July 4, 1961 G. E. LAUER 2,990,955

GRADING APPARATUS

Filed March 28, 1958 2 Sheets-Sheet 1

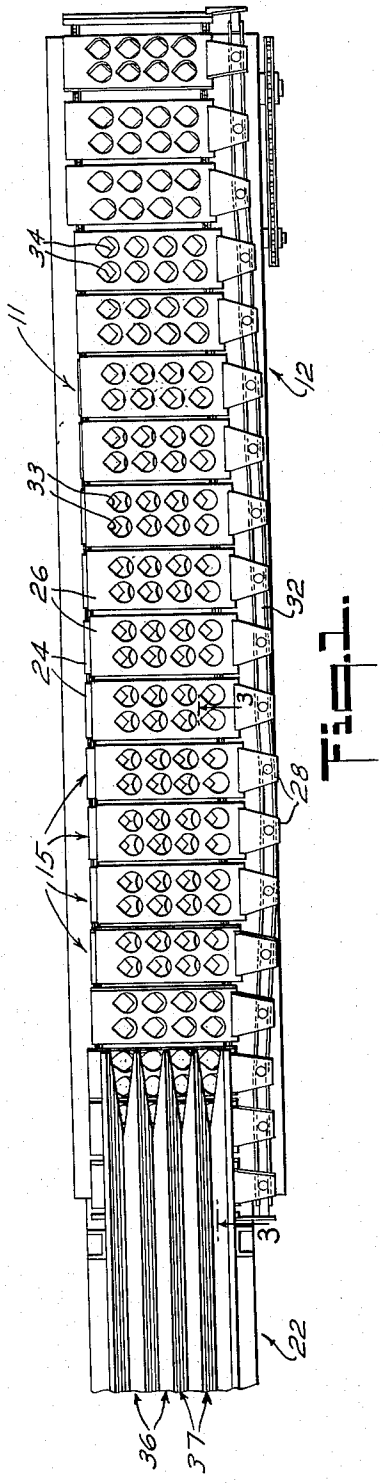


Fig. 1

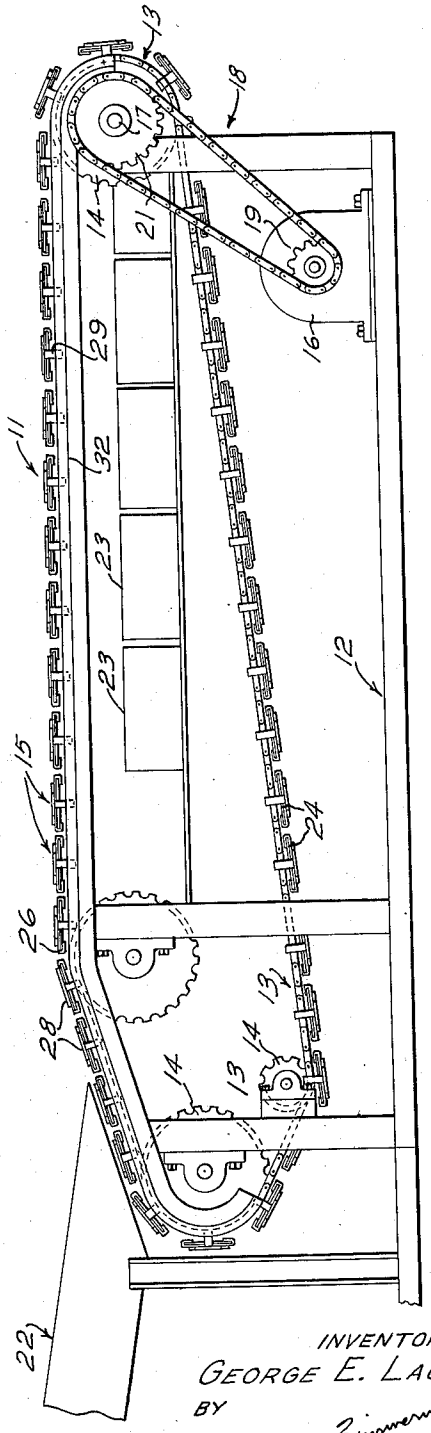


