

Jan. 30, 1968

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3,366,236

CLASSIFYING AND SORTING BY DENSITY

Filed April 6, 1966

3 Sheets-Sheet 1

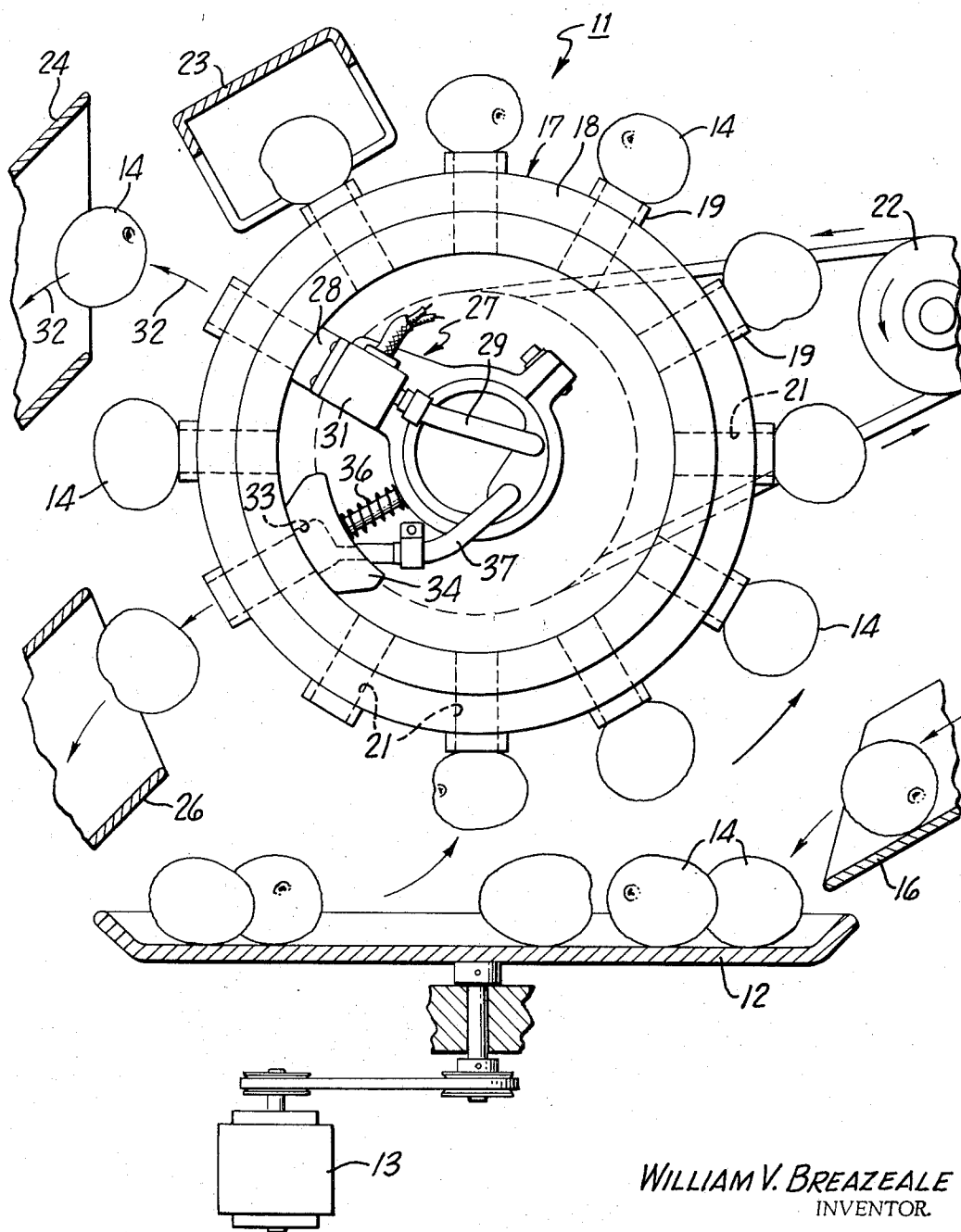


FIG. 1

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3 Sheets-Sheet 2

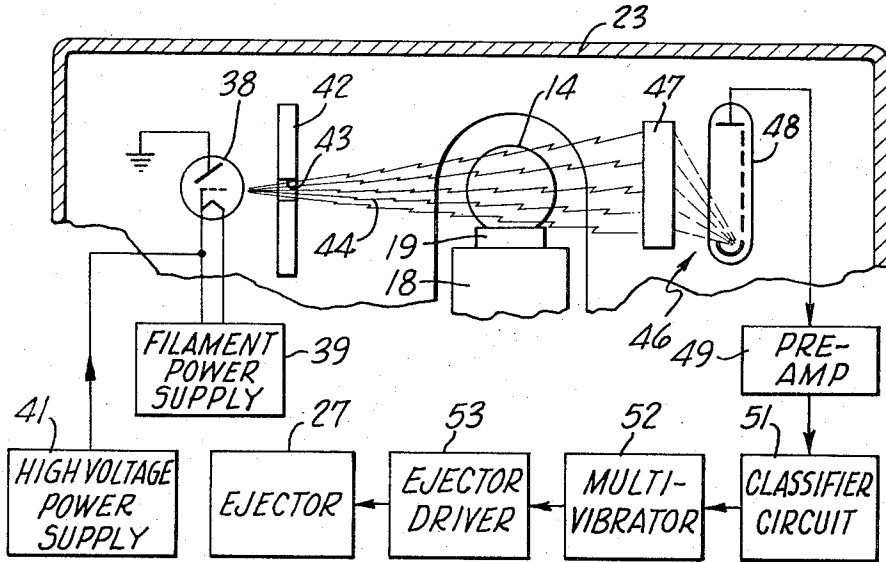


FIG. 2

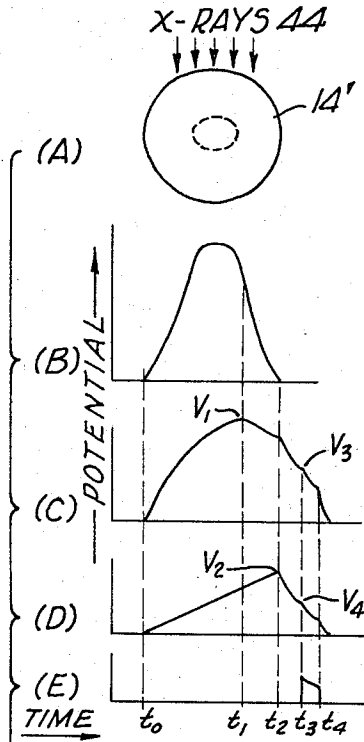


FIG. 4

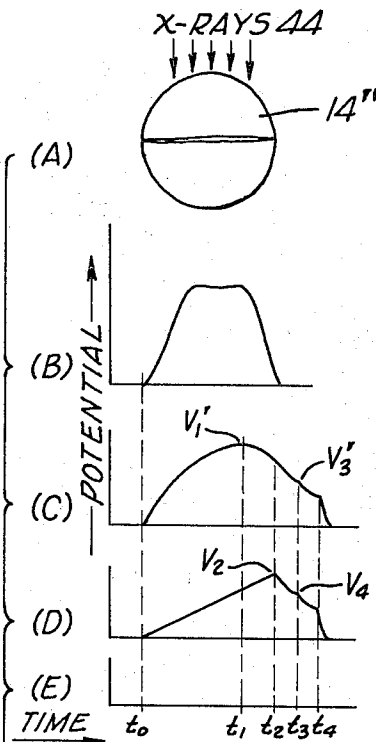


FIG. 5

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3 Sheets-Sheet 5

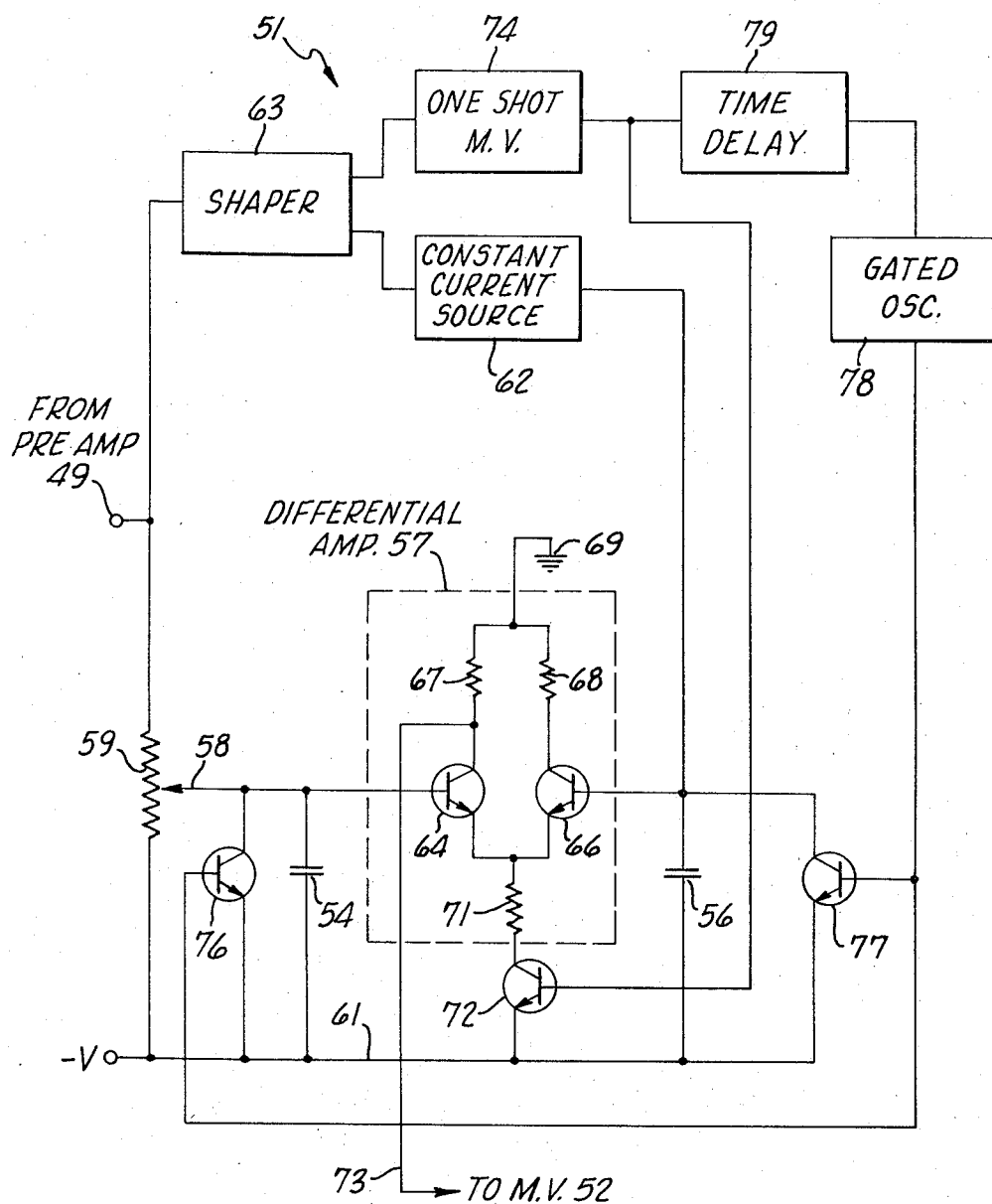


FIG. 3

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CLASSIFYING AND SORTING BY DENSITY

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10 Claims. (Cl. 209—111.5)

This invention relates generally to the sorting of products according to their density characteristics, and is more particularly directed to a density classification and sorting system for separating cherries and other food products containing pits from similar food products from which the pits have been removed.

Various food products such as cherries, olives, and the like, which normally contain pits, are frequently provided to the consumer in pitted form. The pitting operation is accomplished automatically at a high rate