatus. The carriages 31 are also used to support the automatic feed mechanism via the support rams 29 and the guide bars 23.

Hence, once the automatic feeding mechanism and the destacking apparatus have been adjusted for the particular size of article 1 to be destacked, the destacking apparatus can be operated on a continuous basis and continually fed by the automatic feed mechanism. As previously desired this combination can be mounted on or adjacent a conveyor to provide a continuous stream of articles at a predetermined rate.
CLAIMS

1. An apparatus for destacking articles (1) comprising a lead-screw (3;11;25) comprising a spiral flight (5;12) of at least one revolution on a shaft (6), drive means (4;30) for the rotating the shaft, and means (7;9;25) for supporting a stack (24) of the articles (1) in a predetermined orientation relative to the lead-screw (3;11;25) in order that, on rotation of the shaft, an edge of the flight (5;12) is inserted in a gap (2) defined between two of the articles (1) at one end of the stack so that on rotation of the shaft, the lead-screw (3;11;25) will act to separate the end article from the rest of stack.

2. An apparatus as claimed in Claim 1, wherein the edge of the flight (5;12) is tapered to facilitate its insertion into the gap (2) between the articles (1).

3. An apparatus as claimed in Claim 1 or Claim 2, wherein the spiral flight (5;12) comprises at least three revolutions.

4. An apparatus as claimed in any of Claims 1 to 3, wherein the pitch of the spiral flight (5) is equal to the spacing of the gaps (2) between adjacent articles (1) in the stack.

5. An apparatus as claimed in any of Claims 1 to 3, wherein the pitch of the spiral flight (12) is variable.

6. An apparatus as claimed in Claim 5, wherein the pitch of the spiral flight (12) increases gradually along the length of the lead-screw (11;25).

7. An apparatus as claimed in Claim 6, wherein the lead-screw (11;25) is orientated vertically with the pitch of the spiral flight (12) increasing gradually in a downwards direction and the lead-screw (11;25) is
adapted initially to engage the bottom of a stack of articles (1) at its uppermost end (13) where the pitch of the flight (12) is at its smallest.

8. An apparatus as claimed in any of Claims 1 to 7, wherein the end article (1) is located at the bottom of the stack and after separation therefrom falls away under the influence of gravity.

9. An apparatus as claimed in any of Claims 1 to 7, wherein the lead-screw (3) extends the full length of the stack and rotates such that the uppermost article in the stack is separated therefrom.

10. An apparatus as claimed in Claim 9, wherein the uppermost revolution (10) of the spiral flight (5) has a pitch which is greater than the height of the articles (1) in order that the uppermost article can be completely detached from the stack by rotation of the lead-screw (3).

11. An apparatus as claimed in any of Claims 1 to 10, wherein a plurality of lead-screws (25) are provided.

12. An apparatus as claimed in Claim 11, wherein a pair of lead-screws (25) of opposite hand is linked to a common drive means (30).

13. An apparatus as claimed in Claim 12, wherein two pairs of lead-screws (25) are provided and located on opposite sides of the stack (24) in order that each pair of lead-screws (25) can provide the means for supporting the stack (24) for the other pair of lead-screws (25).

14. An apparatus as claimed in Claim 12 or Claim 13, wherein each pair of lead-screws (25) is mounted on a height-adjustable carriage (31) and can be moved horizontally relative to the carriage to accommodate differently sized articles (1).
15. An apparatus as claimed in any of Claims 1 to 12, wherein the means supporting the stack comprises a guide means (7;9;23) which retains the stack at such an angle relative to the lead-screw (3) that gravity alone is sufficient to maintain the stack in contact with the flight (5) of the lead-screw (3;25).

16. An apparatus as claimed in any of Claims 1 to 15, wherein the drive means (4;30) for rotating the lead-screw comprises either a constant-run motor or a stepper motor.

17. An apparatus as claimed in any of Claims 1 to 16, wherein the apparatus is mounted on a conveyor in order that the articles can be separated from the stack and sequentially located at different predetermined positions.

18. An apparatus as claimed in any of Claims 1 to 17, wherein the apparatus is mounted adjacent to a conveyor which moves relative to the apparatus in order that the articles can be separated from the stack and sequentially located at the same position on the conveyor.

19. An apparatus as claimed in any of Claims 1 to 18 in combination with an automatic feeding mechanism.

20. An apparatus as claimed in Claim 19, wherein the operation of the automatic feeding mechanism is controlled by at least one detector (26, 27) that detects when the height of the stack (24) has been reduced to a critical height and thereafter causes operation of the automatic feeding mechanism to add an additional stack of articles (21) to the end of the first stack (24).
Fig. 1
#### INTERNATIONAL SEARCH REPORT

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC 7 B65G59/10

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification systems followed by classification symbols)

IPC 7 B65G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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**Date of the actual completion of the international search**

26 November 2004

**Date of mailing of the international search report**

08/12/2004

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**C.** (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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