Fig. 2

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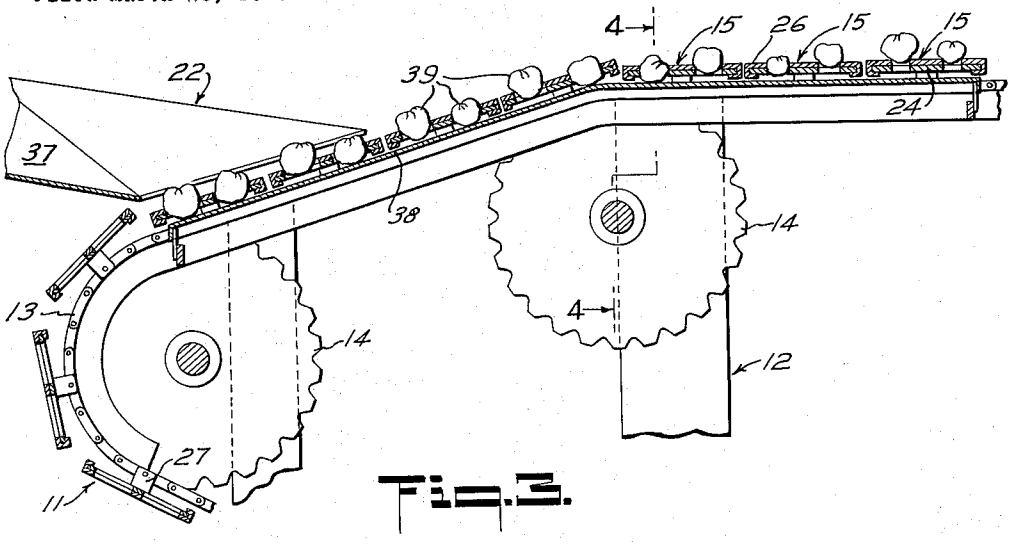


Fig. 3.

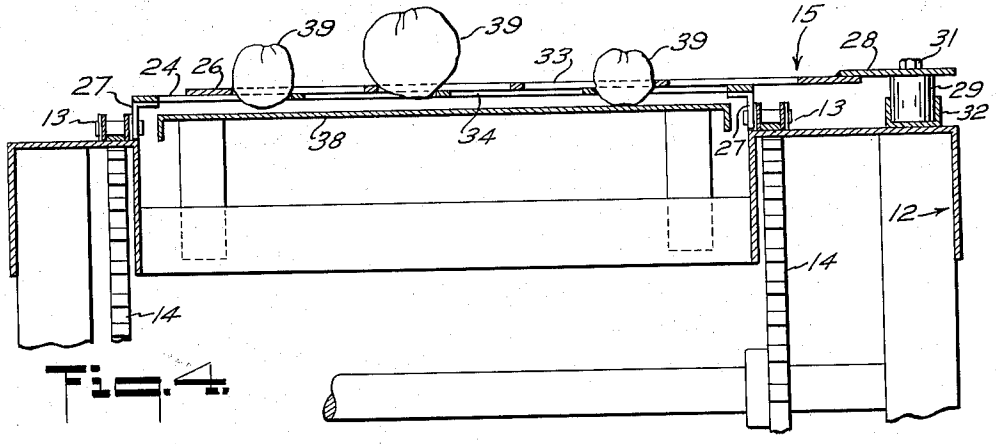


Fig. 4.