by means of a pitting machine. Although the pits are in most instances removed from the products, there is a small percentage of the products which passes through the machine without being pitted due to a variety of reasons such as misalignment of the product in the machine, abnormal disposition of the pit in the product, etc. Consequently, in a batch of the products delivered from the pitting machine, some of the products remain unpitted. Before the pitted products are packaged for delivery to a consumer, it is virtually imperative that the unpitted products be detected and eliminated.

Heretofore various fluoroscopic devices utilizing X-rays have been employed to scan the products delivered from a pitting machine, or the like, to provide a visual indication of pits remaining in the products. Such devices are necessarily attended by an inspector who observes the fluoroscopic display of the products passing, for example, on a conveyor line. Upon detecting a product with a pit, the inspector removes such product from the line. It will be appreciated that such attended inspection and sorting of the products is disadvantageous from the standpoint of the personnel requirements involved and the limited throughput of the products that is obtained.

It is therefore an object of the present invention to provide a system for automatically classifying a food product as being pitted or unpitted and sorting the products according to such classifications in an unattended manner.

Another object of the invention is the provision of a sorting system in which density characteristics of a food product provide the basis for classifying the product as acceptable or defective.

It is still another object of the invention to provide a sorting system of the class described in which attenuation of a low energy X-ray beam by the product passing there-through provides the density characteristic upon which classification of the product is based.

Yet another object of the invention is the provision of a sorting system of the character outlined hereinbefore having a classifier which operates on a difference between normalized height and width of the attenuation vs. time characteristic effected by a product passing through the X-ray beam to reliably classify the product irrespective of its particular orientation in the beam.

It is a further object of the invention to provide a sorting system classifier of the class described which is capable of operating at relatively high speed.

