April 20, 1954 J. B. POWERS 2,675,917

SORTING DEVICE

Filed Aug. 22, 1949 2 Sheets-Sheet 1

Fig. 1.

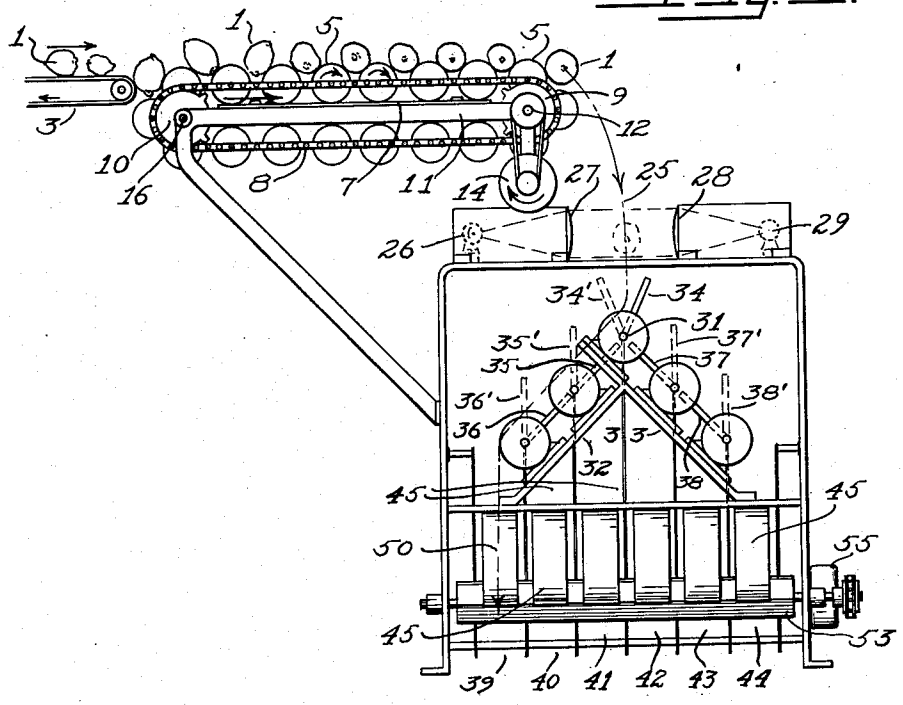


Fig. 2.

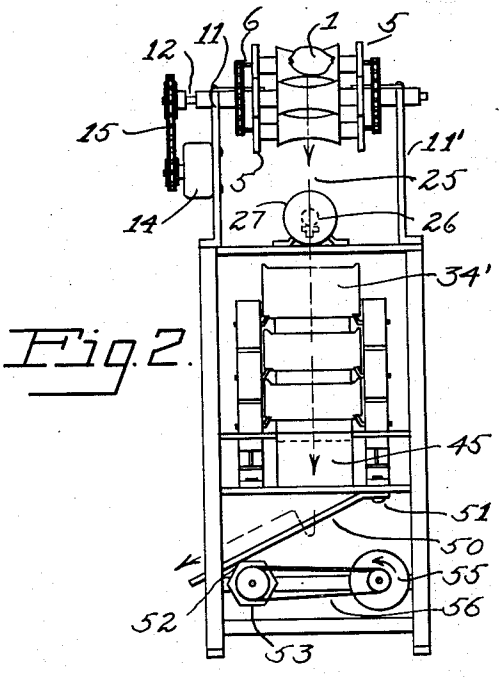
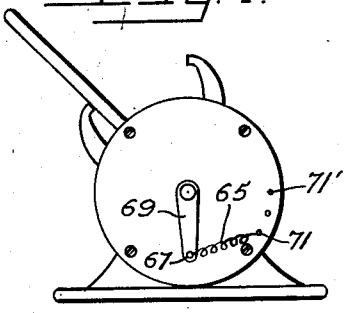


Fig. 7.



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April 20, 1954 J. B. POWERS 2,675,917

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Filed Aug. 22, 1949 2 Sheets-Sheet 2

Fig. 3.

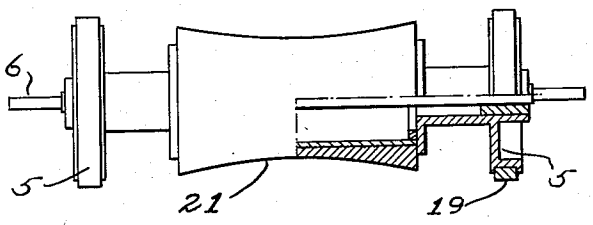


Fig. 4.

