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METHOD AND SYSTEM FOR APPLYING A CLOSURE TO A CONTAINER

(57) Abstract:  

A method is disclosed for applying a closure to a container. The method may comprise: identifying a feature on the closure representative of an orientation of the closure and identifying a feature on the container representative of an orientation of the container. The method may then also comprise determining the orientations of the closure and the container from the identification of the feature on the closure and the feature on container. The method may also comprise determining what if any adjustment is required in the orientation of the closure relative to the container to bring the closure and the container into a suitable thread start orientation and then effecting any adjustment in orientation that is required to bring the closure and the container to the suitable thread start orientation.
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TECHNICAL FIELD

This relates to a method and system for applying a closure to a container.

BACKGROUND

Various methods and systems have been employed to apply a closure to a container. Additionally methods and systems have been employed for applying closures to preform containers.

Containers including preform containers may be made from a variety of materials including glass, metals and polymers/plastics. Many containers are configured in the form of a bottle and many are made from polymers/plastics such as for example polyethylene terephthalate ("PET").

It is often important that the container is properly sealed with a closure. One or more items or products may then be sealed within the container. The sealing may prevent the items or products from seeping out of the interior of the container and/or may prevent moisture and/or air or other gas from seeping into or out of the interior of the container. In general, it is often desirable to ensure that a sufficient amount of angular rotation of the closure relative to the container has been carried out.

In at least some manufacturing environments, the application of the closures to the containers may be automated with the use of various types of devices that are sometimes referred to as capping machines, capping systems, or "cappers". However, it has been difficult to provide a capping machine or capping system that ensures that a substantially consistent and/or predetermined amount of angular rotation of the closure relative to the container is achieved.

Additionally, during capping processes, typically the closure and the container are presented to each other for applying the closure to the container with the closure and container being randomly angularly oriented relative to each other. In certain situations where the closure and container are at certain relative angular orientations, the starting point of the thread for the closure and the starting point of the thread for the container can come into abutment or interference with each other as rotation of the closure relative to the container commences.

Some closures are known as "multi-start caps" and as these have more than one location where a thread start is located or commences, these closures are particularly vulnerable to coming into
interference with the thread start of the container. If there is interference between the thread start of
the closure and the thread start of the container, in some circumstances one or more thread starts of
the closure may move onto the wrong side of the thread start of the container during the relative
rotation of the closure and the container. This will typically result in a problem with the closure
application process.

It is therefore desirable to provide improved apparatuses and methods for applying a closure to a
container.

**SUMMARY**

According to an aspect, there is provided a method of applying a closure to a container, the method
comprising: (a) identifying a feature on the closure representative of an orientation of the closure; (b)
identifying a feature on the container representative of an orientation of the container; (c)
 determining the orientations of the closure and the container from the identification of the feature on
the closure and the feature on container; (d) determining what if any adjustment is required in the
orientation of the closure relative to the container to bring the closure and the container into a
suitable thread start orientation; (e) effecting the any adjustment in orientation to bring the closure
and the container to the suitable thread start orientation.

According to another aspect, there is provided a method of applying a closure to a container, the
method comprising: (a) determining an initial orientation of the closure; (b) determining an initial
orientation of the container; (c) determining what, if any, adjustment in orientation of the closure
relative to the container is required from the initial orientations of the closure and the container to
bring the closure and the container into a suitable thread start orientation; (d) if it is determined that
any adjustment in orientation is required, effecting the adjustment in orientation between the closure
and the container to bring the closure and the container from the initial orientations to the suitable
thread start orientation.

According to another aspect, there is provided a system for applying a closure onto a container
proximate an opening of the container to close the opening, the system comprising: (i) a capping
head having a rotatable shaft rotatable about an axis with a chuck device, the chuck device operable
to releasably hold a closure and rotate with the rotatable shaft about the axis, the capping head
operable to cause the closure held by the chuck device to engage with the container by rotating the
closure relative to the container about the axis; (ii) a drive device for driving the rotatable shaft about
the axis; (iii) a controller and a feature identification sub-system operable to: (a) control the rotation
of the rotatable shaft to thereby control the rotation of the closure relative to the container to engage the closure with the container; (b) identify a feature representative of an angular orientation of the closure about the axis; (c) identify a feature representative of an angular orientation of the container about the axis; (d) determine the relative angular orientation about the axis of the closure and the container; (e) determine what, if any adjustment angle for relative angular rotation of the closure relative to the container about the axis is required to bring the closure and the container into a thread start angular orientation; (f) cause the application of any the adjustment angle between the closure and the container by the capping head to bring the closure and the container into a thread start angular orientation; (g) after any adjustment angle is applied pursuant to (f), control and cause the rotation of the rotatable shaft to apply the closure to the container.

According to an aspect, there is provided a system for applying a closure to a container comprising: (i) an apparatus operable to hold a closure and a container and the apparatus also operable to effect a change in relative orientation between the closure and the container; (ii) a controller; (iii) a feature identification sub-system; the system operable to: identify a feature on the closure representative of an orientation of the closure; identify a feature on the container representative of an orientation of the container; determine the orientations of the closure and the container based on the identifications of the features on the closure and the container; determine what, if any, adjustment in orientation of the closure relative to the container required to bring the closure and the container into a suitable thread start engagement orientation; effect the any adjustment in orientation between the closure and the container to bring the closure and the container into the suitable thread start engagement orientation.

According to an aspect, there is provided apparatus comprising a combination of a closure and a container, each of the closure and the container having threads that co-operate during the rotation to facilitate the application of the closure to the container and wherein the closure and the container each have a visual feature, the visual features being associated with a suitable thread start orientation of the closure relative to the container.

According to an aspect, there is provided a method of applying a closure to a container, the method comprising: (a) identifying a feature on the closure representative of an orientation of the closure; (b) identifying a feature on the container representative of an orientation of the container; (c) determining the relative orientation of the closure and the container from the identification of the feature on the closure and the feature on container; (d) determining what if any adjustment is required in the orientation of the closure relative to the container to bring the closure and the
container into a suitable thread start orientation; (e) effecting the any adjustment in orientation to bring the closure and the container to the suitable thread start orientation.

These and other aspects and features of non-limiting embodiments will now become apparent to those skilled in the art upon review of the following description of specific non-limiting embodiments in conjunction with the accompanying drawings.

**DESCRIPTION OF THE DRAWINGS**

The non-limiting embodiments will be more fully appreciated by reference to the accompanying drawings, in which:

FIG. 1A is an elevation view of part of a closure and part of a container in an interference thread starting relative angular orientation;

FIG. 1B is an elevation view of a part of a closure and part of a container in non-interference thread starting relative angular orientation;

FIG. 1C is an enlarged view of the area marked 1C in FIG. 1A;

FIG. 1D is an enlarged view of the area marked 1D in FIG. 1B;

FIG. 2 is a schematic diagram in top view of a system for applying a closure to a container;

FIG. 2A is an enlarged top view of the part of the system depicted in FIG. 2;

FIG. 3 is a schematic diagram in side view illustrating one of a plurality of apparatuses forming part of the system of FIG. 2, with the one apparatus shown progressively applying a closure to a container;

FIG. 4 is a side view of part of a container, and part of an apparatus forming part of the system of FIG. 2;

FIG. 5 is a perspective close up view of the part of the system of FIG. 2 including the apparatus of FIG. 3;
FIG. 6 is another perspective close up view of the apparatus of FIG. 3;

FIG. 7 is another perspective close up view of the apparatus of FIGS. 3, 5 and 6;

FIGS. 8A to 8H are schematic elevation views illustrating one of a plurality of apparatuses forming part of the system of FIG. 2, with the one apparatus shown progressively applying a closure to a container; FIGS. 8B and 8C are schematic views that include an example imaging sub-system that may be part of the system of FIG. 2;

FIG. 9A is a perspective view of a closure that may be used in the system of FIG. 2;

FIG. 9B is a side elevation view of the closure of FIG. 9A;

FIG. 9C is a top elevation view of the closure of FIG. 9A;

FIG. 9D is a bottom elevation view of the closure of FIG. 9A;

FIG. 9E is a perspective view of the underside of the closure of FIG. 9A;

FIG. 10A is a perspective view of a neck region of a container that may be used in the system of FIG. 2;

FIG. 10B is a top elevation view of the neck of FIG. 10A;

FIG. IOC is a perspective view of the neck region of another container;

FIG. 10D is a top elevation view of the neck region of FIG. IOC;

FIG. 10E is a side elevation view of the neck region of FIG. IOC;

FIGS. 11A and 11B are schematic views of an example alternate imaging sub-system that may be part of the system of FIG. 2;

FIG. 12 is a flow chart illustrating an example method of operation of the capping process of the system of FIG. 2;
FIG. 13, 14 and 15 are cross sectional side elevation views of part of an alternate container and closure that may be employed with the system of FIG. 2; and

FIG. 16 is a chart illustrating characteristics an example process control for a capping system of the system of FIG. 2.

The drawings are not necessarily to scale and may be illustrated by phantom lines, diagrammatic representations and fragmentary views. In certain instances, details that are not necessary for an understanding of the embodiments or that render other details difficult to perceive may have been omitted.

**DETAILED DESCRIPTION OF THE NON-LIMITING EMBODIMENTS**

With reference to **FIGS. 1A and IB**, an example closure 220 is shown in two different angular orientations relative to a neck region 229 of an example container 230. Closure 220 may be made from any suitable material such as by way of example only a hard plastic/polymer, such as by way of example only high density polyethylene (HDPE) or poly propylene (PP). Similarly container 230 may be made from any suitable material such as by way of example only polyethylene terephthalate (PET). Container 230 may be a container that may be filled with one or more items or products such as for example a liquid. Alternatively, in some embodiments, container 230 may be a preform container that is required to have a closure applied thereto.