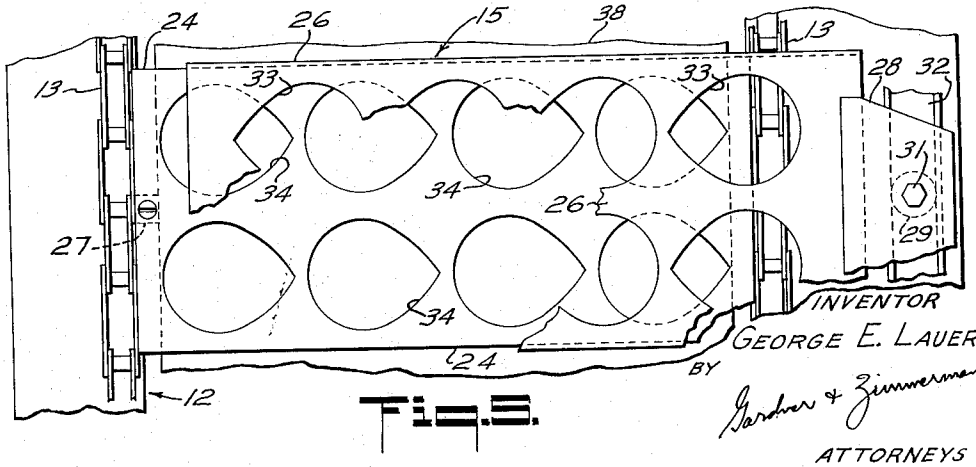


Fig. 5.

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GRADING APPARATUS

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The present invention relates to apparatus for the grading and sorting by size of articles such as fruits or the like.

Although the present invention may be employed to sort by size a wide variety of articles, maximum advantage is derived from application of the invention in the grading of foodstuffs such as fresh produce, including fruit, and thus the following is referenced thereto. In the commercial sorting of produce it is necessary not only for same to be very carefully handled to avoid damage, but also for the process to proceed at a high rate of speed. Inasmuch as the foregoing imposes contradictory requirements upon the conditions of sorting, wholly satisfactory mechanized sorting apparatus are not known and much sorting is yet carried out manually. In particular, great difficulty has previously been encountered in establishing a steady rapid flow of produce without such mechanical complexity as to render same impractical.

Various grading and sorting devices known in the art operate to transport items such as produce in a steady stream along a path from which progressively larger items are removed. Such devices generally employ a travelling conveyor, however, in order to prevent damage to the produce it is necessary to seat same individually thereon so that they do not tumble together, roll or otherwise suffer repeated collisions or abrasions that damage same. This limitation militates against rapid grading or produce flow, for the conveyor loading has been materially slowed thereby.

It is an object of the present invention to provide an improved high speed apparatus for grading and sorting items according to size.

It is another object of the present invention to provide high speed sorting apparatus wherein individual items are transported out of contact with each other.

It is a further object of the present invention to provide a fully automatic sorting device for produce and the like.

It is yet another object of the present invention to provide an improved conveyor for separately retaining irregularly shaped items thereon.

It is a still further object of the present invention to provide improved loading means for a sorting conveyor.

The invention possesses other objects and features of advantage, some of which, with the foregoing, will be set forth in the following description of the preferred form of the invention which is illustrated in the drawings accompanying and forming part of the specification. It is to be understood, however, that variations in the showing made by the said drawings and description may be adopted within the scope of the invention, as set forth in the claims.

The invention is illustrated in the accompanying drawings, wherein:

FIGURE 1 is a plan view of a grader constructed in accordance with the present invention.

FIGURE 2 is a side elevational view of the grader of FIGURE 1.

FIGURE 3 is an enlarged partial sectional view in elevation taken longitudinally of the grader in the plane 3—3 of FIGURE 1.

FIGURE 4 is a transverse sectional view taken in the plane 4—4 of FIGURE 3.

FIGURE 5 is an enlarged partial plan view taken generally at the same location as FIGURE 4 and having portions broken away as indicated.