Other objects and advantages of the invention will become apparent upon consideration of the following description thereof in conjunction with the accompanying drawings, wherein:

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FIGURE 1 is a schematic representation of a sorting machine embodying the density classification and sorting system of the present invention;

FIGURE 2 is a schematic illustration of the classifying and sorting system;

FIGURE 3 is a schematic circuit diagram of a preferred form of classifier circuit employed in the system;

FIGURE 4 is a graphical representation of an unpitted product and corresponding signal waveforms generated at various points of the classifying and sorting system; and

FIGURE 5 is a graphical representation of a pitted product and corresponding signal waveforms generated at various points of the classifying and sorting system.

Referring first to FIGURE 1, there is shown a sorting machine 11 of a generally conventional design, and which is therefore only briefly described hereinafter. The machine includes a horizontal feed bowl 12 rotated about a vertical axis as by means of a drive motor 13 coupled thereto. The feed bowl receives a product 14 to be sorted from a hopper 16, or the like. The rotating feed bowl operates in a well known manner to centrifugally form a single row of the product at the outer or transfer edge of the bowl moving at the proper speed for a successful transfer to a nearly tangentially rotating ferrule wheel conveyor 17. Such conveyor includes a hollow disc or wheel 18 having a plurality of ferrules 19 projecting radially outward therefrom at circumferentially spaced positions. The ferrules communicate through bores 21 with the hollow interior of the wheel which is evacuated by means of a pump or the like (not shown) to establish a vacuum therein. The wheel is rotated, as by means of a motor 22 coupled thereto, to thereby move the ferrules successively into close adjacency to the product in the feed bowl. The vacuum acting through the ferrules is effective to lift the product from the bowl singly upon the tips of the ferrules. In this manner, the products are held in a single row and at a fixed distance apart as they are conveyed by the wheel through an inspection housing 23 and past defective and acceptable product chutes 24 and 26, or equivalent collection points. The products are released to such chutes in accordance with classification information derived at the inspection station.

In order to classify the products conveyed through the inspection housing 23, inspection means, of a type subsequently described, are provided therein to inspect the product and generate a signal representative of a predetermined characteristic thereof. The inspection means are associated with classifier means, of a type subsequently described, arranged to determine whether the product is acceptable or defective from its characteristic signal. Upon determining the product to be defective, the classifier means generates an eject pulse which is applied to an ejector mechanism 27 mounted in fixed position within the wheel 18 in close proximity to the inner periphery thereof. In the present case, the ejector mechanism is angularly displaced from the inspection housing 23 by an amount substantially equal to the angular spacing between adjacent ones of the ferrules 19. The ejector mechanism preferably includes an ejection nozzle 28 having a pressurized air hose 29 coupled thereto through a normally closed solenoid actuated valve 31. The nozzle is radially disposed adjacent the inner wheel periphery for successive communication with the bores 21, and the mouth of the defective product chute 24 is positioned radially opposite the nozzle. The solenoid actuated valve, or other actuating means of the ejector mechanism is coupled to the classifier means to receive the eject pulses therefrom. In response to an eject pulse being gener-

ated as a product classified as defective is leaving the inspection housing 23, the valve is opened to release pressurized air to the nozzle 28. Substantially simultaneously, the bore 21 communicating with the ferrule carrying the defective product is registered with the nozzle. Pressurized air is thus directed from the nozzle through the bore and ferrule to blow the defective product from its tip into the chute 24, as indicated by arrows 32. The valve is then closed before the next successive bore approaches.

When a product is classified as acceptable in being conveyed through the inspection housing 23, no eject pulse is applied to the valve 31 such that it remains closed while the bore 21 communicating with the ferrule carrying the acceptable product moves past the nozzle 28. As a result, the acceptable product is held on the tip of the ferrule as it is conveyed past the defective product chute 24. Such acceptable products are next conveyed adjacent the acceptable product chute 26. Each ferrule and associated bore 21 are here aligned with a nozzle 33 of a stationary cut-off shoe 34 mounted within the wheel and resiliently urged, as by means of a spring 36, against the inner periphery of the wheel. An air hose 37 continuously supplying low pressure air is connected to the nozzle 33. The shoe cuts off the vacuum in the ferrules to thus cause separation of the acceptable products therefrom. The low pressure air issuing from nozzle 33 enhances the separation process by insuring that the products do not stick to the ferrule tips and prevent air from entering to overcome the vacuum. With the vacuum in the ferrules thus overcome, the acceptable products carried on the tips of the ferrules are directed into the acceptable product chute 26.

