Apparatus and method for gripping a cigarette.

A gripping device 500 for gripping securely each of a plurality of differently dimensioned smoking articles 580 without damaging any of the smoking articles is disclosed. Two opposing members 510, 520 having opposing notches 515, 525 for contacting and gripping the article are provided. The members are translated together to grip securely a smoking article therebetween. One member is movably connected to a support member 560 for relative movement therewith and a means 570 for adjusting the force exerted by the members on the smoking article is provided to control the relative motion of the one member and to adjust the force exerted by the opposing members so that the range of differently sized articles can be securely gripped without deformation and without having to change or readjust the position of the opposing members. The gripping device is useful in an automated test facility for testing smoking articles of different dimensions, particularly circumferences.
Background of the Invention

This invention relates to a method and apparatus for gripping a smoking article, and more particularly to gripping cigarettes of different dimensions with the same two fingers of a robotic device.

It is common practice to perform a sequence of one or more tests or measurements on commercial and experimental smoking articles and their component parts following assembly. These tests include measuring the physical characteristics of the article and component parts. More specifically, a plurality of like smoking articles are subjected to one or more tests corresponding to one or more specific properties. The test results are used to evaluate the uniformity of the measured property or properties from article to article and to obtain statistical data regarding the characteristics of like articles. Different groups of like articles are typically subjected to the same series of tests under conditions that permit comparing the statistical characteristics of different like articles and different groups of like articles.

Tests performed on components of a complete article, for example, the filter portion of the smoking article, require that the filter be severed from the smoking article. This typically occurs after the complete article body has been examined. Any tobacco shreds that remain affixed to the filter are removed from the filter portion.

The smoking article (or one of its component parts) must be maneuvered from one location to another and/or maintained in a stable, fixed portion so that the various tests or measurements can be conducted or the smoking article processed, e.g., to sever and deshred the filter.

One known technique for gripping, maneuvering, and positioning a smoking article for such tests and procedures requires an individual to grip and manipulate the article accordingly. Although this technique works, it is unsatisfactory and inefficient because it requires an operator to be in attendance throughout the procedure. Tests on manually guided articles also are subject to variations in how or where the smoking article is gripped and/or positioned during the test procedure. These variations are undesirable for obtaining accurate statistical data. Furthermore, the manual technique is not adequate for test/process stations which require that the smoking article be rigidly held in position at a precise location such as, for example, a filter severing station or a tobacco deshredding station.

It is known to use robotic devices having opposing members for grasping and maneuvering objects from one location to another in an analytical laboratory. One such device is the MasterLab™ System available from Perkin-Elmer Corp., Norwalk, CT 06856. One of the problems with such robotic systems is that they are not readily capable of gripping crushable, nonresilient objects such as smoking articles without damaging such articles. Further, such robotic devices typically do not have the ability to grasp securely a preselected range of differently dimensioned smoking articles without deforming at least some articles in the range. The use of force transducers to monitor the forces exerted to control gripping of the article has been considered. However, such transducers increase the cost and complexity of the device. Also, because such transducers monitor force, they do not detect whether or not the deformable article is securely gripped yet not deformed or damaged. Thus, such force transducers are not likely to prevent the opposing members from damaging relatively fragile smoking articles.

Accordingly, there is a continuing need for improved gripping devices for grasping a range of differently dimensioned smoking articles. There is a further need for such gripping devices for use in maneuvering from place to place and positioning smoking articles for automatic test devices.

It has, therefore, been desired of to provide for an improved method and apparatus for gripping a crushable smoking article.

It has also been desired to provide an apparatus and method for gripping one of a plurality of differently dimensioned smoking articles having dimensions in a preselected range of dimensions without crushing any of the smoking articles in that range of dimensions.

It has also been desired provide for a process and apparatus for gripping maneuvering, and positioning a smoking article which can be incorporated into an automated facility for testing smoking articles.