Considering now the present invention in some detail and referring first to FIGURES 1 and 2 of the drawings, there will be seen to be provided an endless segmented conveyor **11** disposed upon a frame **12** for movement up an incline and along a level atop the frame toward the right of the figures. The belt **11** has a substantial width and includes a pair of link chains **13** longitudinally thereof adjacent the outer edges and engaging a plurality of sprocket wheels **14**, which are mounted in pairs for rotation on the frame **12**. The belt includes a plurality of separate segments **15** and drive means such as a motor **16** affixed to the frame is employed to rotate the conveyor through one pair of sprocket wheels **14** on a common shaft **17** as by means of a chain drive **18**, including a drive wheel **19** on the motor shaft and a driven wheel **21** on the shaft **17**. The conveyor **11** is fitted tightly upon the sprocket wheels **14** to move thereover under the influence of the driven sprocket pair **14** and the wheels are oriented upon the frame so that the conveyor moves up a slope to the top of the frame where the conveyor traverses a substantial distance generally horizontally. The inclined portion noted above comprises the loading area, and suitable feed means **22** disposed thereat and later described serve to feed produce or the like onto the conveyor in this loading area.

It is contemplated by the invention that produce or the like fed onto the conveyor in the loading area shall be carried along by the conveyor and shall pass vertically through same at spaced areas along the horizontal conveyor traverse in accordance with the size of the individual produce, and thus there are disposed a plurality of individual receiving means **23** aligned beneath the horizontal conveyor. These receiving means **23** may comprise only a plurality of boxes, as shown, or may alternatively comprise such as separate conveyors, chutes or the like to separately remove graded produce from the grading area.

Considering now in some detail the conveyor structure, and referring to FIGURES 4 and 5, it will be seen that each conveyor segment **15** includes a rectangular lower plate **24** disposed transversely of the conveyor structure in adjacent parallelism with like plates of other segments. Atop the lower plate **24** is disposed an upper plate **26** with an upper plate upon each lower plate in sliding engagement therewith transversely of the conveyor length. This sliding engagement may be provided by folding under the opposite edges of the upper plate about the lower plate longitudinally thereof, so that the lower plate slides within the partially enveloping upper plate. Attachment of the lower plates **24** is made to the link chains **13** as by angle brackets **27** secured one to the end of each lower plate and at spaced points to the chains **13**. With the lower plates **24** mounted as described, it will be apparent that movement of the chains **13** over the sprocket wheels **14** also moves the lower plates and thus the upper plates affixed thereto along the conveyor loop.

In addition to the foregoing, there are provided a substantially coplanar longitudinal extension **28** upon each of the upper plates **26**, extending laterally from the conveyor length and having attached thereto a cylindrical roller **29**. Attachment of the roller is accomplished by such as a bolt **31** or the like through the upper plate extension **28** and axially into the roller **29** so as to mount the latter for rotation about the bolt **31**. The above described rollers **29** serve somewhat as cam followers and are adapted to fit at least partially within a U-shaped track **32** secured to the frame **12** and extending along the loading and grading portions of the conveyor path. Inasmuch as the upper plates are slideably secured to the lower plates, the lateral disposition of the track **32** will

be seen to determine the relative lateral disposition of the upper and lower plates of each segment. Thus the track which follows a particular path, as more fully described below, may extend inward and outward of the chain path and, as the lower plate motion is determined by the latter and the upper plate motion by the track, the upper and lower plates slide relative to each other transversely of the conveyor length, depending upon the relative lateral disposition of the track.