In accordance with the particularly salient aspects of the present invention, the inspection means employed in the inspection housing 23 are arranged to provide a signal representative of the density characteristic of a product as a basis for classification. Such a signal characteristic enables a determination be made as to whether or not products such as cherries, olives, etc., which have been previously subjected to an automatic pitting operation, still contain pits. More particularly, with reference to FIGURE 2, an X-ray tube 38, or equivalent means, is disposed within the inspection housing 23 to generate low energy radiation. A filament power supply 39 and high voltage power supply 41 are connected to the tube to appropriately energize same. A collimator 42 is also mounted within the housing adjacent the X-ray tube to define a slit 43 for collimating the emerging X-rays into a well defined beam 44 directed transversely of the path of product conveyance through the housing by the ferrule wheel. The beam cross section is of vertically elongated rectangular configuration and in the vicinity of its impingement with a product conveyed therethrough is of a length approximating the diameter of the product. An appropriate detector 46 is mounted in the housing in transverse alignment with the collimating slit 43 on the opposite side of the path of product travel therefrom. Preferably, the detector includes a scintillation crystal 47 receiving the X-ray beams 44 subsequent to its transmission through the product, and a photomultiplier tube 48 viewing the crystal. In a well known manner, the crystal produces light radiation having an intensity proportional to the energy of the impinging X-rays. The photomultiplier tube in turn generates an electrical signal proportional to the intensity of light emitted from the crystal, and which is therefore proportional to the X-ray beam energy. It will be appreciated that the beam is attenuated by a product passing therethrough to an extent determined by the product density, and as a result the output or inspection signal from the photomultiplier is representative of product density. The density of a pit is different than the density of the meat of a cherry, or similar product. A distinct difference between the amount of beam attenuation produced by a pitted cherry

and that produced by a cherry containing a pit, and corresponding difference between the heights of output pulses from the photomultiplier tube, might therefore be expected, in which case classification of the products could be simply based on pulse height. Unfortunately, this is not the case. Although there is a difference between the respective densities of the pit and meat, the difference is not greater. The orientation and size of the product cause greater differences in the attenuation of an incident X-ray beam than does the presence of a pit. For example, a small cherry containing a pit may attenuate the beam the same amount as a large cherry without a pit. Similarly, since cherries are usually ovate rather than spherical, there may not be any appreciable difference between the peak attenuation produced by comparable pitted and unpitted cherries which are respectively oriented in lengthwise and widthwise alignment with the beam. Accordingly, as an extremely important feature of the invention, a normalized attenuation characteristic which takes into account the size and/or orientation of the product is utilized as a basis for classification. More particularly, the difference between a normalized height and width of the attenuation vs. time characteristic inspection pulse generated by the photomultiplier 48 responsive to a product traversing the beam, facilitate classification of the product as being unpitted (defective) or pitted (acceptable). The pulse width is representative of the product dimension transverse to the beam and is therefore indicative of the size of the product and/or its orientation in the beam. A normalized height and width can be so selected that the former significantly exceeds the latter in the case of a cherry containing a pit, while the normalized height and width are substantially equal or the width exceeds the height in the case of a pitted cherry. Such relationships generally hold, irrespective of the size and/or orientation of the product in the beam. The difference between the normalized height and width thus provides a reliable basis for classification of the product.

The attenuation vs. time output pulses of photomultiplier tube 48 are coupled as by means of a preamplifier 49 to a classifier circuit 51 arranged to normalize the pulse height and width in accordance with the previously noted considerations, and to differentially compare the normalized values. In response to the normalized height being substantially greater than the normalized width, the classifier circuit generates an output pulse of appropriate polarity to trigger a one-shot multivibrator 52. In response to the normalized width being substantially equal to or less than the normalized height, no output, or a pulse of improper polarity to trigger the multivibrator is generated by the classifier circuit. Upon being triggered, the multivibrator generates an eject pulse of predetermined duration which is applied by an ejector driver 53 to the ejector 27. The time at which the classifier circuit 51 generates an output pulse is chosen relative to the speed of rotation of the conveyor such that the ferrule directly in advance of the one moving through the inspection housing 23 and carrying the product effecting generation of the pulse, has moved beyond the ejector nozzle 28 or equivalent eject means. The duration of the eject pulse of multivibrator 52 is predetermined to actuate the ejector for a dwell time sufficient for the ferrule carrying the product originating the eject pulse, to move into registration with the nozzle 28. However, the duration is not so long that the pulse persists beyond the time the classifier circuit generates an output pulse in response to the immediately following ferrule conveying a defective product through the inspection housing. Thus, when a product subjected to the X-ray beam 44 at the inspection housing 23 contains a pit and is classified as defective by the classifier circuit 51, the ejector 27 is actuated to eject the product to the defective product chute 24. If the product is classified as acceptable, the ejector is not actuated and the product is conveyed beyond same for subsequent release to the acceptable product chute 26.