Summary of the Invention

In accordance with the present invention, an apparatus and method for gripping, maneuvering, and positioning a smoking article is provided. Broadly, the invention concerns a gripping mechanism for use in a robotic device. One embodiment of such a device includes a first member and a second member arranged in opposition for gripping therebetween a smoking article, a means for positioning the first and second members about the smoking article, a means for controlling the distance of separation between the first and the second members, and a force altering means for controlling the force that is exerted on the smoking article between the first and second members. In a preferred embodiment, the force altering means is dependant upon the distance of separation between the first and second members when said members are in secure gripping contact with the smoking article so that the force exerted on a smoking article is adjusted in response to the distance of separation and does not exceed a selected force that would crush or deform that smoking article. More particularly, the force exerted is adjusted to be about the...
same for each differently dimensioned smoking article in the selected range of dimensions and below a maximum force which is selected to be the maximum force that will not crush the smoking article.

The first and second members have respective gripping surfaces in opposition so that the gripping surfaces contact the smoking article. In one embodiment, the respective gripping surfaces are notches formed in the first and second fingers having a contoured surface for contacting the smoking article. In a preferred embodiment, the notches are planar surfaces, preferably two planar surfaces intersecting at a 90° angle, to contact the gripping article at four or more separate locations for increased stability. Further, the planar surface may be lined with a mildly abrasive material.

In a preferred embodiment, one of the first or second members comprises a fore-finger having a gripping surface for contacting the smoking article, a finger support element, and a means for connecting the fore-finger to the finger support element for movement relative to the finger support element, and the force altering means further comprises means for moving the fore-finger relative to the finger support element to adjust the force exerted on the smoking article by the fore-member and the other of the first or second members.

In one preferred embodiment, the fore-finger is pivotally connected to the finger support and pivots in response to the size of the dimensioned article being contacted. A biasing means, preferably a spring, is used to urge the fore-finger toward and in contact with the smoking article being gripped, even as the fore-finger is moved relative to the finger support and away from the other member in response to the dimension of the smoking article being contacted. The amount of pivot and force alteration is responsive to the dimension of the smoking article and the distance between the first and second members.

Another embodiment of the invention is directed to an apparatus for gripping one of a plurality of differently dimensioned smoking articles having dimensions in a predetermined range of dimensions with a force below a selected maximum force. One such apparatus includes:

- a first member having a first gripping surface;
- a support member;
- a second member having a second gripping surface;
- means for mounting the second member to the support member so that the second member may be moved relative to the support member;
- means for moving the first member and the support member so that the first and second gripping surfaces contact the one smoking article; and
- means for moving the second member relative to the support member in response to the dimension of the one smoking article, thereby adjusting the force exerted on the smoking article to below the selected maximum force.

Preferably, the means for moving the first member and the support member moves the members from an open position spaced apart a first distance to a closed position a second distance apart, the second distance being independent of the dimension of the smoking article to be gripped.

In one preferred embodiment, the second member is pivotally connected to the support member and the means for moving the second member includes a lever secured to the second member and a spring interposed between the support member and the lever to bias the second member towards the first member in a first direction. Such moving means also may include a means for limiting the range of motion of the second member in the first direction. Also, each of the first and second gripping surfaces preferably has a notch in the surface of the member for contacting the article, more preferably a first and second planar surfaces intersecting at an angle selected in a range between from 70 to 110 degrees.

Another embodiment of the present invention is directed to a method for gripping a smoking article by a robotic device. One such method includes:
- providing a first member and a second member for contacting and gripping a smoking article having a selected dimension;
- moving the first and second members together for contacting the smoking article therebetween;
- controlling the distance of separation between said first and second members when said members are in contact with said smoking article; and
- adjusting the force that is exerted on the smoking article through said first and second members so that the force adjusted is dependant upon the distance of separation between said first and second members when said members are in contact with the smoking article.