Closure 220 may be configured in a generally right cylindrical shape with a top wall 220a with downward facing surface 220d, and a cylindrical side wall 220c having an inner cylindrical shaped inward facing surface area 220b provided with a plurality of angled, spiral spaced threads 203. Threads 203 on the inward facing surface 220b of closure 220 may complement corresponding angled, spiral spaced threads 235 on an exterior cylindrical surface proximate an upwardly oriented opening 239 of container 230, such as on the outer surface 228 of neck region 229 at the top of the container 230. By providing a series of complementary spaced threads 203, 235, it is possible to have more than one thread start engagement position.

Closure 220 can be secured to container 230 to close opening 239 by engaging threads 203 of closure 220 with threads 235 of container 230. To effect such an engagement, respective threads 203, 235 should be initially positioned in a suitable thread start engagement position of closure 220 relative to container 230 such as the position that is shown in **FIGS. IB and ID**. A suitable thread start engagement position of closure 220 relative to container 230 includes both a suitable thread start
angular orientation and a suitable thread start axial (e.g. vertical) position of closure 220 relative to container 230. When closure 220 and container 230 are positioned relative to each other at both a suitable thread start angular orientation and a suitable thread start axial / vertical position, the rotation of closure 220 in one rotational direction relative to container 230 will cause threads 203 to engage with threads 235. In such a thread start engagement position threads 203 of closure 220 are axially aligned about a common axial axis X-X, and are also angularly and axially positioned, with respect to threads 235 of container 230 so that threads 203 of closure 220 are capable of properly engaging with threads 235 of the container 230 when closure 220 is rotated relative to container 230 about common axial axis X-X (FIG. 1B).

From a suitable thread start engagement position such as is shown in FIGS. 1B and ID, where closure 220 and container 230 are axially aligned, clockwise rotation of closure 220 relative to neck region 229 can cause threads 235 of container 230 to engage and mate with threads 203 of the closure 220. Continued relative rotation will cause threads 203 on the closure 220 to pass relative to threads 235 on container 230, and due to the angled path of the corresponding threads 203, cause closure 220 to be drawn axially towards (e.g. vertically downwards onto) neck region 229 of container 230. Rotation of closure 220 about axis X-X relative to container 230 can continue until a suitable final application angle has been reached, opening 239 is closed and closure 220 is adequately secured to container 230 w with a suitable seal being formed between closure 220 and container 230. At some point during the rotation of closure 220 relative to container 230, possibly due to progressively enhanced friction resulting from the ever increasing engagement between threads 203 of closure 220 and threads 235 of the container 230, further rotation with a given amount of torque may not be possible. Typically, the rotation of closure 220 relative to container 230 will stop when the inside surface of the closure top panel 220a (sometimes referred to as the Closure Top Sealing Surface - Closure TSS) comes into contact with the top edge surface 228a of the container 230 (the container Top Sealing Surface - TSS), and when resistance induced by tension in the structure of closure 220 in the region between the threads and closure top sealing surface exceeds the set or a predetermined torque level.

As will become evident form the following description of a capping system 100 (with reference particularly to FIGS. 2 and 2A) the final application / completion rotation angle of closure 220 relative to container 230 may be predetermined and/or selected in advance of commencing the rotation from the thread start engagement position to achieve a desired amount of frictional resistance between the closure and the container that will inhibit the removal of the closure from the container and/or appropriately secure and seal the closure to the container over opening 239.
In at least some capping systems, at some instances during operation, a suitable initial thread start engagement position of closure 220 relative to container 230 as shown in FIG. 1B may not be achieved, at least not consistently. Instead, threads 203 of a particular closure 220 may at an initial engagement position be in an undesirable relative angular orientation relative to the threads 235 of the respective container 230 such that interference results between threads 203 and threads 235 when the closure is rotated relative to the container, as for example is depicted in FIGS. 1A and 1C. For example, in such an initial engagement position, upon rotation of closure 220 relative to container 230, a first thread 203a of closure may upon rotation be directed on the upper side of thread 235a of container 230; while a second thread 203b may during that rotation be directed on the lower side of thread 235b of container 230. The result may be that closure 220 can not be properly secured to container 230 and possibly a buckled or "cocked" closure/container combination may result. It is therefore desirable to be able to ensure that at an initial thread start engagement position that the thread start angular orientation of closure 220 relative to container 230 is at a suitable orientation that will permit proper engagement of their respective threads 203, 235 during rotation of the closure relative to the container to apply the closure to the container, such as is shown in FIGS. 1B and 1D, as is possible using capping system 100 as depicted schematically in FIG. 2.

Capping system 100 may have several components as hereinafter described that may be controlled by any suitable controller such as a Programmable Logic Controller (PLC) 250. Capping system 100 may incorporate components that enable a suitable thread start engagement position of closure 220 relative to container 230 to be achieved consistently, thus enabling a proper and consistent application of closures 220 to respective containers 230 to be achieved and reducing or eliminating the degree to which improper threading of closures 220 with containers 230 occurs.

System 100 may include one or more capping heads 210. Each capping head 210 may be operable to pick up/engage a closure 220 from a supply of closures 220 and apply a closure 220 to one of a plurality of containers 230 delivered in series to the capping head 210 and then release the closure 220/container 230 combinations.

As will be explained further, system 100 does not simply rotate a closure 220 delivered to a capping head 210 at an unknown, random starting angular orientation, the same angular rotation relative to the container 230 for every closure/container combination in order to obtain a final application angle of the closure relative to the container. System 100 may instead be operable to identify the relative angular orientations of each closure 220 and container 230 combination as they are presented to each other in system 100; then if, and to the extent required, system 100 can make an initial angular
rotational adjustment to ensure closure 220 and container 230 are placed in a suitable thread start
angular orientation (such as shown in FIG. IB), prior to or while moving closure 220 axially relative
to container 230 so that the closure may be put into a desired initial, thread start engagement
position.

With reference still to FIG. 2, a plurality of closures 220 may be delivered serially from a supply of
closures generally designated 218 that may be controlled by PLC 250, to a rotating closure supply
table/wheel 221 that may be mounted for anti-clockwise rotation about axis X2 in a circular path in a
known manner. In other embodiments, other devices for delivery of closures 220 to a capping head
210 may be employed. The rotation of closure supply table/wheel 221 may be driven by any suitable
drive mechanism and may be controlled by PLC 250.

The closures 220 may each be delivered serially to capping heads 210 that are part of a capping sub-
system 215 (FIG. 2) such that each capping head 210 receives a closure at position A in FIG. 2A.
Capping sub-system 215 (FIG. 2) may comprise a plurality of capping heads 210, each of the
plurality of capping heads 210 being similarly mounted at spaced angular positions on an upper
section of a carousel 223 of capping sub-system 215 which may be mounted and configured for
rotation in a clockwise circular path about an axis XI in a known manner such that the circular path
of the capping heads 210 overlaps with the circular path of the closure supply table/wheel 221. The
rotation of carousel 223 may be driven by any suitable drive mechanism and may be controlled by
PLC 250. Capping heads 210 and carousel 223 may be configured to rotate about a central turret 224
that may be generally cylindrical and may be also centered on vertical axis XI. Turret 224 may be
remain stationary during operation of system 100 and may have a generally cylindrical outer surface
with a cam track 329 (FIG. 3) traversing a path on the outer cylindrical surface of turret 224. A lifter
rod and cam follower assembly 339 (shown schematically in FIG. 2) may be carried by each capping
head 210 and may thus guide each capping head 210 in vertical upward and downward (i.e. axial
relative to axes X6) movement as the carousel 223 rotates about turret 224.

As it reaches position A depicted in FIG. 2A, each capping head 210 is operable and positioned to be
able to pick up/engage a closure 220 with a chuck device 315 (FIGS. 3 and 6) from rotating closure
supply table/wheel 221 as the path of each capping head 210 and the path of each of the closures 220
overlap at position A.

Once a capping head 210 has retrieved a closure 220 from closure supply table/wheel 221, it may
securely grip closure 220 as the capping head 210 rotates away from closure supply table/wheel 221.
Containers 230 may be supplied serially by a container supply wheel or table 232 that may rotate in a circular path about axis X3 in an anti-clockwise direction. The rotation of supply wheel 232 may be driven by any suitable drive mechanism and may be controlled by PLC 250. Containers 230 delivered from container supply wheel 232 may have already been filled with one or more products or items. Containers 230 may have been filled by a filling sub-system 205 (FIG. 2) having an upstream container filler wheel 247. Filler wheel 247 of filling sub-system 205 may rotate about axis X4 in a clockwise direction and have a path for containers 230 that overlaps with carousel 224 so that filled containers 230 can be transferred to container receptors 225. Filler including filler wheel 247 may be controlled by PLC 250 and filler wheel 247 may be driven by any suitable drive means.

Containers 230 may be thus be delivered holding one or more products or items by supply wheel 232 to container receptors 225. The container receptors 225 may fixed to and carried by a lower plate 223b (see FIG 4) of carousel 223 of capping sub-system 215. Thus container receptors 225 may rotate together with corresponding capping heads 210 on carousel 223.

Each container 230 (which may be filled) may be supported in an appropriate position beneath a respective capping head 210 by such container receptors 225 connected with lower plate 223(b) of carousel 223 such that the containers 230 will each rotate in axial alignment with a respective closure 220 about turret 224. In this way, at position B as marked in FIG. 2A, each capping head 210, while carrying a closure 220, may be vertically and axially aligned above a container 230 and then both the capping head 210 with its closure 220, along with its respective container receptor holding a container 230 may be rotated by carousel 223 together in synchronized rotational movement counterclockwise to position C. In some other embodiments, only a single capping head 210 may be utilized and it may not be necessary to transversely move the capping head 210 in space in order to apply a closure 220 to a container 230 using a capping head 210. A separate drive and control system for the vertical/axial position of capping head 210 relative to axis X3 may be provided for each capping head 210.