Considering now the classifier circuit 51 in detail as to a preferred embodiment thereof, and referring to FIGURE 3, it is to be noted that the circuit includes pulse height and width sensing capacitors 54 and 56, or equivalent charge storage means, respectively coupled to inputs of a differential amplifier 57. The height capacitor is connected between the variable tap 58 of a potentiometer 59 and a bias bus 61 energized with a bias, $-V$. The opposite ends of the potentiometer are respectively connected to the bus and coupled to receive the attenuation pulse output from preamplifier 49. Thus, the capacitor 54 is charged exponentially to a potential proportional to the height of each attenuation pulse appearing at the output of the preamplifier. By virtue of the variable tap 58, the potential to which the capacitor is charged for a given pulse height may be varied and set to establish a normalized value.

The width capacitor 56 is coupled between the bias bus 61 and the output of a constant current source 62. The constant current source is gated by one output of a pulse shaper 63 which receives the attenuation pulse output from the preamplifier 49. The shaper shapes each pulse to a suitable form for gating of the constant current source over the duration of the pulse. During this interval constant current is supplied to the capacitor 56 which is thus charged linearly to a potential proportional to the pulse width. It will be appreciated that the potential for a given pulse width may be set to different values by varying the magnitude of the current supplied by the constant current source. In this manner, a normalized pulse width signal is obtained.

The differential amplifier 57 is conventional and includes a pair of transistors 64 and 66, which in the illustrated case are of type NPN. The collectors of the transistors are coupled by equal resistors 67 and 68 to ground, as indicated at 69. The emitters of the transistors are coupled by a common emitter resistor 71 in series with a sampling transistor 72 to the bias bus 61. The bases of transistors 64 and 66 provide the inputs of the amplifier for receiving the normalized height and width signals from capacitors 54 and 56. An output line 73 connected to the collector of transistor 64 facilitates the application of a difference signal to the multivibrator 52 in response to energization of the amplifier transistors by triggering on of the sampling transistor 72. The sampling transistor is triggered at a predetermined time relative to the initiation of an attenuation pulse. More particularly, in the illustrated case transistor 72 is of type NPN and its collector is connected to resistor 71, while its emitter is connected to the bias bus 61. Transistor 72 is thus forward biased, however the base of this transistor is coupled to the output of a one-shot multivibrator 74 which is triggered by a second output of the shaper 63. In response to the initiation of an attenuation pulse from the preamplifier 49 as shaped by shaper 63, the multivibrator 74 is triggered to initiate an output pulse of predetermined duration. The polarity of the pulse is such as to cut-off the sampling transistor, and in the present case is thus negative. The pulse duration is set to correspond to a time slightly longer than that required for a nominal size product to traverse the X-ray beam 44. Upon termination of the multivibrator pulse, the sampling transistor 72 is turned on to thus forward bias the differential amplifier transistors 64 and 66 and effect generation of a difference signal in the output line 73. It will be thus appreciated that the difference between the normalized pulse height and width is sampled at approximately the time inspection of the product is completed.

The capacitors 54 and 56 are reset to their normal discharged states subsequent to comparison of the potentials thereon by the differential amplifier 57 preparatory to a subsequent cycle of operation initiated by the next attenuation pulse. To this end, a pair of transistors 76 and 77, serving as crow bar switches, are paralleled

with the capacitors 54 and 56. In the illustrated case, transistors 76 and 77 are of type NPN and the emitters thereof are connected to the sides of the capacitors that are connected to bias bus 61, while the collectors thereof are connected to the opposite sides of such capacitors. The bases of the transistors 76 and 77 are connected to the output of a gated oscillator 78, the input of which is coupled by a time delay 179 to the output of multivibrator 74. The time delay is effective to delay only the trailing edge of the multivibrator pulse, and thus functions as a pulse stretcher. The delay is selected to be relatively short and the extended pulse gates the oscillator off. Thus, the oscillator is turned off in response to initiation of an attenuation pulse, and turned on a short time after the potentials on capacitors 54 and 56 are sampled by the differential amplifier 57. The oscillator pulses render the transistors 76 and 77 rapidly periodically conducting to short the capacitors 54 and 56. The capacitors are typically fully discharged after but several cycles of the oscillator pulses.