Yet another embodiment of this invention is directed to a method for gripping one of a plurality of differently dimensioned smoking articles having dimensions in a predetermined range of dimensions with a force below a selected maximum force. One such a method includes:
- providing a first member having a first gripping surface, a support member, and a second member having a second gripping surface;
- mounting the second member to the support member so that the second member may be moved relative to the support member;
- moving the first member and the support member so that the first and second gripping surfaces contact and grip the one smoking article; and
- adjusting the force exerted on the smoking article to below the selected maximum force by moving the second member relative to the support member in response to the dimension of the one smoking article.
In a preferred embodiment, the second member is pivotally connected to the support member and moving the second member further comprises securing a lever to the second member, interposing a spring between the support member and the lever, and biasing the second member in a first direction toward the first member in response to the spring. The spring thus adjusts the force in response to the distance between the first and second members and the dimension of the article being gripped. In another embodiment, the moving step also could include limiting the range of motion of the second member in the first direction.

Advantageously, the present invention provides for an economical and efficient gripping of a large number of conventionally sized smoking articles having a circumference in a preselected range of circumference dimensions, including cigarettes, for efficient manipulation of such articles without having to change or adjust manually the gripping elements for each differently dimensioned article in the range.

Description of the Drawings

Further features of the invention, its nature and various advantages will be more apparent from the accompanying drawings and the detailed discussion of the invention, in which like reference numerals refer to like elements, and in which:

FIG. 1 is a front plan view of a gripping mechanism in accordance with a preferred embodiment of the present invention;
FIG. 2 is a side view taken along line 2-2 of FIG. 1;
FIG. 3 is a side view taken along line 3-3 of FIG. 1;
FIG. 4 is a front view taken along line 4-4 of FIG. 3;
FIG. 5 is a side view of a grasping member taken along line 5-5 of FIG. 1;
FIG. 6 is a front view taken along line 6-6 of FIG. 5;
FIG. 7 is a partial sectional view of a yoke member taken along line 7-7 of FIG. 1; and
FIG. 8 is a front view taken along line 8-8 of FIG. 7.

Detailed Description of the Invention

Referring to FIGS. 1-8, a preferred embodiment of the present invention is shown in the context of a robot hand 500 having attached thereto flanges 501 and 502 to which are respectively connected a first member 510 and a support member 560. Attached to support member 560 are a force altering means 570 and a second member 520. First member 510 is secured to flange 501 and support member 560 (and hence member 520) is secured to corresponding flange 502 so that members 510 and 520 are generally disposed in relatively fixed angular orientations, e.g., in parallel, and have opposing respective inner surfaces 511 and 521. Force altering means 570 provides for moving member 520 relative to support 560 to alter or adjust the force exerted on a gripped smoking article 580, to maintain the force below the force that would otherwise be imposed on smoking article 580 if there was no such movement and below a selected maximum force that might crush or deform article 580.

In the preferred embodiment, force altering means 570 includes lever 530, spring 540, stop 550, and pin 563. Lever 530 is secured at one end to member 520 by bolt 531. Spring 540 is set within receptacle 541 milled in support 560 and urged against lever 530. Member 520 is pivotally secured to support 560 between yokes 561 and 562 about pin 563. Stop 550 is adjustably secured to support 560 so that it extends a selected distance from support 560. Stop 550 includes a flange 551 that is configured to fit over end 533 of lever 530. Spring 540 thus urges lever 530 against stop 550 flange 551. The range of motion of lever 530, and hence member 520, is limited by the motion of lever end 533 between support 560 and stop 550 as lever 530 pivots about pin 563. The position of stop 550 is adjustable to control the range of motion and is typically set so that member 520 is normally biased parallel to member 510 when not in contact with any article 580. Stop 550 also is used to keep member 520 from over-extending due to the force that spring 540 exerts on lever 530.

In an alternate embodiment, stop 550 could be adjusted so that tip 522 is biased closer to tip 512 than yokes 561 and 562 are spaced to member 510. This provides for gripping a slightly greater range of differently dimensioned articles as compared to when members 510 and 520 are biased parallel, but makes positioning members 510 and 520 about each article more difficult, requiring a comparatively larger first distance in the open position as described herein. Similarly, member 570 could be adjusted so that some of the force that would otherwise be exerted by members 510 and 520 on article 580 is altered when each article in this preselected range of differently dimensioned articles is gripped between notches 515 and 525.