In system 100, at position C shown in FIG. 2A, each container 230 is positioned beneath a closure 220. Container 230 may then rotate with carousel 223 about axis XI in synchronized movement with capping head 210 positioned axially aligned and spaced away (vertically above) it, from position C to position E in FIG. 2A. During the synchronized rotational movement about axis XI of container 230 and capping head 210 in the path defined by the carousel 223, capping head 210 will apply closure 220 to container 230, thus transferring a closure 220 to a container 230, such that by the time a
container 230 reaches position E, a closure 220 is fully applied to the container 230 and thus may properly seal the container with the closure. At position E, container 230 with closure 220 applied thereto is started to be released from capping head 210, and the combination of container 230 and closure 220 applied thereto, may then be discharged from carousel 223 to a discharge device 252 such as a discharge wheel 253. Discharge device 252 may also be controlled by PLC 250 and discharge wheel 253 may be driven by any suitable drive mechanism.

Once the container 230 is discharged from capping head 210 and carousel 223, the carousel 223 including capping head 210 and respective container receptor 225 will rotate from position E back to the closure supply position A, and thereafter the afore-described cycle can be repeated. If capping system 100 employs multiple capping heads 210, a relatively higher production rate of containers with closures applied thereto may be achieved than with a single capping head 210.

It should be noted that the angular orientation of each container 230 relative to the angular orientation of each closure 220 held by each capping head 210 as each closure 220 and container 230 combination are presented to each other may be unknown and random prior to the commencement of the application of the closure to the container. Nevertheless, as described hereinafter, system 100 can be provided with the capability such that by the time the combination of closure 220 and container 230 are unloaded at or just after position E in FIG. 2A, each closure 220 will have been applied at a substantially predetermined/known and/or consistent angular rotation relative to its respective container 230.

With reference now to FIG. 4, an individual container 230 is shown being held by a container receptor 225 of lower rotating plate 223(b) of carousel 223. Neck region 229 of container 230 may provide, at an upper end thereof, an opening 239 into an interior cavity 231 of the container. Threads 235 formed on the outer surface of neck region 229 may configured to co-operate with threads 203 on an inner surface of a closure 220 to provide for rotational threaded engagement of the closure 220 with the neck region 229 of container 230 as generally described above in relation to FIG. 1B.

Lower carousel plate 223(b) may have a plurality of container receptors 225 that are angularly spaced about plate 223(b). Container receptors 225 may be used to hold containers 230 in a vertically axially aligned position relative to a respective capping head 210 so that when lowered, capping head 210 can apply a closure 220 to a container 230.
Forming part of container receptors 225 may be collar members 227 mounted on an upper surface of carousel plate 223(b) of carousel 223. Collar members 227 may have an opening (not shown in FIG. 4) that is sufficiently large to allow neck region 229 of a container 230 to be received into a holding slot formed by collar members 227. Upper facing surfaces of collar members 227 may be provided with spikes or protrusions 226 that are sufficiently sharp or provide enough frictional engagement to engage the underside surface of integrally formed neck collar 237 of the neck region 229 of container 230. When a downward axial load is applied to the container 230 as a result of a closure 220 being applied to the neck region 229, spikes/protrusions 226 may engage the neck collar 237 of container 230 and prevent the container 230 from rotating relative to collar members 227 when the capping head 210 is rotating the closure 220 during engagement of threads such as threads 235 of neck region 229 with inner surface threads 203 of the closure 220. Other known devices/methods for preventing the containers 230 from rotating while a closure 220 is applied thereto may be utilized in other embodiments. In other embodiments, container 230 may be able to rotate with closure 220 or instead of closure 220 during the application of the closure to the container.

With reference now to FIGS. 3, 5, 6 and 7, a representative capping head 210 is shown in more detail, which may be a known type of servo drive/motor driven capping head 210. Examples of commercially available capping heads that may be suitable to be employed and which have features/capabilities required for system 100 are capping heads made by manufacturers Krones, Arol, or Zalkin. Capping head 210 may include a main body 317, a support block 316, a spur gear 321, a rotatable shaft 313, a vertical support shaft 325, and a chuck device 315. Support block 316 may be generally horizontally oriented and may be fixedly secured to main body 317 of capping head 210. Also, secured to a rear portion of support block 316 may be a lift rod and cam follower assembly 339 (only shown schematically in FIG. 2). A roller type cam follower of lifter rod and cam follower assembly 339 may be configured to also engage cam track 329 (only shown schematically in FIG. 3) of turret 224. The main body 317 of each capping head 210 may be configured to rotatably support rotatable shaft 313 for rotation about axis X6.

A vertical support shaft 325 may be mounted to an upper, generally horizontally oriented support block 331. Main body 317 and rotatable shaft 313 may be mounted for vertical (axial) upwards and downwards sliding movement relative to and on vertical support shaft 325. Support block 316 may itself be mounted for sliding up and down vertical movement on a support shaft 337 that may, like shaft 325, be oriented generally parallel to axis X6. Thus main body 317 and rotatable shaft 313 of capping head 210 may move vertically (axially) upwards and downwards with support block 316, as the cam follower of lifter rod and cam follower assembly 329 (see FIGS. 1 and 2) moves up and
down in cam track 329 (FIG. 2) as each capping head 210 is rotated about turret 224. In other embodiments, capping heads 210 may be moved up and down by another drive mechanism controlled by PLC 250 such as a non-mechanical cam (e.g. a servo motor drive system) that may also be controlled by PLC 250.

The commencement of the application of each closure 220 held in a capping head 210 of capping sub-system 215 to a container 230 axially aligned with it may commence at or about position C in FIG. 2A with the application of any adjustment angle that may be required (as described below) and then the commencement of the application of a completion angle to complete the application of the closure to the container, may commence at or about position D in FIG. 2A.

The vertical position of the groove/cam track 329 around the perimeter of turret 224 reflects the desired axial/vertical position of each capping head 210 at each angular position of the carousel 223 about axis X1 (FIG. 2). As carousel 223 turns relative to turret 224, each of the capping heads 210 and their associated lifter rod and cam follower assemblies 339 may turn with the carousel 223. As the cam follower of each lifter rod and cam follower assembly 329 reaches a downwards or upwards slope in the cam track 329, the cam follower will start moving downwards or upwards respectively as well and result in a downwards/upwards movement of the lifter rod and cam follower assembly 329 and the respective other components of each capping head 210, including chuck device 315.

Chuck device 315 may be fixedly secured at a lower end portion of rotatable shaft 313 and rotate with shaft 313 about vertical axis X6. Chuck device 315 may be a known type of device that is capable of picking up and holding a closure 220, and preventing rotation of the closure 220 held therein relative to rotatable shaft 313, as described hereinafter. For example, chuck device 315 may be a conventional type of spring loaded chuck with spring loaded spheres/ball bearings that interface with the outward facing side surface of a closure and exert a radial force onto the closure to hold the closure in position. To assist in transmitting torque from the chuck device 315 to a closure 220 held therein, chuck device 315 may be provided with a series of interior vertical surfaces (not shown) which are complimentary in configuration to outward facing surfaces (not shown) of the closure 220.

Thus, the series of faces on closure 220 can interface with the complimentary outer surfaces on the chuck device 315 to transmit torque from the chuck to the closure 220. The closure 220 may be released from the chuck device 315 by a downward force being applied to the closure (or in particular to the container 230, once the closure 220 is attached thereto).
In order to drive the rotation of rotatable shaft 313 and chuck device 315 while holding a closure 220, about axis X6, a servo drive/motor 335 may be provided and mounted to carousel 223. Servo drive/motor 335 may be at least partly supported by support block 331 (see FIG. 5). Servo drive/motor 335 may be controlled by PLC 250 and may have a drive shaft 333 aligned generally parallel to axis X6 of capping head 210. Secured to drive shaft 333 for rotation therewith may be a drive gear 323. Spur gear 321 affixed to rotatable shaft 313 of capping head 210, may mesh and engage with drive gear 323 of servo drive/motor 335. Drive gear 323 may extend longitudinally, to allow the spur gear 321 to be able to move vertically upwards and downwards while still remaining in driving engagement with drive gear 323. Thus, servo drive/motor 335 may, under control of PLC 250, by rotating drive shaft 333 and thus drive gear 323, cause spur gear 321 to rotate about axis X6 operable for driving the rotatable shaft 313 in rotational movement about axis X6. The vertical movement, may allow each capping head 210 to move vertically downwards so that chuck device 315 may engage a closure 220 on closure supply table 221 and then move upwards clear of the closure supply table 221 and thereafter move downwards to apply the closure 220 to the container 230 and then release the closure 230 to release the container with closure applied thereto.

PLC 250 may be operable to control the servo drive/motor 335 to rotate the rotatable shaft 313 about a vertical axis X6 (FIG. 2). In some embodiments, servo/drive motor 335 may be operable to provide signals and/or data back to PLC 250 indicative of the magnitude of the torque being applied to the rotatable shaft 313 and/or the chuck device 315 being held by the rotatable shaft 313. Additionally, in some embodiments, by use of a suitable encoder associated with servo/drive motor 335, signals may be provided that are indicative of the relative angular position of the chuck device 315 (and the closure 220 while held therein) about axis XI to PLC 250, so that PLC 250 would be able to monitor the angular rotational position of the chuck device 315 about axis XI. Also, in some embodiments, PLC 250 may also be configured to receive signals directly representative of the axial position of chuck device 315 and closure 220. For example, by use of a suitable encoder, signals representative of the rotational position of each capping head 210 in system 100 as each capping head 210 rotates about axis XI (FIG. 2) with carousel 223 about turret 224, as each capping head 210 is guided in vertically upward and downward movement by the cam track 329 (FIG. 3), as the carousel 223 rotates about turret 224. In this way, PLC 250 may be operable to monitor both the relative angular position of the chuck device 315 and a closure 220 held therein about axis X6 and its axial / vertical position.