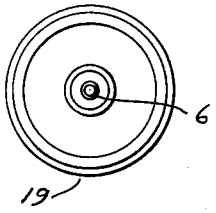
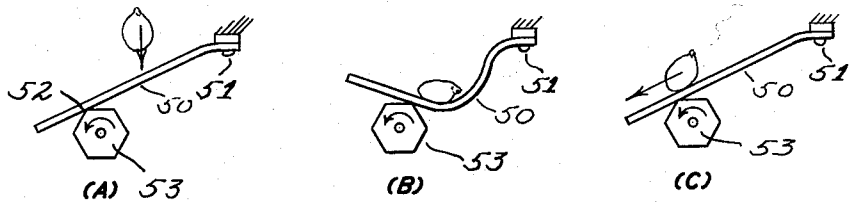


Fig. 5.



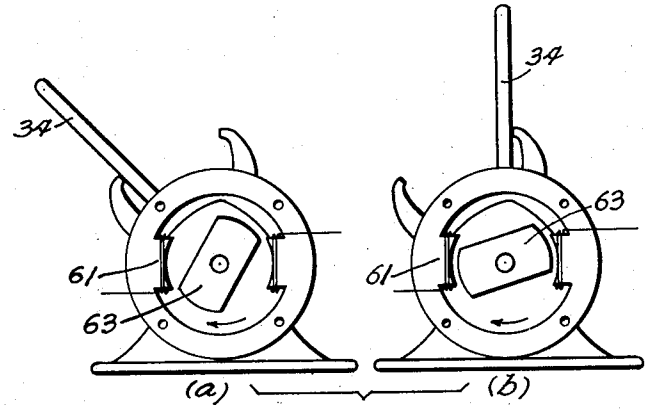


Fig. 6.

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SORTING DEVICE

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Application August 22, 1949, Serial No. 111,719

9 Claims. (Cl. 209—111)

1

This invention relates to apparatus arranged for feeding articles of varying sizes to an automatic sorter wherefrom the articles are finally discharged into outlet ducts, containers, hoppers or the like after having been segregated as to size. As the invention is set forth it embodies a device wherein the control of sorting is accomplished through electronically operated mechanisms under the control of which articles of different sizes are segregated or sorted in such a way as to provide uniform grading into size.

Many sorting and segregation operations are readily accomplished where the articles are of substantially spherical form. Articles of such configuration can be selected as to size and weight by directing them through sorting holes or apertures which are of progressively increasing size so that as the articles are moved they are sorted into generally like size characteristics. Units having only a single axis of symmetry cannot be so readily graded because the major and minor axes may be of little difference in length, in some cases, whereas in other cases there may be considerable differences in length between the two axes. This fact thus substantially precludes sorting by the aforementioned sizing methods to provide reasonably accurate selections of like weight or cross-sectional area where any considerable differences in article shape exist between different units.

The invention thus to be described may be considered as one which is particularly adapted and suited for the sorting to size and weight of articles having generally different-length major and minor axes. Various arrangements have been tried in the past to provide sorting of this general type, but no reasonable degree of success has been attained as far as is known. The result is that the operations have, for the most part, been carried on by hand, with a result that much valuable time has been lost and the expense of sorting and segregating has become considerable. Furthermore, it has been found that the hand-sorting operation is very much subject to variances, even when carried on by experienced help.

The apparatus herein to be described is such that the sorting may be carried on efficiently and without damage to the article or product being sorted. In the form in which the invention will be described reference will be made to the sorting of citrus or other fruits having asymmetrical characteristics, such as lemons, avocados and the like. It will be understood, however, that the invention has generally wide application and

2

the illustration of a field of usage is merely to exemplify one form which has proven satisfactory in practice. In this form of the invention, provision will be made not only for sorting the articles as to size and weight, but also the invention will incorporate features whereby damage, such as would result from permitting the articles to fall from any considerable height, into the containers, crates or hoppers, can be avoided through the utilization of unique and novel features of what will herein be described. Furthermore, the invention in its preferred form, as will herein be set forth, is so constituted and arranged that the articles which are to be sorted and selected may be fed into the machine in random fashion and they will then automatically aline themselves into one appropriate and generally similar pattern from which measurements as to size, cross-section and shape readily may be obtained.

The present invention proposes apparatus which is so constituted and arranged that nonsymmetrical articles may be fed into the mechanism indiscriminately and arranged to be delivered from the apparatus to hoppers or containers after having been sorted precisely as to their size. In its preferred form, the apparatus of the invention comprises a conveyor mechanism, upon which the articles are placed initially in random fashion, and from which the articles are discharged by gravity after having previously been accurately alined and positioned relative to one another. Upon discharge of each article from the conveyor system, it passes in such a way as to eclipse to varying degrees substantially parallelly directed light rays issuing from a light source, which rays are directed to be projected upon a photoelectric tube which serves to control sorting gate operating devices. The subject matter of the particular form of electron control apparatus is presented particularly in a concurrently filed U. S. patent application Serial No. 111,718, and now U. S. Patent No. 2,627,347, granted February 3, 1953, of this same applicant entitled "Photoelectric Control Circuit," in which the circuit mechanism and an arrangement for providing the control is particularly presented and claimed. It is, of course, to be understood, however, that the present application and that related application above named are, generally speaking, inter-related, so that reference may be had to the named pending application for a description of one suitable form of circuit arrangement for accomplishing the closure and opening of the sorting gates.