Robot hand 500 further includes a means for moving flange 501 and flange 502 (and thus first member 510 and second member 520) towards and away from each other (not shown). Flanges 501 and 502 may be part of a conventional mount that interconnects with robotic hand 500 which, together with the means for moving flanges 501 and 502 relative to each other, and together with the means for maneuvering a gripped article in a three or more dimensions and holding the gripped article in a selected position, is conventional and not otherwise a part of this inven-
vention. Such a robotic device may be the Perkin-Elmer Corporation MasterLab™ product.

Referring to FIGS. 1 through 6, member 520 has a notch 525 cut in surface 521 near tip 522 and member 510 has a corresponding notch 515 cut in opposing surface 511 near its tip 512. Notches 515 and 525 are thus in opposition for gripping a smoking article 580 therebetween. Notches 515 and 525 each preferably comprises two planar surfaces that intersect at an angle α of about 70 to about 110 degrees, more preferably approximately 90 degrees. Further, the notches are arranged to form a receptacle for receiving and supporting article 580.

The shape and dimension of notches 515 and 525 are chosen so that a preselected range of dimensions of differently dimensioned smoking articles 580 can be supported and securely gripped by opposing forces exerted by members 510 and 520. Differently dimensioned articles thus may have different contact points on the respective planar surfaces. Furthermore, notches 515 and 525 are configured so that each smoking article is held rigidly in place between members 510 and 520 and does not "slip" axially or longitudinally while it is being maneuvered from place to place or held in place at a work-station, for example, a filter severing station. In this regard, members 510 and 520 are provided with a dimension d and a depth h (see FIG. 2) so that article 580 is gripped for a corresponding length d along four contact points about its surface. Thus, by providing a notch having an appropriate dimension d and depth h, the forces applied by members 510 and 520 on article 580 may be relatively distributed around the gripped surface of article 580 to minimize any deformation of article 580. Other angles and contoured shapes for notches 515 and 525 may be used.

In a preferred embodiment, the gripping surfaces of notches 515 and 525 are lined with conventional emery paper 515a, 525a for example, 240 grade some other mildly abrasive material to increase the friction between the smoking article and members 510 and 520 to minimize slip.

In operation, preferably upon an appropriate instruction from a microprocessor controlling robot hand 500, flanges 501 and 502 are located in an "open" position spaced apart a first distance and maneuvered to position notches 515 and 525 on opposite sides of and in alignment with a selected smoking article 580. Article 580 is preferably resting on a support structure (not shown) and has a cross sectional dimension within a predetermined range of such dimensions. The first distance is large enough to straddle the largest dimensioned smoking article in the preselected range.

Next, flanges 501 and 502 are relatively translated toward a second "closed" position, whereby member 510 and support member 560 are spaced apart a second distance and notches 515 and 525 are in gripping contact with the smoking article. Preferably, member 510 and support 560 are maintained in a parallel orientation and move only in one dimension relative to hand 500. The second distance and the dimensions and depth of notches 515 and 525 are selected so that in the closed position, notches 515 and 525 will grip securely without deformation the smallest and largest dimensioned smoking articles in the preselected range of articles.

In accordance with one embodiment of the present invention, force altering means 570 does not substantially alter the forces exerted on the smallest dimensioned article 580 when member 510 and support 560 are in the closed position. However, for larger dimensioned smoking articles 580 in that preselected range, member 570 does after the force in that member 520 contacts smoking article 580 and is moved relative to support 560 in response to the larger dimension so that the force exerted on article 580 is less relative to the force that would be exerted if the member 510 and support 560 were in the closed position and member 520 did not move.