A further important feature of the conveyor is the individual plate configuration. As previously stated, the general plate outline is rectangular, or at least the plates have parallel sides transversely of the conveyor length in order that they may slide relative to each other in this direction. In addition, the upper plates are provided with a plurality of rows of apertures **33** arranged transversely of the conveyor. Each aperture **33** has a major or greater axis transversely of the conveyor with one end of the aperture curved as in a semicircle and the other forming an acute angle away from the curved end and both lying on the major axis. The apertures may be visualized as generally heart-shaped without the upper indent normally associated with such a shape. All of the apertures in a single upper plate are oriented in the same direction, i.e., the points of each are directed toward the same side of the conveyor. The lower plates have apertures **34** therein aligned in rows with the same spacing between rows and among apertures in a row as the apertures in the corresponding upper plate. These apertures in the lower plates have the same configuration as those in the upper plates, but are oriented oppositely, i.e., the points of the apertures **34** are directed to the opposite side of the conveyor from those of the apertures **33**. Further, the apertures in corresponding or connected upper and lower plates are disposed for maximum registry when the plates are aligned and the apertures are oriented relative to plate displacement so that the aperture points approach; see FIGURES 1 and 5.

From the foregoing it will be seen that relative lateral displacement of the upper plate of a segment with respect to the lower plate thereof varies the aperture registry so as to change the size of the openings through the segment. This lateral displacement is accomplished by the relative lateral displacement of the track from the center of the conveyor, for the lower plates follow the latter, while the upper plates are tied to the track by the rollers so that the upper plates move laterally in accordance with the track position. The consequence of the foregoing is that as the conveyor moves the size of the openings therein is variable in accordance with the lateral track position and in the grading zone above the receptacle means **23** the track generally extends from a maximum lateral displacement to a minimum one in the direction of conveyor travel, i.e., away from the loading zone adjacent the loading means **22**.

Considering now loading of the conveyor **11**, the loading means **22** preferably includes a plurality of troughs **36** directed onto and inclined toward the conveyor in the direction of travel thereof. These troughs **36** are disposed side by side laterally of the conveyor and are defined by tapered walls **37**, which are cut back at the trough ends to form pointed guides, as best seen in FIGURE 1. In order to fully load the conveyor, there are provided the same number of troughs as there are apertures in each row thereof in the plates with the troughs aligned one with each aperture in the lower plates. The conveyor is inclined upwards in the direction of travel thereof in the loading zone and the loading means **22** are inclined toward the conveyor and also with respect to horizontal, terminating at a substantial distance from the top of the conveyor incline, as best seen in FIGURES 2 and 3. As an additional portion of the invention provided in the loading zone thereof, a stationary plate **38** is affixed to the frame **12** immediately beneath the conveyor **11**, extending to the lateral extremities of the latter and longitudinally throughout the inclined portion of the conveyor traverse and a short distance along the following horizontal portion. This stationary plate **38** forms a positive bar to the passage of items through the conveyor and is spaced quite closely to the conveyor beneath same, so that produce or the like cannot extend but minutely through the lower plate apertures **34** in the conveyor, no matter what the upper and lower plate aperture orientation.

One of the serious difficulties in grading and sorting devices employing conveyor means is the complete loading of same, for items of irregular or spherical shape tend to roll therefrom or at least to move around thereupon and strike each other. The present invention operates to place an item in each of the upper plate apertures of the conveyor in the loading zone, so that a maximum number of items are carried to the sorting and grading zone by the conveyor. The conveyor is designed to operate at high speed so as to grade and sort a large quantity of articles rapidly, and thus the above noted problem is materially magnified but is yet overcome herein. In the loading zone the track is initially disposed relatively close to the conveyor substantially in alignment with the lower plates for maximum registry of the plate apertures. At the point where the loading troughs **36** feed produce **39** onto the conveyor, the conveyor apertures are in maximum registry so that the produce have natural depressions through both upper and lower plates to settle into. Along the incline of the loading zone the track angles laterally outward of the conveyor so that at the conveyor moves the upper plates thereof are drawn laterally outward to close off the holes completely through the conveyor by diminishing the registry between the apertures in the upper and lower plates thereof. The produce thus moves by gravity down the troughs which are aligned with the apertures in the upper and lower plates of the conveyor thereat and settle into same possibly even resting upon the stationary plate. As the conveyor moves, the plates of each segment thereof move relative to each other laterally of the conveyor with the points of the corresponding apertures in upper and lower plates approaching each other so that the produce is raised onto the lower plate. In this latter operation, the aperture configuration is important, for with round apertures a guillotine action occurs which tends to cut or crush the produce. With aperture points approaching each other, the produce cannot seat about a circumference thereof, but must rest on a few points so that they are readily raised therefrom without damage. The curved aperture end serves to improve the seating action of the produce, while the pointed end operates to facilitate closure of the opening through the conveyor without damage to the items carried thereby.