In a preferred form of this apparatus several sorting or size-allocating gate members are provided for directing the articles into or through one or another of a plurality of hoppers or ducts. One of these gate members is preferably arranged along the ridge of a gable-like structure with the ridge being approximately at the center of the path along which the articles to be sorted are discharged by gravity from the conveyor. The falling article, after passing through and eclipsing the light passing from the light source to operate the electronic control circuit, is adapted to strike this first sorting gate in a somewhat glancing fashion and to be directed thereby along one or another side of the gable. Arranged along the gable section and on either side of the sorting gate positioned along the gable ridge there have been provided a group of additional sorting gates. These gates are operated individually under the control of the output of the photoelectrically responsive control mechanism and circuit set forth in its details in the above named co-pending application. Closure or opening of the gate members determines into which of a plurality of ducts the articles are directed for segregation purposes so as then to be allocated into collection hoppers or containers. The gate members operate in such a manner that articles of one size only, or of one size within reasonable limits of departure from a set standard, are to be directed along the selected paths.

Because the articles fall by gravity into the path of the various segregating gates, and from there into the duct members, it is desirable prior to discharge of the article into the final hopper or container to provide a suitable mechanism for decelerating each falling article so that no damage or injury to the article occurs by reason of the sorting operation itself. To this end, provision is made for catching each falling article in a hammock-like arrangement, from which the article is subsequently discharged into an appropriate container or hopper.

Various forms of mechanisms for the carrying out of the aims and objectives of this invention may be provided, but it becomes one of the primary objects of the invention to provide ways and means by which articles fed into the mechanism in random fashion may, with a minimum of difficulty, be segregated as to size. Other objects of the invention are the provision of relatively simple means for segregating and sorting articles of a similar character in such a way that the articles are effectively measured as to size and separated accordingly. Still other objects of the invention are the provision of sorting mechanisms whereby the objectives hereinabove stated are achieved without damage to the articles supplied to the mechanism. Other objects of the invention, of course, are those of arranging a simple, efficient and yet inexpensive structure to achieve the ends hereinabove named.

The invention in one of its preferred forms has been shown particularly by the accompanying drawings, wherein Fig. 1 illustrates in general elevation and in a rather schematic manner one form of the sorting mechanism; Fig. 2 is a view of the apparatus depicted in Fig. 1, looking from right to left in Fig. 1; Fig. 3 is a schematic view, partly in section, to show the form of conveyor roller serving to aline the articles supplied for sorting; Fig. 4 is a view looking at Fig. 3 from right to left, and in order to depict clearly the configuration of the roller mechanism; and, Fig. 5, comprised in parts (A), (B) and (C), and is to show more particularly and yet schematically the decelerating mechanism whereby articles, after having been sorted and segregated, are arrested in their motion and discharged into hoppers or containers at substantially slow velocity and without damage to the article as a result of falling from the conveyor through substantially to the final hopper into which they are segregated. In this arrangement of Fig. 5, part (A) shows the hammock position immediately prior to the receipt of a falling article thereon; portion (B) shows the flexure of the hammock upon receiving the article, and portion (C) shows the manner in which the article received by the hammock is subsequently discharged under the control of a rotating support member for freely holding one end of the hammock. Fig. 6 shows in part (A) the open gate with the relative shaping of the armature and pole pieces of the operating motor shaped to provide rapid gate opening and part (B) shows the relative shaping such that the high torque becomes effective in the gate open position. Fig. 7 illustrates the appropriate arrangement of the spring from the gate control arm to the two separate anchoring pins to provide the effect of varying strength springs for different gate operating conditions.

Referring now to the drawings for a further understanding of the invention, it will be seen that the apparatus comprises essentially four main components. First, is the form of the article orienting device, which provides for alining the articles on the conveyor from which they are discharged; secondly, there is the photoelectrically responsive measuring or gauging device which produces output currents measuring substantially precisely the size or cross-section of the articles fed therethrough; thirdly, there is the segregating device, which allocates the articles into definite size classifications; and, fourthly, there is the decelerating device serving to discharge the finally sorted article into collecting hoppers or containers.