As described above, chuck device 315 may have a downward facing cavity that may be adapted to receive and securely grip a closure 220 such that when the chuck device 315 is rotated by rotatable
shaft 313, the chuck portion 315 with the closure 220 being held in its cavity, may rotate therewith, even when there is a resistive force being applied to the closure (i.e. frictional resistance as the closure threads mates with the threads of the container).

Turning now again to FIG. 3, vertical movement of a single representative capping head 210 of system 100 is shown relative to a container 230. In movement between position (a) and position (b), the capping head 210 moves axially/vertically downwards so that the chuck device 315 may pick up and grip a closure 220 (corresponding to the angular position A in FIG. 2A). Thereafter, the capping head 210 moves up and down while maintaining vertical alignment with the container 230 to apply the closure 220 to the neck region 229 of the container 230 by rotational engagement of the threads 235 of neck region 229 with threads 203 of closure 220. In FIG. 3, the carousel lower plate 223(b) and collar members 227 (shown in FIG. 4) are omitted for simplicity. However, it will be appreciated that during the application of the closure, when the capping head 210 is in the position illustrated in (d), in addition to a rotational movement imparted by rotation of rotatable shaft 313 and chuck device 315, a downward axial force may also be provided by capping head 210 acting through the closure 220 held in chuck device 315. The downward imparted axial force acting on the closure 220 and container 230 may result in the container 230 being prevented from rotating within the container receptor 225 by spikes 226 acting on neck collar 237 as the spikes engage the neck collar 237.

The rotational forces imparted on container 230 may at least in part result from the resistance to the rotational movement of the closure 220 relative to the neck region 229 of the container 230 as the closure 220 is rotated by rotatable shaft 313 of capping head 210 and thus drawn onto threads 235 of the neck region 229. This combined vertical downward and rotational movement about axis X6 allows the capping head 210, with the closure in the chuck device 315, to move downwards so that the closure 220 may be screwed onto the neck region 229 of the container 230 as the threads 203, 235 of the closure and the neck region 229 of container 230 co-operatively engage with each other.

With particular reference again to FIG. 3, during the rotational movement of the rotatable shaft portion 313 of capping head 210, PLC 250 may in some embodiments in real time also be calculating or monitoring the torque being applied through the servo drive/motor 335 that drives the rotatable shaft 313 of capping head 210. As indicated above, by virtue of an encoder associated with the servo motor 300 and thus rotatable shaft 313, the relative angular rotation of the rotatable shaft 313 and the closure 220 held in the chuck device 315 about axis X6 can be calculated and monitored continuously at specific time intervals in real time. However, it may be appreciated that while the
actual angular orientation in space of the chuck device 315 may be known and monitored, the angular orientation of the closure 220 held in chuck device 315 may not be known, at least until that angular orientation is ascertained as described herein. That is because, when the chuck device 315 picks up a closure 220, the angular orientation of that specific closure 220 relative to the chuck device 315 may be random and not known.

Similarly, the angular orientation of each container 230 may also not be known, at least until that angular orientation is ascertained. That is because when container 230 is delivered to container receptor 225 (FIG. 4) (corresponding to position B in FIG. 2A) its angular orientation may also be random and not known.

Nevertheless, in system 100, PLC 250 may be also configured and/or coupled with another device or sub-system, such as a feature identification sub-system that may for example be an imaging sub-system 400 comprising for example imaging sensors 402A, 402B (FIGS. 2, 2A 8B and 8C), that enables system 100 to determine and adjust the relative angular orientations of each closure 220 and its respective container 230 prior to applying the closure to the container. Imaging sub-system 400 may be deployed for each capping head 210 when each capping head 210 moves between the positions (c) and (d) in FIG. 3 (angular positions A and C in FIG. 2A) and the path of cam track 329 may be appropriately oriented and chosen to facilitate the same. The use of imaging sub-system 400 enables system 100 to ascertain the relative angular rotation of closure 220 and container 230, and then make an appropriate adjustment in the relative angular orientation of closure 220 and container 230 to place each combination of closure 220 and container 230 in a suitable thread start angular orientation prior to applying the closure to the container.

System 100 may be operable to apply a closure 220 to a container 230 by:

(a) identifying a feature on the closure 220 representative of an orientation of the closure 220;
(b) identifying a feature on the container 230 representative of an orientation of the container 230;
(c) determining the orientations of the closure 220 and the container 230 from the identification of said feature on the closure 220 and the feature on container 230;
(d) determining what if any adjustment is required in the orientation of the closure 220 relative to the container 230 to bring the closure and the container into a suitable thread start orientation;
(e) effecting any required adjustment in orientation to bring the closure 220 and the container 230 to the suitable thread start orientation.
The method may provide that the identifying of the feature on the closure 220 comprises identifying a feature on the closure representative of an angular orientation of the closure; and the identifying of the feature on the container 230 may comprises identifying a feature on the container 220 representative of an angular orientation of the container 230; and the effecting the adjustment in orientation may comprise applying an adjustment angle between the closure 220 and the container 230 to bring the closure 220 and the container 230 to a suitable thread start angular orientation.

The method may also provide that the determining the orientations comprises determining the initial relative angular orientation of the closure 220 relative to the container 230; and the determining what if any adjustment in orientation comprises determining what if any adjustment angle for angular rotation of the closure 220 relative to the container 230 from the initial relative angular orientation is required to bring the closure 220 and the container 230 into a suitable thread start angular orientation; and the effecting the adjustment in orientation may comprise applying the adjustment angle between the closure 220 and the container 230 to bring the closure 220 and the container 230 from the initial relative angular orientation to the suitable thread start angular orientation.

As party of system 100, imaging sub-system 400 may be operable to image/identify: (i) a visual feature on closure 220 that is indicative of an angular orientation of closure 220 about axis X6; and (ii) a visual feature on container 230 that is indicative of an angular orientation of container 230 about axis X6. The identification of the features on closure 220 and container 230 by imaging sub-system 400 may occur while the capping head 210 remains at a constant axial/vertical position (see the relatively horizontal section of cam track path 329 between positions (c) and (d) in FIG. 3 In other embodiments the imaging sub-system may identify the features on each closure 220 at another time after closure has been secured by a capping head 210 and may identify the features on a respective container 230 once the container has been acquired, so long as both identifications and any angular adjustment that is required, occur prior to the closure engaging with and being applied to the container.

Imaging sub-system 400 having identified these visual features, PLC 250 and/or imaging sub-system 400 may be operable to: (i) determine the angular orientation of the closure and determine the angular orientation of the container about axis X6 and/or determine the relative angular orientation of closure 220 and container 230 about axis X6 (e.g. calculate the angular difference between the angular orientation of the feature on the closure and the angular orientation of the feature on the container); (ii) determine if that relative angular orientation corresponds with a suitable thread start angular orientation for the closure and container combination, and if not (iii) determine the adjustment angle that is needed to the relative angular orientation of the closure and the container to
position the closure and container in a suitable thread start angular orientation; and (iv) cause the
capping head 210 to apply / effect the required adjustment angle, if any, to the closure 220, for
example by rotating rotatable shaft 313 of the capping head 210, chuck device 315 and closure 220
held therein by the determined adjustment angle so that the threads 203 of closure 220 and the
threads 235 of container 230 are brought into the suitable thread start angular orientation.

In some embodiments the visual feature on closure 220 that is indicative of an angular orientation of
closure 220 about axis X6 may be positioned at or aligned with the same angular orientation about
axis X6 of a suitable thread start location on closure 220. However in other embodiments, the visual
feature(s) on closure 220 that is/are indicative of an angular orientation of closure 220 about axis X6
may be not be the same, but may be related to, or be a known function of, the angular orientation
about axis X6 of a suitable thread start location of closure 220.

Similarly, the visual feature on the container 230 that is indicative of an angular orientation of
container 230 about axis X6 may be positioned at the same angular orientation of a suitable thread
start location on the container 230. However in other embodiments, the visual feature(s) on the
container that is/are indicative of an angular orientation of container 230 about axis X6 may be not
be the same, but may be related to, or be a known function of, the angular orientation of a suitable
thread start location of the container 230.

In some embodiments the visual features on both closure 220 and container 230 that may be
identified by imaging sub-system 400, may be angularly aligned with the respective suitable thread
start locations on both closure 220 and container 230. This may make it computationally easier to
determine the adjustment angle required to be applied to the closure 220 by the capping head 210 to
angularly align the visual features on the closure and the container and reach a suitable thread start
angular orientation.

The axial/vertical positioning of capping head 210, chuck device 315 and closure 220 may be
adapted by providing a suitable cam track path 329 (FIG. 3) to provide for suitable axial/vertical
positioning of the capping head 210, chuck device 315 and closure 220 to allow for operation of the
imaging sub-system 400 as described in further detail hereinafter. In some embodiments, PLC 250
may also be operable to control an axial position adjustment mechanism such that the axial/vertical
position of closure 220 can also be monitored and directly controlled.

It may also be appreciated that in some embodiments, in applying/effecting a relative adjustment
angle between closure 220 and container 230, the closure and/or the container may be rotated/moved
in space relative to each other by suitable apparatuses to effect an adjustment in relative angular rotation to reach a suitable thread start angular orientation.

Returning to system 110 of **FIG. 2A**, once the angular orientation of the closure 220 relative to container 230 is such that PLC 250 recognizes that the desired relative angular position has been achieved (i.e. the closure and container are at a suitable thread start angular orientation - such as after angular location C but prior to angular location D in **FIG. 2A**) capping head 210, chuck device 315, and closure 220 may be lowered into the suitable vertical/axial thread start position so that the suitable thread start engagement position is acquired.