The operation of the classifier circuit 51 in classifying the cherries, or other products, as being unpitted or pitted will be better understood upon consideration of the waveforms of FIGURES 4 and 5. As indicated in FIGURE 4, an unpitted cherry 14' enters the X-ray beam 44 at the time t_0 to initiate the generation of an attenuation pulse of the character shown in portion B of the figure. This pulse is applied to the classifier circuit from the preamplifier 49 to simultaneously initiate charging of height capacitor 54, gate on constant current source 62 to in turn initiate charging of width capacitor 56, gate on one shot multivibrator 74 to in turn gate off the sampling transistor 72, and gate off oscillator 78, at time t_0 . The corresponding charging curves of the capacitors 54 and 56 are shown in portions C and D of FIGURE 4. Capacitor 54 charges to a peak potential V_1 , and at a time t_1 , corresponding to the beginning of the trailing edge of the attenuation pulse, begins to discharge at a relatively slow rate. The attenuation pulse terminates at a time t_2 , whereupon capacitor 54 discharges at a more rapid rate. In the time interval t_0-t_2 the width capacitor 56 charges linearly to a peak potential V_2 . Since the attenuation pulse terminates at time t_2 the constant current source 62 is turned off at this time and capacitor 56 begins to discharge at a relatively rapid rate. At a time t_3 , the output pulse from multivibrator 74 is terminated. The potentials on the capacitors 54 and 56 at time t_3 are respectively V_3 and V_4 , and at this time the sampling transistor 72 is turned on since the multivibrator pulse has terminated. The differential amplifier transistors 67 and 68 are thus biased on at time t_3 to produce a signal in output line 73 proportional to the potential on capacitor 54 less the potential on capacitor 56. Potential V_3 being greater than V_4 , an output pulse is initiated at time t_3 having a positive peak proportional to V_3-V_4 , as shown in portion E of FIGURE 4. This pulse is of the proper polarity to trigger multivibrator 52 to in turn effect ejection of the cherry 14' in the manner previously described. At a time t_4 , the pulse applied to oscillator 78 is terminated, the trailing edge of the output pulse from multivibrator 74 having been delayed for a time interval t_4-t_3 introduced by delay 79. The output pulse from the differential amplifier 57 is thus terminated at time t_4 , since at this time the oscillator renders transistors 76 and 77 conducting to discharge the capacitors.

When a pitted cherry 14'' of the same size as cherry 14' passes through the X-ray beam 44, the classifier circuit operates in a manner similar to that described relative to the unpitted cherry 14', and waveforms are produced as shown in FIGURE 5. The peak of the attenuation pulse shown in portion B of the figure is not as great as the peak of the attenuation pulse produced by the unpitted cherry 14', however the pulse duration t_0-t_2 is the same. As shown in portions C and D of FIGURE 5,

the height capacitor 54 charges to a potential V_1' , less than the potential V_1 , but the width capacitor 56 charges to the potential V_2 . At time t_3 when the differential amplifier 57 is biased on, the capacitors 54 and 56 respectively have potentials V_3' and V_4 . The potential V_3' , is less than the potential V_3 , and in the illustrated case is substantially equal to the potential V_4 . As a result, no output pulse is produced in output line 73, as indicated in portion E of FIGURE 5.

It will be appreciated that the hereinbefore described cases of unpitted and pitted cherries are somewhat idealized in that the cherries are nearly spherical and have the best possible orientations in the X-ray beam. However, when the potentiometer 59 and constant current source 62 have been set to normalize the pulse height and width signals developed by capacitors 54 and 56 for greatest sensitivity to the presence of pits, the classifier circuit determines the proper classification of the products with few exceptions despite departures from the idealized cases. For example, a pitted cherry of abnormally large size which produces an attenuation pulse having a relatively high peak comparable to that produced by a smaller cherry containing a pit, is still properly classified as pitted. In this regard, although the height capacitor 54 is charged to a relatively high potential, the width capacitor 56 is charged to a corresponding high potential because of the large size of the cherry. When the respective potentials are sampled, there is no appreciable difference and no output pulse is generated by the differential amplifier. In instances where pitted cherries are oriented in the beam with the pit removal bore made by the pitting machine aligned with the beam, the attenuation characteristic is double peaked since there is negligible attenuation in the vicinity of the bore. If the cherry is oriented with its narrower dimension in alignment with the beam, the height of the double peaked attenuation pulse is relatively small compared to the width and either no output pulse or a negative output pulse is generated by the differential amplifier. The pitted cherry is thus not ejected to the defective product chute. If the cherry is oriented with its longer dimension in alignment with the beam, the height of the double peaked attenuation pulse is generally comparable to the width such that no output pulse is generated. However, in some instances the pulse height may be sufficiently large that a positive output pulse is generated and the pitted cherry is ejected. Similarly, in instances where the pit removal bore is transverse to the longer dimension of a cherry and the cherry is oriented with its longer dimension in alignment with the beam, the pitted cherry may or may not be ejected. It should be noted that such occurrences of ejection of pitted cherries are statistically quite small. Moreover, the improper ejection of a few pitted cherries is not particularly detrimental, since the primary concern is to eject unpitted cherries with high reliability from large batches of cherries, the majority of which are pitted. Of more importance is the improper classification of an unpitted cherry as being acceptable. In one particular instance, such an improper classification may be made by the classifier circuit. More particularly, if an abnormally elongated unpitted cherry is oriented with its longer dimension transverse to the beam, the normalized width signal stored by capacitor 56 may be comparable to or less than the normalized height signal stored by capacitor 54. A positive pulse will therefore not be generated by the differential amplifier 57 and the cherry will not be ejected. It has been found, however, that the occurrence of such an improper classification of an unpitted cherry is statistically less than 1%. The classifier circuit of the present invention thus has a reliability of greater than 99% in effecting ejection of unpitted cherries, and a comparable reliability in effecting ejection of other products containing pits.