Considering first the orientation of the articles to be supplied, and assuming, for instance, that the invention from the above set forth standpoint as being directed to the sorting of citrus fruits such as the lemons conventionally represented by the numeral 1, these articles are fed, for instance, by means of a belt feed, which is designated by the numeral 3, in such a way that the articles thereby conveyed are caused to move to conveyor rollers generally designated at 5. The conveyor rollers are supported upon an axis or spindle 6 in such a way as to roll across a guide track 7, rotating in the direction shown by the arrows. The axle or spindle 6 of each conveyor roller 5 is secured in an appropriate fashion to a drive chain mechanism 8, which is arranged to move in the direction also shown by the arrow. The drive chain 8 feeds over a pair of sprockets 9 and 10, the former of which is supported in one end of a support frame 11 upon an axis or spindle 12 and is arranged to be driven by means of a drive motor 14 connected to drive through a pulley and belt mechanism 15, or, alternatively, by way of any suitable chain or gearing drive, if desired. The sprocket 9 is appropriately keyed to the spindle or axle 12, upon which it is supported, and so arranged that on the opposite side of the frame 11, as at 11', a second drive sprocket may be arranged to drive a second chain connected to move and drive the rollers on the opposite side of the mechanism. The sprocket 10

is supported in the opposite end of the frame support 11 upon a spindle or axle member 16, which also extends through to the side 11' of the support frame. At the opposite side of the support frame there is a second sprocket (not shown) corresponding in purpose to that shown at 10 and serving as an idler sprocket over which the chain mechanism is arranged to move.

The rollers 5 are preferably surfaced with a tire, such as indicated at 19, to roll upon the track surface 7 and frictionally engage it. Between each of the rollers 5 is a concave cylindrical member 21 on to which the articles 1 from the belt feed 3 are adapted to fall for orientation. Each concave cylinder 21 is preferably surfaced with a rather soft material covering which will not injure the articles as they move and are transported the length of the conveyor system. As is shown in Fig. 1 of the drawings, the articles, such as the lemons 1 in feeding on to the conveyor from the belt feed 3 strike it initially in random fashion, and, as schematically represented, these articles, due to the rotation of the concave cylinders, are rotated and turn in such a way as to orient themselves in the time between leaving the belt 3 at one end of the conveyor system and when the article is finally moved off the conveyor system and falls by gravity along the indicated path 25, shown by the dot-dash line.

The points shown as dark but large size dots on the articles 1 are intended to represent the long axis of the fruit and, as can be seen from the schematic showing, the rotation of the concave cylinders is such that with the rotation transferred to the article the alinement automatically takes place. The spacing and the surface of curvature of the rolls is such that the center of gravity of the supplied article continuously falls as the lemon is rotated about a vertical axis from the position in which the axis of the lemon is generally parallel to the conveyor at the time it first strikes the rollers. This explains the reason why the lemons as they move along the conveyor tend to nest between the rollers with the long axis transverse to the direction of conveyor travel, in that this position is the equilibrium position which the article tends to assume.

The concavity of the rollers or cylinders tends to cause the article to arrange themselves in a substantially straight line in the passage from that end of the conveyor whereat the articles are discharged from the conveyor belt 3 to that point whereat the article falls free of the conveyor proper. The rotating motion imparted to the articles as they traverse the rollers of the conveyor tends to insure that the established orientation will be maintained as the articles fall free of the conveyor along the path indicated at 25.

Experimentation has shown that if the peripheral velocity of the rollers or cylinders 21 exceeds a maximum of the order of about 20'' per second, this orientation of the supplied article no longer occurs. If it is desired to permit higher conveyor speeds, it is important that the wheels 5 be made of considerably greater diameter than the concave cylinder members 21, since the angular velocity of rotation of the rolls is inversely proportional to the diameter of the driving wheels at any given speed.

Various mechanisms for driving the conveyor of course may be used, but it has been found that that indicated is reliably and sufficiently positive in its nature, as well as simple and free from difficulty, so as to make it desirable in preference to more complicated arrangements. While not shown for reasons of simplicity it is apparent that guide edges may be built up at the end of each roller to maintain the article in the belt, although this is usually not essential.

The next operation after the article has been segregated in such a way as to be oriented as to its axial position is to permit the article as it falls along the path designated at 25, to come within the substantially uniform intensity beam of parallelly directed light rays issuing from any suitable source, such as the lamp 26 and collimated by the convergent lens 27. The shadow cast by the falling article promptly reduces, eclipses, or even interrupts in some conditions, the light received by the objective 28 and directed into the conventionally represented photocell or phototube 29. The eclipsing of the light directed to the phototube serves to control (by an appropriate electronic relay circuit of the type described in the above-named concurrently filed copending application, for instance) the operation of the appropriate sorting gate or closure mechanisms. It can readily be established that the shadow cast by the falling article is a measure of its greatest cross-sectional area, and in this way it is possible to utilize the control measured in accordance with the degree to which the light to the phototube is eclipsed as a means whereby the falling article may be accurately and precisely sorted as to size.