In accordance with the preferred embodiment, spring 540 biases lever 530 against stop 550 so that member 520 is urged parallel to member 510. Thus, for the smallest dimensioned article, members 510 and 520 are configured and spaced to grip securely the article in notches 515 and 525 whereby member 520 does not move relative to support 560. For larger dimensioned articles, the larger dimension will urge member 520 against spring 540 so that member 520 will pivot away from member 510. However, spring 540 will continue to bias member 520 toward member 510 to grip securely article 580, even though the second distance is such that the larger dimensioned article would have been crushed in notches 515 and 525 had member 520 not pivoted relative to support 560. In this manner, spring 540 alters or adjusts the force exerted on article 580 so that article 580 is not crushed.

Advantageously, force altering means 570, or in the preferred embodiment spring 540, permits members 510 and 520 to grip securely a wider variation of smoking article dimensions, specifically circumferences, than would be possible by members 510 and 520 that did not have a force altering means. These improvements in gripping performance are important for use automated testing facilities where the plurality of smoking articles under test do not inherently have identical physical characteristics. For example, there may be a variation in smoking article circumference from article to article or from one group of article to another. In addition, different groups of differently dimensioned articles may be automatically tested in sequence without an attendant or need to adjust or change the gripping members. A gripping mechanism for a robotic device in accordance with the present invention is able to accommodate the desired varia-
tions in dimensions so that the resulting testing data is reliable and reproducible.

Spring 540 alters the force versus member-separation-distance characteristics of the gripper in comparison to a gripper without the added spring. For example, as member 520 closes upon the smoking article, and begins to pivot about pin 563, the force that is exerted upon article 580 is altered in comparison to a gripper that has member 520 rigidly mounted so that member 520 could not move relative to the support 560 (i.e., a two-moving-part, as opposed to three-moving-part, design). The motion of member 520 relative to support 560 allows the force versus member-separation-distance characteristics to be tailored for the particular application. In the present embodiment, as member 520 closes upon smoking article 580, and begins to rotate about pin 563, the magnitude of the derivative of the force exerted on the smoking article, with respect to member-separation-distance, is reduced in comparison to a gripper without spring 540. As a result, the gripper in a three-moving-part design of the present invention is more sensitive as the fingers close upon each other than in a two-moving-part design.

A pair of gripping members 510 and 520 has been constructed and operated successfully for grasping smoking articles having a circumference dimension selected in the range of from 22 to 25 mm. Referring to FIGS. 1 and 3-6, members 510 and 520 were constructed with mirror image tip portions each having a width d of about 6.6 mm (0.26 inches) and a thickness t of about 7.1 mm (0.28 inch). Notches 515 and 525 each have two planar sides cut at 45° angles to the surface, thereby forming an angle α of 90°, the vertex of which extends a depth h of about 4.37 mm (0.172 inches) relative to member surfaces 511 and 512. The notch base of depth h is located a distance r of about 7.11 (0.280) inches from the tip of the member, and the opening of the notch has a space s of about 8.76 mm (0.345 inches). The distance between surfaces 511 and 521 was fixed at about 2.0 mm, which was obtained by manually filing down a shim plate (not shown) to bring faces 521 and 511 sufficiently close together to obtain a good, secure grip on the smallest dimensioned articles to be processed, e.g., 22 mm in circumference, without deflecting members 510 and 520.

Member 520 is configured so that the base of notch 525 is space about 30.1mm (1.22 inch) from the axis of pin 563. The spring force of spring 540 is selected to be a few tens of grams (a few ounces), preferably 85g to 170g (3 to 6 ounces). Of course, the optimum spring force for a given gripper design will be selected based upon the particular geometric distances employed in the design particular geometric distances employed in the design of lever 530, member 520, notches 525 and 515, the spacing between member 510 and 520, the range of motion of the hinge of member 520, and the selected range of differently dimensioned smoking articles. Important in the choice of the magnitude of the spring force will be the distance of separation between pivot pin 563 and notches 525 and 515 and the distance of separation between pivot pin 563 and spring 540.

In accordance with the invention, other types of three-moving-part finger designs are possible in order to improve the force versus finger-separation-distance characteristics of the gripper over a two-moving-part design. For example, a member which translates, as opposed to rotates, relative to a support is also possible as long as there is a force altering means which allows the member to move relative to the support. Furthermore, the force altering means can have non-linear characteristics in contrast to the typically linear characteristics of a conventional spring.