Once the desired thread start engagement position is reached, further rotation of closure 220 relative to container 230 can be commenced to apply the closure to the container (angular location C). Closure 220 may be rotated from the suitable thread start engagement position a specific predetermined additional desired amount of angular rotation (which may be referred to as a "completion angle") relative to container 230 about axis X6 while at the same time the closure may move axially further onto the neck region 229 of container 230 as required by the orientation of threads 203, 235. The application of a completion angle from the thread start angular orientation can then place closure 220 in a desired final angular orientation and an associated final vertical/axial position relative to the container 230 determined by the orientation of the mating threads 203, 235.

PLC 250 may be programmed with a predetermined desirable completion angle that is appropriate for the particular combination of closure 220 and container 230 that is being processed. The completion angle will have been applied and the desired relative orientations of the closure 220 and container 230 achieved by the time the capping head 210 reaches the position (e) in **FIG. 3** (angular location E in **FIG. 2A**). Thereafter, chuck device 315 may release closure 220 and the container 230 to which it is now secured, so the combination of container and closure is released from capping head 210 as depicted by position (f) in **FIG. 3**.

As referenced above, system 100 may include an imaging sub-system 400 operable to identify both: (i) one or more visual features on the closure that is/are indicative of an angular orientation of closure 220 about axis X6; and (ii) one or more visual features on the container 230 that is/are indicative of an angular orientation of container 230 about axis X6. In order to achieve a suitable thread start relative angular orientation of the closure and container, an imaging sub-system 400 may be employed as depicted schematically in **FIGS. 2, 2A, 8B and 8C** (omitted for simplicity in **FIG. 8A** and **FIGS. 8D-8H**).
A suitable imaging sub-system 400 may include a pair of imaging sensors 402A, 402B angularly spaced about axis XI of carousel 223, and turret 224 (FIG. 2) and suitably positioned and oriented in relation to the capping heads 210, closures 220 and the containers 230 such that as each capping head/closure and each container is rotated about axis XI from angular positions A/B through to C (FIG. 2A), an image of the closure can be taken and an image of the container can be taken as described further below. Each imaging sensor 402A, 402B may have associated with it a respective mounting frame 406A, 406B to which may be secured one of imaging sensors 402A, 402B. Each imaging sensor 402A, 402B may be by way of example only an appropriate digital camera.

Also mounted to each frame 406A, 406B may be a mirror 404A. 404B that may have a reflecting surface 405A, 405B that may be oriented at an appropriate angle such as 45 degrees or some other angle that will provide a line of sight from the imaging sensors to the desired parts of closure and container. Light waves emanating from closure 220 may be reflected by surface 405A of mirror 404A to imaging sensor 402A. Similarly, light waves emanating from container 230 may be reflected by surface 405B of mirror 404B to imaging sensor 402B.

Thus imaging sensors 402A, 402B being generally oriented in a direction parallel to a transverse axis Y1, can be configured to be operable to capture/acquire images in one of an upward direction parallel to axis X6 (as shown in FIG. 8B) and a downward direction parallel to axis X6 (as shown in FIG. 8C). It will be appreciated that by use of an angled mirror 404A, 404B with a respective imaging sensor 402A, 402B, one imaging sensor (e.g. imaging sensor 402A) can be used to obtain a lower plan view image of the underside of closure 220 and the other imaging sensor (e.g. imaging sensor 402B) can be used to obtain an upper plan view images of the top side of the container 230 including neck region 229.

As shown in FIG. 2A, imaging sensor 402A may be located between angular positions A and B such that the image of the closure may be acquired. Imaging sensor 402B may be located between angular positions B and C such that the image of the container may be acquired. However, various alternate positions/locations are possible in other embodiments.

Imaging sub-system 400 may be operable to image a visual feature (such as a thread start location 298, 299) of both closure 220 and container 230 and function in co-operation with PLC 250 and a computing device 251 to determine the angles 1 and 2 (FIGS. 8B and 8C) associated with the visual feature on the closure and container and then determine the appropriate adjustment angle that is to be
applied to adjust the relative angular orientation of the closure and container about axis X6 such that a suitable thread start angular orientation is achieved, as described further below.

One example of an alternate to imaging sub-system 400 is shown in FIGS. 11A and 11B. In this embodiment, imaging sub-system 1400 does not use a mirror. Instead the mounting frame 1406A to which the imaging sensor 1402A (which may be like imaging sensor 402A) is mounted, puts the imaging sensor 1402A in such a position (shown in FIG. 11A) where it directly senses the image of the underside of the closure 220. Similarly, mounting frame 1406B to which the imaging sensor 1402B (which may be like imaging sensor 402B) can be configured such that it puts the imaging sensor 1402B in such a position where it directly senses the image of a side portion of the neck region 229 of the container 230 (shown in FIG. 11B) from a side elevation view.

Imaging sensor 1402A may be located between angular positions A and B of FIG. 2A such that the image of the closure may be acquired. Imaging sensor 1402B may be located between angular positions B and C of FIG. 2A such that the image of the container may be acquired. However, various alternate positions/locations are possible in other embodiments.

Imaging sub-system 1400 will be able to image a visual feature (such as a thread start location 298, 299) of both closure 220 and container 230 and function in co-operation with PLC 250 and computing device 251 in the same or a similar manner as imaging sub-system 400 as described herein to determine the angles Alpha and Beta associated with the visual feature on the closure and container and then determine the appropriate adjustment angle that is to be applied to adjust the relative angular orientation of the closure and container about axis X6 such that a suitable thread start angular orientation is achieved.

As shown in FIGS. 9A-9E, an example closure 220 that may be utilized with system 100 is illustrated in detail. Closure 220 with top wall 220a and cylindrical side wall 220c may have one or more different visual features that may be imaged by imaging sub-system 400. For example, closure 220 may include a thread start 520 which may be sensed by imaging sensor 402 (see FIGS. 9D and 9E). Visual features that may be utilized may also include an external thread start mark or protrusion 522 that may be closely angularly aligned with the thread start 520. Visual features such as one or more oriented engravings or other marks 524 whose orientation can be visually ascertained which may be located on the lower surface 220d of the top wall 220a of closure 220 may also or alternatively be utilized.
Similarly, as shown in FIGS. 1OA-10 example neck region 229 of a container 230 is shown that may also be utilized with system 100. Neck region 229 may have one or more different visual features that may be imaged by imaging sub-system 400. For example, neck region 229 may include a thread start 620 which may be sensed by imaging sensor 402 (see FIGS. 1OA and 10B). Visual features that may be utilized also include an external thread start mark or protrusion 622 on a neck support ledge 621. In the embodiment of FIGS. 1OC-10E, engravings or other marks such as engraved letters 624 may also provide visual features that can be identified by imaging sub-system 400. Protrusion 622 and/or engraved letters 624 may be closely angularly aligned with thread start 620. Other visual features such as vent slots 625 (FIG. 10E) whose orientation can be visually ascertained may also be utilized.

By way of example only, suitable imaging sensors 402A, 402B (or imaging sensors402A, 1402B) that may be employed in imaging sub-systems 400 and 1400 may include In-Sight 5000 series industrial cameras by Cognex of Massachussetts or the A20 series smart cameras by Datalogic of Italy.

Imaging sub-systems 400 and 1400 may also include a computing device 251 such as a personal computer running an imaging system software application. By way of example only a personal computer running VisionPro software by Cognex might be employed.

Computing device 251 may be operable to receive image data from imaging sensors 402A, 402B (or 1402A, 1402b) and store the image data in an image buffer or other memory. Computing device 251 may for example create a two-dimensional pixel array representing the captured image and store the array. The pixel array may be a two dimensional of values providing information about color and/or intensity for each pixel. Computing device 251 may also be operable to analyze and possibly also conduct some processing of the image data (e.g. the two-dimensional pixel array).

Computing device 251 may be configured and operable to analyze the matrix of values to identify one or more visual features on closure 220 and one or more visual features on container 230 in the two separate sets of image data, by for example looking for a particular pattern in the matrix of values representative of the captured images of the visual features. Additionally, computing device 251 may be able to analyze the matrix to calculate an angle of orientation of the visual features about fixed axis X6 whose position is known, in relation to a fixed angular datum (e.g. datum N in FIGS. 8B and 8C) and thus determine the angular orientation of these visual features on closure 220 and container 230 relative to the datum about axis X6.
For example, imaging sensor 402A, may produce image data associated with an image 410 of the downward facing surface of the closure 220 as shown in FIG. 8B. Computing device 251 may then receive the image data from imaging sensor 402A, produce the matrix of values representative of the image 410, identify a visual feature such as thread start mark 522 in the matrix of values, and determine an angle of orientation of the thread start mark 522 (Angle 1) about axis X6 from datum N that is associated with the desired thread start location for the closure 220. Similarly, imaging sensor 402B may produce image data associated with the image 411 of the upward facing container 230 as shown in FIG. 8C.

Computing device 251 may similarly receive the image data from imaging sensor 402B, produce the matrix of values representative of the image 411, identify a feature such as protrusion 622 in the matrix of values, and determine an angle of orientation of the protrusion (Angle 2) about axis X6 from datum N that is associated with the desired thread start location for container 230. In some embodiments the visual features on the container and the closure may be angularly aligned with suitable thread start angular locations, (i.e. when the visual features of the closure and container are angularly aligned, then suitable thread start locations on the closure and container would also be angularly aligned).

Computing device 251 may then further: (i) calculate the relative angular orientation of the closure 220 and the container 230 (e.g. calculate the angular difference between the angular orientation of the desired thread start on the closure (e.g. Angle 1) and the angular orientation of the desired thread start on the container (e.g. Angle 2); (ii) determine if that relative angular orientation/angular difference is within a desired range that provides for the closure and container being relatively positioned in a suitable thread start angular orientation (iii) if not, calculate the adjustment in relative angular orientation (the "adjustment angle") that is required to position the closure 220 and container 230 in the predetermined suitable thread start angular orientation; and (iv) provide data relating to the required adjustment angle to PLC 250. PLC 250 may then cause the rotatable shaft 313 of capping head 210 to be rotated by the adjustment angle so that the threads 203 of closure 220 and the threads 235 of container 230 are brought into the desired thread start angular orientation.