In cases where it is desired that even more precise sorting than originally occurred should be made, it is possible to rerun the operation by supplying to the sorting mechanism only those articles which have first been selected as to size. Then, the light beam from the source 26, as indicated, may be rotated to a position substantially at right angles to that represented by the drawing, and in this category the articles will then be subdivided on the basis of the least cross-sectional area thereof, rather than the maximum cross-sectional area thereof, as was the basis of initial sorting. It is thus possible to segregate the articles on the basis of shape, as well as on the basis of size, and it is to be understood that in either arrangement the principles adopted and disclosed herein are equally applicable.

Since the manner of control of the mechanism operated under the influence of the variations in light gauged by the falling article eclipsing the light beam have been set forth as the subject matter of the separate and complete patent application above named, further details thereof will not be described in this specification, other than to point out that the control introduced by the photoelectrically operated apparatus 29 is such as to control or regulate the opening and closing of the various sorting gates herein later to be described.

After the article has fallen from the conveyor along the path 25 and has eclipsed the light beam from the source 26 to the phototube 29, it next encounters a bank of sorting gates which are controlled and operated under the influence of the electronic relay circuit hereinabove mentioned. The gates are arranged in such a way that one gate unit functions, for instance, to segregate all articles below an intermediate average size into one group of sorters and articles of a size larger than the same intermediate average size into another group of sorters. This gate mechanism is arranged to pivot and hinge from axis 31 immediately above the ridge to which

two supporting gable members **32** and **33** are positioned.

While it has not been shown particularly in Fig. 1, the gate support framework is carried upon the gable members **32** and **33**, and the gate itself is then pivoted along axis such as **31** formed in the gate support mechanism, not shown. It has been assumed that the gate member **34** which is pivoted on the axis **31** will divide the sorted articles into two groups larger and smaller than the mid-size chosen. Thus, if it be assumed that the gate **34** in its indicated position moves the falling articles to the left of the ridge and through the mechanisms supported upon gable **32**, then it can be seen immediately that if an article larger than one of midsize falls to interrupt the light beam between the source **26** and the phototube **29**, the gate **34** will pivot about its axis **31** to the dotted line position **34'**, or, in other words, move counterclockwise, and the articles will then pass to the right side or through sorting gate mechanisms carried upon the gable **33**. The details of the gate operating mechanisms will be presented in a separate concurrently-filed copending application Serial No. 111,720 of this inventor and entitled "Gate Operating Motor," and now U. S. Patent No. 2,541,937, granted February 13, 1951. For the purpose of this application, suffice it to say, therefore, that the various sorting gates, **34**, **35**, **36**, **37** and **38**, operate so as to select of various particular sizes from the articles supplied to the conveyor unit. Then, the selected articles are next fed through suitable ducts or passages into collecting hoppers or containers.

With the showing of five separate gate mechanisms it will be apparent that six separate size classifications may be obtained. This result is achieved, for instance, by so arranging the gate **34**, as above mentioned, that it divides the classification between articles below a midsize and articles above a midsize arbitrarily selected. For instance, in the position shown and represented by the dot-dash line, the falling article traversing the path **25** from the conveyor mechanism will strike the left side of the gate **34** and be passed along the dotted path out through to the hopper or container immediately below the exit port **39** in that the gate mechanisms **35** and **36** are indicated as being closed. This position of the gate mechanism **34** likewise may be assumed to be its closed position or, in other words, that position which is maintained normally against the force of the control spring mechanism described particularly in connection with the showing in each of the aforesaid copending applications. If, however, it be assumed that an article which is of larger size than that which would be allocated to the hopper **39** falls along a path **25**, then one of the gate devices **35** or **36** would arrange to open. If it be assumed that the gate **35** opens to select an article of the third size classification, then, of course, also the gate **36** would open, because current magnitude sufficient to operate the gate **35** would also operate the gate **36**, but this factor is of no consequence in these considerations, in that an article falling and guided in its initial trajectory by the gate **34** would strike initially the gate **35**, and thus be guided in accordance therewith.

One important factor in the operation of the device is the relative timing of the gates. Only one object can be passing through the apparatus at any one instant, and although the passage is rapid, a finite time does elapse between the time of passage of gate **34** and gate **36** or **38**. The whole operation of the device depends upon gate **34** which must be ready to make its primary selection by the time the fruit has dropped a very few inches below the light-beam. This gate must therefore operate very rapidly to "open," but since the next selection cannot be made until the fruit has had time to pass the final gate—**36** or **38**—it may close more slowly. The later gates of the series need not open so rapidly, but if they do not they must close more quickly, since the length of their cycle of operation must be the same as that of gate **34**.