Claims

1. Apparatus (500) for gripping a smoking article (580), comprising:
   a first member (510) and a second member (520), in opposition for gripping a smoking article therebetween;
   means (501, 502) for positioning the first and second means about a smoking article and for controlling the relative position of the first and said second members between a first position and a second position thereby to control the separation between the members; and
   means (570) for automatically and continually adjusting the force that is exerted on the smoking article through the first and second members as a function of the distance of separation between the first and second members when the members are in contact with a smoking article.

2. Apparatus (500) according to claim 1, in which each of the first (570) and second (520) members comprise a notch (515, 525) in the member for gripping a smoking article (580).

3. Apparatus (500) according to claim 2, in which each notch (515, 525) comprises a first planar surface and a second planar surface joined at an angle between 10 and 110 degrees.

4. Apparatus (500) according to claim 2 or 3, in which the surfaces of the notches (515, 520) comprise a mildly abrasive material.

5. Apparatus (500) according to any preceding claim further comprising a support member (560), the second member (520) being connected to the support member for relative movement therewith.
and in which the force adjusting means (570) comprises means (540) for moving the fore-member relative to the support member.

6. Apparatus (500) according to claim 5, in which the force adjusting means (570) comprises a spring (540) biasing the second member (520) towards the first member (510), the spring adjusting the force exerted on a gripped smoking article (580) through the second member (520, 560).

7. Apparatus (500) according to claim 6 in which the force adjusting means (570) comprises a lever (530) secured to the second member (520) the spring (540) being interposed between the support member (560) and the lever and biasing the second member toward the first member (510) in a first direction.

8. Apparatus (500) according to claim 7, further comprising means (550, 551) for limiting the range of motion of the second member (520) in the first direction.

9. Apparatus (500) according to claim 5, 6, 7 or 8 in which the second member (520) is pivotally connected to the support member (560).

10. A method for gripping a smoking article by a robotic device, comprising:

providing a first member and a second member for contacting and gripping a smoking article having a selected dimension;

moving the first and second members together for contacting the smoking article therebetween;

controlling the distance of separation between the first and the second members when the members are in contact with the smoking article; and

automatically and continually adjusting the force that is exerted on the smoking article through the first and second members as a function of the distance of separation between the first and second members when the members are in contact with the smoking article.

11. A method according to claim 10, further comprising providing the first and second members with respectively a first and second notch for contacting the smoking article.

12. A method according to claim 11, in which providing each notch comprises forming plane surfaces at an angle between 10 and 110 degrees.

13. A method according to claim 11 or 12, further comprising coating the surfaces of the notches with a mildly abrasive material.

14. A method according to any of claims 10 to 13, further comprising providing a support member, and connecting the second member to the support member for relative movement therewith, and in which adjusting the force comprises biasing the second member for movement relative to the support member in response to the dimension of the smoking article and the distance of separation of the second member and the first member.

15. A method according to claim 14, in which adjusting the force comprises providing a spring for biasing the second member.

16. A method according to claim 14 or 15, further comprising pivotally connecting the second member to the support member.

17. A method according to claim 16, in which moving the second member is achieved by a lever secured to the second member and spring interposed between the support member and the lever, biasing the second member in a first direction toward the first member in response to the spring.

18. A method according to claim 17, further comprising limiting the range of motion of the second member in the first direction.

19. A method according to any of claims 10 to 18, for gripping one of a plurality of differently dimensioned smoking articles having dimensions in a predetermined range of dimensions with a force below a selected maximum force, comprising:

providing a first member having a first gripping surface, and a second member having a second gripping surface, and a support member;

mounting the second member to the support member so that the second member may be moved relative to the support member;

moving the first member and the support member so that the first and second gripping surfaces contact and grip the said smoking article; and

adjusting the force exerted on the smoking article to below the selected maximum force by moving the second member relative to the support member in response to the dimension of the said smoking article.