Imaging sub-system 1400 may be operable to function and can be employed in a similar manner as imaging sub-system 400 to determine an appropriate adjustment angle for container and closure combinations.
With reference now to FIGS 8A - 8H, the process of applying a closure 220 to a container 230 with system 100 is explained in further detail. With reference again to FIGS. 8A and 8B, the capping head 201 may be positioned in an axial/vertical position shown in FIG. 8A and FIG. 8B. In FIG. 8B, a capping head 210 and closure 220 held therein are in a suitable imaging positions such that an image of closure 220 can be captured with imaging sub-system 400/1400, and processed as described above. Then, as carousel 223 is rotated imaging sub-system 400/1400 can capture an image of container 230, also as described above and with reference to FIG. 8C.

Next, as depicted in FIG. 8D, with PLC 250 having calculated the adjustment in relative angular orientation (adjustment angle) that is required to enable closure 220 to be positioned in the desired thread start angular orientation relative to the container 230, PLC 250 can cause rotatable shaft 313 of capping head 210 to be rotated by an adjustment angle (which could be zero in some particular cases) such that the threads 203 of closure 220 and the threads 235 of container 230 are brought into the desired thread start angular orientation where threads 203 of closure 220 and threads 235 of container 230 are appropriately aligned. This may occur during angular rotation on carousel 223 of capping head 210, closure 220 and container 230 between angular positions C and D in FIG. 2A.

The next step may be that capping head 210 is then lowered as shown in FIGS. 8E to 8F so that closure 220 and container 230 are positioned relative to each other at both a suitable thread start angular orientation and a suitable thread start vertical/axial position as depicted in FIG. 8F (i.e. the closure 220 and container 230 are have acquired a suitable thread start engagement position). This may occur when capping head 210, closure 220 and container 230 at are at or shortly after they pass angular position D in FIG. 2A.

It should be noted that the either after or while closure 220 and container 230 are brought into the thread start angular orientation, the closure can be axially positioned relative to the container so that the closure and the container are in a thread start engagement position.

Thereafter, as shown in FIG. 8G, rotation of the closure 220 relative to the container 230 will cause threads 203 to engage with threads 235. In such a thread start engagement position threads 203 of the closure 220 are axially aligned, and angularly and axially positioned, with respect to the threads 235 of the container 230 so that threads 203 are capable of properly engaging with the threads 235 of the container 230 when the closure 220 is rotated relative to the container 230 about a common axis. Continued relative rotation will cause threads 203 on closure 220 to pass relative to threads 235 on container 230, and due to the angled path of the corresponding threads 203, cause closure 220 to be
rotate and be drawn axially towards (e.g. vertically/axially downwards) onto neck region 229 of container 230. Rotation of closure 220 relative to container 230 can continue until a suitable final application angle has been reached, with opening 239 closed and closure 220 adequately secured to container 230. This may occur during angular rotation on carousel 223 of capping head 210, closure 220 and container 230 between angular positions D and E in FIG. 2A.

The final application angle may be predetermined and/or selected in advance of commencing the rotation from the initial thread start engagement position and stored in a memory of PLC 250 to achieve a desired amount of frictional resistance (i.e. where the sealing surface of the closure bottoms out on/engages with the sealing surface of container 230) that will inhibit the removal of closure 220 from container 230 and/or secure the closure to the container.

With reference now to FIG. 8H, once closure 220 is secured to container 230, chuck device 315 (omitted for simplicity in FIGS. 8A-8H) can be removed from engagement with capping head 210 and capping head 210 can move axially away from container 230. Thereafter as carousel 223 rotates, the process will be repeated by another capping head 210, closure 220 and container 230 combination.

So the operation of system 100 may be as follows. Closures 220 are fed serially from a supply of closures 218 to the closure supply table 221. From the closure supply table 221 the closures are transferred to capping heads 210 of capping sub-system 215. Capping heads 210, carried by carousel 223, rotate from angular position A to angular position B where a containers are fed to corresponding container receptors 225 carried by lower plate 223(b) of carousel 2223. The capping process of system 100 as described above can be employed to apply each closure held by a capping head 210 to a container held by a container receptor 225 as they rotate from angular position A through to angular position E in FIG. 2A.

The foregoing capping process utilized by system 100 utilizing capping heads 210, imaging sub-system 400, computing device 251 and PLC 250 as described above, is depicted schematically in FIG. 12. In step 1000 the angular orientation of the closure (Angle 1) can be determined by computing device 251. In step (1010) the angular orientation of the container 230 (Angle 2) can be determined by computing device 251. Once Angles 1 and 2 have been determined, computing device 251 and/or PLC 250 may determine the adjustment angle that must be applied to closure 220 to achieve a suitable thread start angular orientation of the closure relative to container (1020) which may be a function of the difference in Angle 1 and 2. The required adjustment angle may then result
in a signal being sent by PLC 250 to the servo motor/drive 335 to cause rotatable shaft 313 of capping head 210 to rotate (1030) by the adjustment angle. While or after the adjustment angle is applied to closure 220, the capping head 210 can be moved vertically/axially downward to also acquire a suitable thread start axial/vertical position as well by movement of the capping head 210 axially (1050). Once closure 220 and container 230 are brought into a suitable thread start engagement position, PLC 250 can cause servo drive/motor 335 to rotate shaft 313, chuck device 315 and closure 220 held therein (1060) by a predetermined completion angle, and capping head can be moved axially, to reach a desired final application angle and/or a desired torque determined by PLC 250 (1070). Once such a state is reached, the rotation of the closure 220 ceases and servo drive/motor 335 may cease to apply torque to shaft 313 (1080). The chuck device 315 of capping head 210 may then release closure 220 and the capping head may move axially away from the container and closure combination.

System 100 may in some embodiments be used with a container 230 and closure 220 that include tamper evident band located proximate the neck region of a container 230. For example, as depicted in FIG. 9E and FIGS. 10A-10E a tamper evident band 200 of closure 220 having circumferentially spaced protrusions 202 may be configured to engage with a pilfer-proof ring 211 that is on the neck region 229 of a container 230, below threads 235. The tamper evident band 200 may be integrally connected to the rest of the closure 220 and may have one or more generally circumferential protrusions 202 that protrude inward, towards the neck region 229 of the container when the closure is applied to the container. The pilfer ring 211 may be integrally formed with the neck region 229 of the container 230 and have one or more corresponding protrusions 212 that protrude outward, towards the inner surface of the closure, when the closure is applied to the container.

FIGS. 13, 14 and 15 show progressive positions of tamper evident band 200 of a closure 220 in relation to a pilfer-ring 211 of a container 230 during the application of the closure 220 to the container using capping head 210. In the position of FIG. 13, tamper band 200 is shown just before the protrusion 212 starts to engage with protrusion 212 of the pilfer-proof ring 211. Once protrusions 202 and 212 engage, the continued rotation of the closure 220 will necessitate an elastic deformation in one or both of protrusions 202 and 212 and/or the tamper band 200 and/or the pilfer ring 211. Typically, due to the relative stiffness of the parts, it will be mostly the tamper band 200 and its protrusion 202 that will be elastically deformed outwards. The engagement between protrusions 202 and 212 will create an increased resistance to rotation and increase in the torque required to rotate the closure 220 relative to the container 230.
In FIG. 14, tamper band 200 is shown during the maximum outward deformation when due to the specific angular position of the closure 220 relative to container 230. Tamper band 200 and its protrusion 202 are pushed outwards relative to pilfer ring 211 and its protrusion 212, to substantially its maximum relative radial position. It may be at this relative angular position of closure 220 and container 230 which also causes the maximum resistance to rotation and maximum/peak torque required to be applied by the servo drive/motor 335.

FIG. 15 shows the tamper band 200 after it has engaged on the pilfer-proof ring 211 and returned to a more inwardly radial position. At this relative angular position of the closure 220 and container 230, the resistance to further rotation torque required by servo drive/motor 335 to provide further rotation will have decreased. Upon the completion of the engagement, the torque required to rotate the closure decreases rapidly from its peak. This rapid decrease in the torque required by servo drive/motor 235 to rotate the closure 220, signals that the capping process is nearing completion and will be completed upon rotating the closure 220 by a predetermined fixed angle. The value of the fixed angle can be determined from the geometry of the container 230 and the desired relative end position of the closure 220 relative to the container 230.

In FIG. 16 a process control schematic is provided which shows how system 100 may be operated and controlled by PLC 250. By way of explanation, the vertical axis corresponds for each line to one of: (a) the "Rotation Angle" of the capping head 210; (b) the axial/vertical position of the capping head 210 and (c) the torque applied by the capping head 210 to the closure, as indicated in FIG. 16. The horizontal axis may be the carousel's rotational angle i.e. the carousel's angular position in degrees thorough one cycle of its rotation). However, in some cases the horizontal axis may be a measurement of time which can be derived from the carousel's angular position and the carousel's rotational speed.

It will be noted that:
- The initial adjustment angle that is applied will vary from situation to situation - and is determined by imaging sub-system 400 and/or PLC 250 as described above; however since in all cases the closure/container combination are placed into the initial suitable thread angular orientation (the "thread oriented" orientation), the application angle that is applied to reach the final desired relative rotational angle is constant ("cste").
- In this embodiment, once the threads are oriented, the axial position of the capping head 210 can be adjusted as shown by the capping head height position profile. It will be appreciated that this curve may match or correspond with the path of the cam track 339 (FIG. 3).
There may be a first large peak torque when the pilfer/tamper band engages with the container.