A convenient type of motor for operating the gates has essentially the structure of the well-known rotary relays. In the design of such devices it is known that the speed of operation can be controlled by shaping the pole-pieces. Opening is effected electro-magnetically, closure by spring action.

If the field magnetomotive force is high, the maximum value of magnetic flux through the armature is determined by saturation of the armature material. If, under these conditions, the pole pieces are shaped so that the rate of change of flux with rotation in the initial position is high, there will be high torque and high acceleration, and opening will be rapid. The relatively low rate of change of flux near the end of the opening period will, however, result in relatively low torque at this point, and the opposing spring torque must be low to avoid stalling. The gate closes relatively slowly under the influence of this low spring torque. This arrangement is desirable for gate **34**. These two conditions are indicated by Fig. 6 where, in part (A) the gate **34** is shown in open position, and where, in part (B) the gate is shown in closed position. However, in part (A) the pole pieces **61** and armature **63** are so shaped relative to each other that, as above stated, the initial rate of change of flux with rotation is high to provide high torque and acceleration of rapid opening.

If, however, the pole pieces are shaped so that maximum torque occurs in the open position, and, consequently, lower torque during the initial stages of opening, the opening will be slower. The high torque in the open position permits the use of a relatively strong return spring, and closure is therefore rapid. This arrangement is desirable for gates **36** and **38**. The second condition is illustrated where a relatively low rate of change of flux and resultant low torque occurs at the initial point in the operation. The high torque is effective in the open position of the gate **34**.

As above explained, where the rate of change of flux is low near the end of the opening period and relatively low torque is required, as in the condition for part (A) of Fig. 6, a relatively weak spring pressure as exerted by a spring **65** in Fig. 7 is needed. The spring pressure under these conditions must be relatively weak at the beginning of the closing period, since the time required for closing is relatively great. With the pole piece and armature shape as in part (B) of Fig. 6, the reverse is true. By connecting the spring **65** at one end to a pin **67** attached to an arm **69** which is in turn secured to the armature (not shown in Fig. 7), and the other end of the spring being attached to pins such as **71** and **71'**, for instance, various spring tensions may be had from the same apparatus. In the position at which the spring **65** is shown in Fig. 7, the movement of the arm **69** about the armature shaft

does not change greatly between a fully open and a fully closed position of the gate. Hence, the torque on the arm **69** produced by the spring **65** will increase continuously with the opening of the gate. By moving the end of the spring **65** from the pin **71** to the pin **71'** the arm in the open gate position is only a fraction of that in the closed position; hence the torque due to the spring may be caused to decrease as the gate opens. In this way the effect of varying-strength springs is readily attainable.

Various forms of gate motors are available, and the particular form employed is no part of this invention. The principles above mentioned are applicable to nearly all types, however, and the important point in connection with the present invention is that unless motors are available wherein both opening and closing are both extremely rapid those used for the upper gates should open rapidly and close slowly, while for the lower gates the reverse characteristics should be the choice.

In each case as an article is allocated to position by one of the gate members, it passes through a duct such as that represented at **45**, in order to reach the appropriate hopper, which hoppers may be designated, for instance, by the numerals **39** through **44** for the assumed six different sizes of classification. If now the article to be sorted is one of a size larger than the assumed midsize, the gate **34** will move under the control of the current output and the relay mechanism not herein described, operated from the phototube **29**, so that the gate position **34'** is assumed. Then the falling article will traverse a path to the right of the gate member **34'**, and in the absence of any operation of either gate **37** or **38** the size classification with which the hopper **44** is associated. If, however, the largest size article to be selected passes through the light beam path, then it will be observed that the gate **37** will open, as well as gates **34** and **38**, and the falling article will be guided to the right of the gate **34'** and into the hopper **42**, to which it is directed by the open gate **37** reaching a position **37'**.