As the conveyor moves with produce or the like thereon away from the loading zone and into the horizontal grading and sorting zone, it passes the end of the stationary plate **38** and over the separate receiving means **23**. In this grading and sorting zone the track **32** is displaced a decreasing distance from the conveyor in the direction of travel of the latter so that the upper plate **26** of one segment, for example, moves progressively further laterally inward of the conveyor to place the upper plate apertures **33** in increasing registry with the lower plate apertures whereby the effective openings through the conveyor increase in size, and larger and larger sized produce fall through as the distance along the grading zone increases. Although the track displacement from the conveyor may change uniformly in the grading zone, it is preferable for the track to be equally displaced from the conveyor over each separate receiver, i.e., size grade, and to slant between same, as illustrated in FIGURE 1, to maximize the time for articles to pass through the conveyor in each size limitation.

As regards the track disposition and consequent hole size in the conveyor **11**, each segment of the latter has the upper and lower plates thereof substantially in reg-

istry at the point of trough-conveyor confluence so as to provide a depression of maximum size to receive and retain produce or the like 39 from the feed means 22. As the conveyor moves the aforementioned segment away from the loading point, the upper plate 26 is slid along the lower plate 24 laterally of the conveyor because the track is displaced an increasing distance from the conveyor and the upper plate follows the track. This relative lateral motion of upper and lower plates moves the apertures 33 and 34 thereof out of registry so that the resultant conveyor openings are quite small. The stationary plate 38 prevents items from falling through the conveyor in the loading zone where the conveyor openings are large to seat the items and beyond the stationary plate the openings have been reduced to a small size. Also of particular note is the upward incline of the conveyor in the loading zone whereby the produce or the like 39 cannot overflow the conveyor or feed same too rapidly, for the conveyor in effect picks off the produce from the troughs 36 with the produce being fed by gravity as fast as the conveyor can carry same away. In the grading and sorting zone the relative lateral disposition of upper and lower plates is varied to increase alignment thereof and registry of the apertures therein whereby the conveyor openings increase in size and produce of increasing size pass therethrough farther along the grading zone. The produce thus falls through the conveyor in groups of sizes in predetermined lengths of the grading zone spaced along same whereby separate receiving means 23 receive produce of only one size range.

What is claimed is:

1. Grading apparatus for size sorting of items comprising a driven segmented conveyor comprising a plurality of pairs of apertured plates with the plates of each pair slideably engaging each other for relative motion laterally of the conveyor and the apertures of the plates of each pair thereof being in registry with the amount of registration increasing as the relative lateral displacement between each pair of plates is decreased, control means engaging one of said plates of each pair for sliding the plate progressively laterally more with respect to the other plate of the pair as the pairs of plates move longitudinally along a sorting zone in the conveyor travel for increasing registry of the plate apertures of each pair of plates whereby larger items pass therethrough farther along the conveyor traverse, a stationary plate disposed immediately beneath said conveyor and defining a loading zone wherein items are adapted to be received by said conveyor for sorting, and said control means being disposed to effect maximum aperture registry of the plates of each pair at the front end of said loading zone and decreasing registry therealong toward the rear end thereof.