The second peak torque may occur when the rotational angle reaches the desired application/completion angle. The torque applied by the capping head to the closure can be terminated substantially once the application/completion angle has been applied and final desired rotation angle reached.

The capping head 210 can move downwards substantially linearly and may stop moving downwards once the completion angle is complete and/or the closure "bottoms out" on the container upper surface, as it may be the closures relative position on the container that governs its vertical position. It should be noted that any mismatch in the position of the capping head 210 based on the cam path profile and the head position based on the closure's axial position may be compensated for by a compression spring mechanism associated with the chuck device 215 that allows for some limited axial relative movement of the closure held in the chuck device and the capping head 210 itself.

In alternate embodiments, a torque peak monitored by PLC 250 could be used in addition to or instead of the application angle to determine when the closure is considered to be applied to the container in a satisfactory manner and no further rotation of the closure relative to the container is required.

FIG. 15 shows the tamper band 200 after it has engaged on the pilfer-proof ring 211 and returned to a more inwardly radial position. At this relative angular position of the closure 220 and container 230, the resistance to further rotation torque required by servo drive/motor 335 to provide further rotation will have decreased. Upon the completion of the engagement, the torque required to rotate the closure decreases rapidly from its peak. This rapid decrease in the torque required by servo drive/motor 235 to rotate the closure 220, signals that the capping process is nearing completion and will be completed upon rotating the closure 220 by a predetermined fixed angle. The value of the fixed angle can be determined from the geometry of the container 230 and the desired relative end position of the closure 220 relative to the container 230.

As noted, in FIG. 16 the inter-relationship between torque applied by rotatable shaft 313 to closure 220, the angle of rotation applied to the closure and the axial/vertical position of the capping head 210 over time are shown over carousel rotational angle/time. A closure 220 with a tamper/pilfer band 211 can be applied to a container 230 with a pilfer ring 621. As the closure 220 is rotated by the capping head 210 from the thread start engagement orientation there is shown an increase in torque as the threads of the closure 220 and the container 210 start to engage. While the rotatable shaft 313
of capping head 210 further rotates, the torque rises and then flattens out, until it reaches an orientation where a tamper band and pilfer ring start to engage, requiring a significant increase in torque in order to continue to increase the relative rotational angle between closure and container. PLC 250 may continue to monitor the increase in torque until it detects the peak torque (or end of the torque increase).

Once this peak torque characteristic is identified, PLC 250 may in other embodiments then apply a further predetermined completion angle to the closure that is independent of the torque being applied to rotate the closure relative to the container. Alternatively, the identification of the peak torque may be an indicator that the final desired angular position of has been reached. This could also then take the closure to a final fully applied orientation relative to the container.

When introducing elements of the present invention or the embodiments thereof, the articles "a," "an," "the," and "said" are intended to mean that there are one or more of the elements. The terms "comprising," "including," and "having" are intended to be inclusive and mean that there may be additional elements other than the listed elements.

It is noted that the foregoing has outlined some of the more pertinent non-limiting embodiments. It will be clear to those skilled in the art that modifications to the disclosed non-limiting embodiment(s) can be effected without departing from the spirit and scope thereof. As such, the described non-limiting embodiment(s) ought to be considered to be merely illustrative of some of the more prominent features and applications. Other beneficial results can be realized by applying the non-limiting embodiments in a different manner or modifying them in ways known to those familiar with the art. This includes the mixing and matching of features, elements and/or functions between various non-limiting embodiment(s) is expressly contemplated herein so that one of ordinary skill in the art would appreciate from this disclosure that features, elements and/or functions of one embodiment may be incorporated into another embodiment as appropriate, unless described otherwise, above. Although the description is made for particular arrangements and methods, the intent and concept thereof may be suitable and applicable to other arrangements and applications.
WHAT IS CLAIMED IS:

1. A method of applying a closure (220) to a container (230), said method comprising:
   (a) identifying a feature on the closure representative of an orientation of the closure;
   (b) identifying a feature on the container representative of an orientation of the container;
   (c) determining the orientations of the closure and the container from the identification of said
      feature on the closure and the feature on container;
   (d) determining what if any adjustment is required in the orientation of the closure relative to
      the container to bring the closure and the container into a suitable thread start orientation;
   (e) effecting said any adjustment in orientation to bring the closure and the container to said
      suitable thread start orientation.

2. A method a claimed in claim 1 wherein:
   - said identifying said feature on the closure comprises identifying a feature on the
     closure representative of an angular orientation of the closure;
   - said identifying said feature on the container comprises identifying a feature on the
     container representative of an angular orientation of the container; and
   - said effecting said adjustment in orientation comprises applying an adjustment angle
     between said closure and said container to bring the closure and the container to a suitable
     thread start angular orientation.

3. A method as claimed in claim 2 wherein:
   - said determining said orientations comprises determining the initial relative angular
     orientation of the closure relative to the container;
   - said determining what if any adjustment in orientation comprises determining what if
     any adjustment angle for angular rotation of the closure relative to the container from the initial
     relative angular orientation is required to bring the closure and the container into a suitable
     thread start angular orientation; and
   - said effecting said adjustment in orientation comprises applying said adjustment angle
     between said closure and said container to bring the closure and the container from the initial
     relative angular orientation to said suitable thread start angular orientation.

4. A method as claimed in claim 3 wherein:
   - in identifying a feature on the closure representative of an angular orientation of the
     closure, said angular orientation is an angular orientation about an axis;
- in identifying a feature on the container representative of an angular orientation of the container, said angular orientation is an angular orientation about said axis;
- in determining said initial relative angular orientation of the closure relative to the container, said initial relative angular orientation is about said axis;
- said adjustment angle is about said axis; and
- said applying said adjustment angle is about said axis.

5. A method as claimed in claim 4 wherein said axis is a common central axis passing axially through the closure and the container.

6. A method as claimed in claim 1 wherein:
   - said identifying of a feature on the closure comprises imaging a visual feature on said closure; and
   - said identifying of a feature on said container comprises imaging a visual feature on said container.

7. A method as claimed in claim 4 wherein:
   - said identifying of a feature on the closure comprises imaging a visual feature on said closure; and
   - said identifying of a feature on said container comprises imaging a visual feature on said container.

8. A method as claimed in claim 7 further comprising after or while said closure and said container are being brought into said suitable thread start angular orientation, axially positioning said closure and said container relative to each other to bring the closure and the container into said thread start engagement position.

9. A method as claimed in claim 7 further comprising after said closure and said container are being brought into said suitable thread start angular orientation, axially positioning said closure and said container relative to each other to bring the closure and the container into said thread start engagement position.

10. A method as claimed in claim 8 further comprising: after said closure and said container have been brought into said suitable thread start engagement position, rotating said closure and said container relative to each other to secure said closure to said container.
11. A method as claimed in claim 10 further comprising: after said closure and said container have been brought into said suitable thread start engagement position, rotating and axially moving said closure and said container relative to each other to secure said closure to said container.

12. A method as claimed in claim 11 wherein said rotating of said closure and said container relative to each other to secure said closure to said container comprises applying a predetermined completion angle between said closure and said container to secure the closure to the container.

13. A method as claimed in claim 1 further comprising: after said closure and said container have been brought into said suitable thread start engagement orientation, rotating and moving said closure and said container relative to each other to secure said closure to said container.

14. A method as claimed in claim 13 wherein said rotating said closure and said container relative to each other to secure said closure to said container comprises applying a predetermined completion angle between said closure and said container to secure the closure to the container.

15. A method as claimed in claim 6 wherein:
   - said imaging said visual feature on said closure comprises capturing an image of said visual feature on said closure with a first imaging sensor; and
   - said imaging said visual feature on said container comprises capturing an image of said visual feature on said container with a second imaging sensor.

16. A method as claimed in claim 7 wherein:
   - said imaging said visual feature on said closure comprises capturing an image of said visual feature on said closure with a first imaging sensor; and
   - said imaging said visual feature on said container comprises capturing an image of said visual feature on said container with a second imaging sensor.

17. A method as claimed in claim 3 further comprising:
   - after (c), determining if the initial relative angular orientation corresponds to a suitable thread start angular orientation for the closure and the container;
   - if the relative angular orientation is determined not to correspond to a suitable thread start angular orientation for the closure and the container, then determine said adjustment in angular orientation of the closure relative to the to bring the closure and the container into said suitable thread start orientation.
18. A method of applying a closure (220) to a container (230), said method comprising:
(a) determining an initial orientation of the closure;
(b) determining an initial orientation of the container;
(c) determining what, if any, adjustment in orientation of the closure relative to the container is required from the initial orientations of the closure and the container to bring the closure and the container into a suitable thread start orientation;
(d) if it is determined that any adjustment in orientation is required, effecting said adjustment in orientation between said closure and said container to bring the closure and the container from said initial orientations to said suitable thread start orientation.

19. A method as claimed in claim 18 further comprising:
- (e) prior to (a), identifying a feature on the closure indicative of the initial orientation of the closure;
- (f) after (e) determining the initial orientation of the closure from the identification of the feature on the closure;
- (g) prior to (b) identifying a feature on the container indicative of the initial orientation of the container;
- (h) after (g), determining the initial orientation of the container from the identification of the feature on the container;
- (i) after (f) and (h), determining an initial relative angular orientation of the closure to the container.

20. A method as claimed in claim 19 further comprising:
- (j) after (i), determining if the initial relative angular orientation corresponds to a suitable thread start angular orientation for the closure and the container;
- (k) if the initial relative angular orientation is determined not to correspond to a suitable thread start angular orientation for the closure and the container, then (c) determine said adjustment in orientation of the closure relative to the container to bring the closure and the container into said suitable thread start orientation.