In its passage from the conveyor to the hopper the fruit falls a considerable distance and acquires considerable kinetic energy. Part of this is dissipated by glancing impact with the sorting gates, and the latter may be of cloth loosely stretched over skeleton frames so that such impact will do no harm. The energy absorbed is a relatively small proportion of the total, however, and for this reason it is desirable to protect the article from damage to itself or to those other articles with which it comes in contact in the hopper. To this end, the invention makes provision for decelerating the acquired motion, and accordingly, at the end of each discharge duct **45** prior to discharge of the articles into one of the associated hopper mechanisms **39** through **44** there is a hammock member **50**. This hammock member has for its purpose that of decelerating the falling article and dissipating the kinetic energy acquired by it in its fall from the conveyor and yet without in any way damaging or bruising the article itself. The hammock is preferably constructed from sponge rubber or other soft material which has a relatively low elastic modulus and which has relatively high mechanical hysteresis. This hammock is attached rigidly at its upper end **51** to the framework of the sorting apparatus and at its lower end freely rests, as at the point **52**, upon a non-rigid support such as the hexagonally-shaped member **53** which may be rotated, as indicated. The falling article, indicated at Fig. 2 as traversing the dot-dash path, when striking the hammock has its kinetic energy transferred into energy of flexure of the hammock, as is shown particularly by portion (B) of Fig. 5. This is accomplished without transferring any appreciable amount of energy to the article itself. By reason of the choice of the resilient soft material for the hammock structure, there is a relatively low coefficient of restitution of the hammock itself, and consequently the low value of surface transfer of energy to the article is brought about. The extremely high internal hysteresis of the hammock prevents the falling article from rebounding from the hammock after striking it by absorbing some of the kinetic energy of the falling body, although it will be appreciated that a certain portion of the energy is also absorbed in the frictional losses that occur when the resilient hammock member is flexed and drawn over the non-rigid support or roller **53**. The rotating roller such as the hexagonal member **53** shown serves to straighten the hammock after impact so that the article held or supported thereon may be discharged by gravity into the desired hopper. The roller **53** might be of shapes other than the suggested hexagonal (e. g., a cylinder), but for many reasons the hexagonal shape is preferred, and especially because the surface contour is such that in straightening of the hammock **50** the article tends more easily to discharge. Various mechanisms for rotating the roller may be utilized, but for illustrative purposes the drive motor **55** and the belt drive **56** have been found satisfactory to achieve the objectives. The arrangement of the components herein is such that one of the hammock members is arranged in each duct or passage into one of the hoppers, so that prior to discharge of the sorted article the velocity acquired by reason of the drop between the conveyor and the hammock is substantially removed and the articles fall gravitationally into the hopper or container with little or no kinetic energy in excess of that which they would derive by reason of being manually placed into the hoppers.

Having now described the invention, what is claimed is:

1. An apparatus for sorting articles as to size wherein the articles are fed along a continuously moving conveyor having a plurality of concave conveyor rollers for alining the articles during advance motion along the conveyor comprising a plurality of duct members to connect with storage hoppers and a plurality of closure gates for directing the articles into individual ducts in accordance with article size, said gates being arranged in gable fashion with the gable ridge substantially in the path along which the articles fall by gravitational force after discharge from the conveyor, a gate positioned substantially at the gable ridge to direct the falling articles to one or the other side of the gable ridge with variances in article size on either side of a selected average, photoelectric means positioned in the region wherein the articles move by gravitational force for producing current controlled in proportion to article size, means for releasing the individual gate members in accordance with the magnitude of the produced current to allocate the articles to the ducts related to the article size, a motor associated with each gate to control the rate of opening and closing thereof, the

individual motors having different starting torques with a decrease occurring from one motor to another as the motors control gates more remote from the article conveyor so that gates nearer the conveyor open more rapidly than gates remote therefrom, and resilient closing means connected to each gate with the initial force effective to close the gates being greater in proportion to the distance of the controlled gate from the conveyor.

2. An apparatus for sorting articles as to size wherein the articles are fed along a continuously moving conveyor having a plurality of concave conveyor rollers for alining the articles during advance motion along the conveyor and to discharge the alined articles by gravity at the end of the conveyor comprising a plurality of duct members to connect with storage hoppers and a plurality of closure gates for directing the articles into individual ducts in accordance with article size, said gates being arranged in gable fashion with the gable ridge substantially in the path along which the articles fall by gravitational force after discharge from the conveyor, a gate positioned substantially at the gable ridge to direct the falling articles to one or the other side of the gable ridge with variances in article size on either side of a selected average, photoelectric means positioned in the region wherein the articles move by gravitational force for producing a current controlled in proportion to article size, motor means for operating the individual gate members in accordance with the magnitude of the produced current to allocate the articles to the ducts related to the article size, a gate member positioned at the gable ridge to guide articles discharged from the conveyor along either side of the gable dependent upon article size, the motors for controlling the individual gates having different starting torques of which the magnitude decreases from one to another in accordance with the remoteness of the thereby controlled gate from the article conveyor, with the gates nearer the conveyor opening more rapidly than gates remote therefrom, and resilient closure control means connected with each gate and motor with the individual force effective to close the gates being initiated with an interruption of operating current to the motors and being greater in proportion to the distance of the controlled gate from the conveyor.