2. Grading apparatus comprising an endless segmented conveyor adapted to be driven and including a plurality of pairs of apertured plates with the plates of each pair slideably engaging each other laterally of the conveyor and the apertures of the plates of each pair being in varying alignment depending upon the lateral displacement of one plate relative to the other of each pair, a stationary plate underlying a portion of the conveyor and preventing items from falling therethrough, cam follower means secured to one plate of each pair thereof, cam means along the conveyor engaged by said cam followers and laterally positioning the plates of each pair to vary the alignment of the apertures therethrough from a maximum to a minimum above said stationary plate and from a minimum to a maximum beyond same with conveyor travel away from the stationary plate whereby items loaded onto said conveyor at maximum aperture alignment are individually seated on the conveyor and dropped therethrough past the stationary plate in successively increasing sizes along conveyor traverse.

3. Grading apparatus as claimed in claim 2 further

defined by the plates of each of said pairs thereof defining apertures therein of a circular configuration at one end and outwardly pointed configuration at the other end aligned with the points directed laterally of the conveyor and the plates oriented with the pointed configurations of the apertures thereof directed toward opposite sides of the conveyor.

4. Grading apparatus comprising a plurality of pairs of superimposed apertured plates defining conveyor segments in longitudinal side-by-side alignment with the plates of each pair slideably engaging each other longitudinally of the plates for relative movement therebetween laterally of the series of conveyor segments with the apertures of each pair of plates varying in registry according to the relative lateral displacement therebetween, at least one endless chain having a first plate of each pair secured thereto at longitudinally spaced points along same, means mounting said chain in space for rotation and longitudinal motion and defining an upwardly inclined portion followed in the direction of chain motion by a substantially horizontal portion, means defining a cam surface disposed longitudinally along the inclined and horizontal portions of chain traverse at a varying lateral distance from said chain, and a plurality of cam followers secured one to the second plate of each pair of plates and engaging said cam surface for laterally sliding said plates of each pair relative to each other by varying amounts determined by said cam surface along the chain traverse as the segments progress longitudinally therealong whereby the registry of plate apertures and consequently the size of openings through each segment varies in passage along the inclined and horizontal portions of travel.

5. Grading apparatus as defined in claim 4 further characterized by a stationary plate disposed immediately beneath said plates along the inclined portion of travel and defining a loading zone, means feeding items onto said plates in said loading zone, and said cam surface being disposed along said loading zone to vary plate aperture registry from maximum to minimum therein and along the following horizontal portion of traverse comprising a sorting zone from minimum to maximum.

6. Grading apparatus comprising an endless segmented conveyor mounted to traverse an upwardly inclined loading zone followed by a horizontal sorting and grading zone, each conveyor segment including a pair of laterally slideable superimposed apertured plates with the apertures thereof in varying amounts of registry depending upon the relative lateral displacement between the plates, means engaging said plates for controlling the extent of relative lateral displacement between each pair thereof at all points along said loading and sorting zones and thus the registry of plate apertures and opening size in each segment, said means controlling the plate alignment for maximum segment opening reducing in the direction of conveyor traverse through said loading zone to a minimum adjacent the end thereof and increasing therefrom to a maximum along said sorting and grading zone and support means in said loading zone subjacent said plates for preventing items from falling through the aperture openings of said plates.

7. Grading apparatus as claimed in claim 6 further defined by said plates having a plurality of apertures aligned in rows longitudinally thereof, loading means comprising a plurality of inclined troughs directed longitudinally of said conveyor with one for each aperture in one row thereof and aligned therewith in intersection with said conveyor adjacent the bottom of the loading zone, and a plurality of separate receiving means disposed beneath said conveyor and spaced along the sorting zone.

8. Apparatus as set forth in claim 6 in which the apertures in said plates have a semicircular portion with the diametrically opposed edges converging along the lateral extent of said conveyor, and the registrable apertures of the respective elements being positioned with their semi-

circular portions disposed in opposite directions whereby upon smaller aperture registry a diamond shaped opening is defined.

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