21. A method as claimed in claim 20 further comprising further comprising after or while said closure and said container are being brought into said suitable thread start angular orientation, axially positioning said closure and said container relative to each other to bring the closure and the container into said thread start engagement position.
22. A method as claimed in claim 19 wherein:
   - said identifying of a feature on the closure comprises imaging a visual feature on said closure; and
   - said identifying of a feature on said container comprises imaging a visual feature on said container.

23. A method as claimed in claim 22 wherein:
   - said imaging said visual feature on said closure comprises imaging said visual feature on said closure with a first imaging sensor; and
   - said imaging said visual feature on said container comprises imaging said visual feature on said container with a second imaging sensor.

24. A system for applying a closure (220) onto a container (230) proximate an opening (239) of said container (230) to close said opening (239), said system comprising:
   (i) a capping head (210) having a rotatable shaft (313) rotatable about an axis with a chuck device (315), said chuck device (315) operable to releasably hold a closure (220) and rotate with said rotatable shaft (313) about said axis, said capping head (210) operable to cause said closure (315) held by said chuck device (315) to engage with said container (230) by rotating said closure (220) relative to said container (230) about said axis;
   (ii) a drive device (335) for driving said rotatable shaft (315) about said axis;
   (iii) a controller and a feature identification sub-system (250, 251) operable to:
       (a) control the rotation of the rotatable shaft (313) to thereby control the rotation of the closure (220) relative to the container (230) to engage the closure (220) with the container (230);
       (b) identify a feature representative of an angular orientation of the closure about said axis;
       (c) identify a feature representative of an angular orientation of the container about said axis;
       (d) determine the relative angular orientation about said axis of the closure and the container;
       (e) determine what, if any adjustment angle for relative angular rotation of the closure relative to the container about said axis is required to bring the closure and the container into a thread start angular orientation;
(f) cause the application of any said adjustment angle between said closure and said container by said capping head to bring the closure and the container into a thread start angular orientation;

(g) after any adjustment angle is applied pursuant to (f), control and cause the rotation of the rotatable shaft (313) to apply the closure (220) to the container (230).

25. A system as claimed in claim 24 wherein in performing (g), the rotation of the rotatable shaft to apply the closure to the container a pre-determined angular rotation about said axis is applied.

26. A system as claimed in claim 24 wherein said controller is in communication with said feature identification sub-system, said capping head and said device.

27. A system as claimed in claim 24 wherein said feature identification sub-system is an imaging sub-system in communication with said controller and wherein said controller and said imaging sub-system are operable to:
   - capture an image of a visual feature on said closure and determine an angular orientation of said visual feature on said closure; and
   - capture an image of a visual feature on said container and determine an angular orientation of said visual feature on said container.

28. A system as claimed in claim 27 wherein said imaging sub-system comprises:
   - a first imaging sensor operable to capture said image of a visual feature on said closure; and
   - a second imaging sensor operable to capture an image of a visual feature on said container and determine an angular orientation of said visual feature on said container.

29. A system as claimed in claim 27 further comprising a computing device for processing said images.

30. A system as claimed in claim 24 that is also operable to, after or while said closure and said container is being brought into said thread start angular orientation, axially position the closure and the container to bring the closure and the container into said thread start engagement position.

31. A system as claimed in claim 30 wherein said system is further operable such that: after said closure and said container have been brought into said thread start engagement position, said system
will rotate said closure and said container relative to each other to secure said closure to said container.

32. A system as claimed in claim 30 wherein said system is further operable such that: after said closure and said container have been brought into said thread start engagement position, said system will rotate and axially move said closure and said container relative to each other to secure said closure to said container.

33. A system as claimed in claim 32 wherein said system is further operable to apply a predetermined completion angle between said closure and said container to secure the closure to the container.

34. A system for applying a closure (220) to a container (230) comprising:
   (i) an apparatus operable to hold a closure (220) and a container (230) and said apparatus also operable to effect a change in relative orientation between said closure and said container;
   (ii) a controller (250);
   (iii) a feature identification sub-system (400);
said system operable to:
   - identify a feature on the closure representative of an orientation of the closure;
   - identify a feature on the container representative of an orientation of the container;
   - determine the orientations of the closure and the container based on the identifications of the features on the closure and the container;
   - determine what, if any, adjustment in orientation of the closure relative to the container required to bring the closure and the container into a suitable thread start engagement orientation;
   - effect said any adjustment in orientation between said closure and said container to bring the closure and the container into said suitable thread start engagement orientation.

35. A system as claimed in claim 34 wherein said system is operable to determine the initial relative orientation of the closure relative to the container to facilitate said determination of said any adjustment in orientation.

36. A system as claimed in claim 35 wherein said feature identification sub-system is an imaging sub-system and wherein said controller and said imaging sub-system are operable to:
   - capture an image of said visual feature on said closure; and
   - capture an image of said visual feature on said container.
37. A system as claimed in claim 36 further comprising a computing device for processing said images.

38. A system as claimed in claim 37 that is also operable to, after or while said closure and said container are brought into said suitable thread start orientation, axially position the closure and the container relative to each other to bring the closure and the container into a suitable thread start engagement position.

39. A system as claimed in claim 38 wherein said system is further operable to: after said closure and said container have been brought into said suitable thread start engagement position, rotate said closure and said container relative to each other to secure said closure to said container.

40. A system as claimed in claim 39 wherein said system is further operable to apply a predetermined completion angle between said closure and said container to secure the closure to the container.

41. An apparatus comprising a combination of a closure (220) and a container (230), each of said closure (220) and said container (230) having threads (203, 235) that co-operate during said rotation to facilitate the application of the closure (220) to the container (230) and wherein said closure and said container each have a visual feature, said visual features being associated with a suitable thread start orientation of the closure (220) relative to the container (230).

42. An apparatus as claimed in claim 41 wherein said visual features of said closure (220) and said container (230) are aligned with said thread start locations.

43. An apparatus as claimed in claim 41 wherein said visual feature of at least one of said closure and said container comprise a thread start mark or protrusion.

44. An apparatus as claimed in claim 41 wherein said visual feature of at least one of said closure and said container comprise an engraving.

45. An apparatus as claimed in claim 41 wherein said visual feature of at least one of said closure and said container comprise a vent slot.

46. A method of applying a closure (220) to a container (230), said method comprising:
(a) identifying a feature on the closure representative of an orientation of the closure;
(b) identifying a feature on the container representative of an orientation of the container;
(c) determining the relative orientation of the closure and the container from the identification of said feature on the closure and the feature on container;
(d) determining what if any adjustment is required in the orientation of the closure relative to the container to bring the closure and the container into a suitable thread start orientation;
(e) effecting said any adjustment in orientation to bring the closure and the container to said suitable thread start orientation.

47. A method a claimed in claim 46 wherein:
   - said identifying said feature on the closure comprises identifying a feature on the closure representative of an angular orientation of the closure;
   - said identifying said feature on the container comprises identifying a feature on the container representative of an angular orientation of the container; and
   - said effecting said adjustment in orientation comprises applying an adjustment angle between said closure and said container to bring the closure and the container to a suitable thread start angular orientation.

48. A method as claimed in claim 47 wherein:
   - said determining said orientations comprises determining the initial relative angular orientation of the closure relative to the container;
   - said determining what if any adjustment in orientation comprises determining what if any adjustment angle for angular rotation of the closure relative to the container from the initial relative angular orientation is required to bring the closure and the container into a suitable thread start angular orientation; and
   - said effecting said adjustment in orientation comprises applying said adjustment angle between said closure and said container to bring the closure and the container from the initial relative angular orientation to said suitable thread start angular orientation.

49. A method as claimed in claim 48 wherein:
   - in identifying a feature on the closure representative of an angular orientation of the closure, said angular orientation is an angular orientation about an axis;
   - in identifying a feature on the container representative of an angular orientation of the container, said angular orientation is an angular orientation about said axis;
   - in determining said initial relative angular orientation of the closure relative to the container, said initial relative angular orientation is about said axis;
- said adjustment angle is about said axis; and
- said applying said adjustment angle is about said axis.

50. A method as claimed in claim 49 wherein said axis is a common central axis passing axially through the closure and the container.

51. A method as claimed in claim 46 wherein:
- said identifying of a feature on the closure comprises imaging a visual feature on said closure; and
- said identifying of a feature on said container comprises imaging a visual feature on said container.
1000 Determine angular orientation of closure (angle1)

1010 Determine angular orientation of closure (angle2)

1020 Reorientation data transmission

1030 Adjustment Angle = f(angle1 - angle2)

1040 Capping head going down

1050 Height position engagement achieved?

1060 Capping head rotation

1070 Torque AND, OR, application angle achieved

1080 Capping end head rotation

1090 Capping head going up

FIG. 12
**INTERNATIONAL SEARCH REPORT**

**International application No.**

**PCT/CA2015/050658**

### A. CLASSIFICATION OF SUBJECT MATTER

IPC: **B67B 3/26** (2006.01), **B65B 7/00** (2006.01), **B67B 3/20** (2006.01), **B67B 3/28** (2006.01), 5 654 740 0/00 (2006.01)

### B. FIELDS SEARCHED

**Minimum documentation searched (classification system followed by classification symbols)**

IPC: B67B 3/26 (2006.01), B67B 3/20 (2006.01), B67B 3/28 (2006.01), B65B 7/00 (2006.01), B65B 7/28 (2006.01)

CPC: B67B/3264

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

None

**Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used)**

QUESTEL ORBIT (FAMPAT), INTELLECT (CPD)

**Keywords:** (imag* or indie* or mark*), (orient* or position* or locat* or align*), (thread* or screw*)

### C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>WO 2013127719 A1 (HEUFT, B.) 6 September 2013 (6-09-2013) *Abstract</td>
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Γ* Further documents are listed in the continuation of Box C. See patent family annex.

E* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means of publication prior to the international filing date

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"A" document member of the same patent family

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

30 September 2015 (30-09-2015)

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

19 October 2015 (19-10-2015)

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