3. An apparatus for sorting articles as to size wherein the articles are fed along a continuously moving conveyor having a plurality of concave conveyor rollers for alining the articles during advance motion along the conveyor and to discharge the articles so that they fall gravitationally from the end of the conveyor comprising a plurality of duct members to connect with storage hoppers and a plurality of closure gates for directing the articles into individual ducts in accordance with article size, said gates being arranged in gable fashion with the gable ridge substantially in the path along which the articles fall by gravitational force after discharge from the conveyor, a gate member positioned at the gable ridge to guide articles discharged from the conveyor along either side of the gable dependent upon article size, and photoelectrically responsive means interposed between the end of the conveyor and the gable ridge to control the opening and closing of individual gate members in accordance with the size of the falling article, and a decelerating device supported at approximately the end of each duct to receive the articles and for subsequently gravitationally discharging them at approximately zero initial velocity.

4. A decelerating device comprising a hammock formed of a soft material having a low elastic modulus and a high mechanical hysteresis, a rigid support for fastening one end of the hammock and a rotatable and movable non-rigid support upon which the opposite end of the hammock is rested at a point below that whereat the hammock is rigidly supported so that after receiving articles tending to flex it the hammock is straightened and articles thereon are gravitationally discharged.

5. A decelerating device comprising an elongated resilient element having a relatively low elastic modulus and relatively high mechanical hysteresis, means to anchor rigidly the element at one end only, a non-rigid support for frictionally holding the other end of the resilient element so that articles falling upon the resilient element in the region between the rigid and non-rigid supports have their kinetic energy transformed into energy to flex the resilient element and the resilient element is slidably supported relative to the non-rigid support so that the energy is partially absorbed frictionally by the resilient element sliding relative to the non-rigid support and the high mechanical hysteresis of the resilient element prevents prompt article rebound therefrom.

6. A decelerating device comprising an elongated resilient element having a relatively low elastic modulus and relatively high mechanical hysteresis, means to anchor rigidly the element at one end only, a non-rigid support for frictionally holding the other end of the resilient element so that articles falling upon the resilient element in the region between the rigid and non-rigid supports have their kinetic energy transformed into energy to flex the resilient element and the resilient element is slidably supported relative to the non-rigid support so that the energy is partially absorbed frictionally by the resilient element sliding relative to the non-rigid support and the high mechanical hysteresis of the resilient element prevents prompt article rebound therefrom; and means for rotating the non-rigid support element so as to draw the resilient element into substantially its original shape subsequent to the receipt of the article thereon, and thereby to aid in the discharge of the supported article from the resilient element.

7. A decelerating device comprising an elongated resilient element having a relatively low elastic modulus and a relatively high mechanical hysteresis, means to anchor rigidly the element at one end only, a rotatable device for freely supporting the said resilient element between its point of anchor and its opposite end so that articles falling upon the element in the region between the anchored end and the rotatable device have their kinetic energy transformed into energy to flex the resilient element, with the high mechanical hysteresis of the element preventing article rebound therefrom, and subsequently, due to rotation of the rotatable device, the element is frictionally drawn to substantially its initial state for discharging articles therefrom.

8. A decelerating device comprising a hammock of soft material having a low elastic modulous and high mechanical hysteresis, a rigid support for fastening one end only of the hammock in cantilever fashion with the opposite end free of fixed support, a rotatable element lo-

cated below the point of rigid support and between the point of rigid support and the free end of the hammock upon which the hammock is adapted to be rested free of any fixed engagement so that after articles are caused to fall upon the hammock in the region between the point of rigid support and the rotatable element so that the article weight tends to flex the hammock the said hammock is straightened by reason of its frictional engagement with the rotatable element so that articles held thereon are gravitationally discharged.

9. A decelerating device comprising an article carrying element formed of sponge rubber, a rigid anchoring means for fastening one end only of the article carrying element, a second support point for the article carrying element comprising an element having polygonal periphery which is supported for rotational movement and is located between the anchoring means of the article carrying element and its free end and upon which the article carrying element is adapted to be rested without securement so that after receiving articles in the region between the rotatable element and the anchoring means the weight of which articles tends to flex the article

carrying element the said element is straightened by rotation of the rotatable member and its straight sides so that articles carried thereon are gravitationally discharged.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
697,360	Pettit	Apr. 8, 1902
1,482,198	Lebeis	Jan. 29, 1924
1,538,122	Kurtz	May 19, 1925
1,722,751	Jones	July 30, 1929
1,927,217	Price	Sept. 19, 1933
1,954,164	Wyland	Apr. 10, 1934
1,958,322	Symington	May 8, 1934
2,019,138	Kliesrath	Oct. 29, 1935
2,045,769	Geffcken	June 30, 1936
2,112,259	Wyland	Mar. 29, 1938
2,229,638	Chamberlin	Jan. 28, 1941
2,442,521	White	June 1, 1948

FOREIGN PATENTS

Number	Country	Date
52,172	Norway	Sept. 8, 1930