Although the invention has been hereinbefore described with respect to a preferred embodiment thereof, it will be appreciated that numerous modifications and

changes may be made therein without department from the spirit and scope of the invention. For example, the classification and sorting system is applicable to horizontal conveyor arrangements as well as rotary conveyor systems of the variety described herein. Thus, it is not intended to limit the invention except by the terms of the following claims.

What is claimed is:

1. In a system for classifying and sorting products according to their density characteristics including means for conveying products at constant speed along a predetermined path extending successively adjacent an inspection station, a defective product collection point, and an acceptable product collection point, ejection means disposed adjacent said defective product collection point for delivering said products from the conveying means thereto in response to actuation, and means disposed adjacent said acceptable product collection point for delivering said products from the conveying means to the acceptable product collection point as the products are conveyed adjacent same, a classifier comprising means disposed at said inspection station for directing a beam of low energy radiation transverse to said path into impingement with said products conveyed therealong, detector means disposed at said inspection station for receiving said beam subsequent to penetration of said products and generating an electrical inspection signal proportional to the energy of said beam, said signal including pulses having heights proportional to the attenuation of said beam by said products and widths proportional to the dimension of said products transverse to said beam, normalizing means coupled to said detector means for generating a height signal having a magnitude proportional to a normalized peak height of each of said pulses and a width signal having a magnitude proportional to a normalized width of each of said pulses, differential comparison means coupled to said normalizing means for comparing the magnitudes of said height and width signals and generating an eject pulse in response to the former exceeding the latter, and means coupling said comparison means to said ejection means for actuating same in response to said eject pulses.

2. A system according to claim 1, further defined by said normalizing means comprising height and width sensing capacitors, a potentiometer coupling said inspection signal to said height sensing capacitor to charge same to potentials proportional to normalized peak heights of the pulses of said inspection signal, a gated variable magnitude constant current source coupled to said width sensing capacitor, means coupling said inspection signal in gating relation to said constant current source whereby said pulses of said inspection signal gate said constant current source to supply current to said width sensing capacitor to charge same to potentials proportional to normalized widths of said pulses of said inspection signal, and sampling means coupled to said differential comparison means to momentarily actuate same for comparison of the potentials on said capacitors subsequent to each charging thereof responsive to each pulse of said inspection signal.

3. A system according to claim 2, further defined by said sampling means comprising switch means normally supplying operating bias to said differential comparison means, means for initiating a gate pulse of predetermined duration in response to the initiation of each pulse of said inspection signal and applying the gate pulse to said switch means to gate same off and thereby deactuate the comparison means for the duration of the gate pulse, and discharge means coupled between the gate pulse means and said capacitors for rapidly discharging same a predetermined delay time following termination of each of said gate pulses.

4. A system according to claim 3, further defined by said discharge means comprising normally open crow bar switch means respectively coupled across said capacitors,

a gated oscillator coupled to said crow bar switch means to cyclically close same, and delay means coupling the gate pulse means in gating relation to said oscillator to delay the trailing edge of said gate pulse by said predetermined delay time, said gate pulse with delayed trailing edge being effective to gate off said oscillator.

5. A system according to claim 1, wherein said means for directing a beam of low energy radiation transverse to said path comprises an X-ray tube for generating low energy X-rays, and a collimator disposed adjacent said tube having a slit for collimating said X-rays into a beam directed transverse to said path, and said detector means comprises a scintillation crystal disposed on the opposite side of said path from said collimator in receiving relation to said beam, and a photomultiplier tube disposed adjacent said crystal to receive light emitted therefrom.

6. A system for separating unpitted products from pitted products comprising means for conveying products at constant speed along a predetermined path extending successively adjacent an inspection station, an unpitted product collection point, and a pitted product collection point, a source of low energy X-rays disposed at said inspection station, a collimator disposed adjacent said source having a slit for collimating said X-rays into a beam directed transverse to said path and having an elongated rectangular cross section which in the region of impingement with said products has a length approximating the diameter thereof, a detector disposed at said inspection station on the opposite side of said path from said collimator in receiving relation to said beam to generate an electrical inspection signal proportional to the energy of said beam, said signal including pulses having heights proportional to the attenuation of said beam by said products and widths proportional to the dimensions of said products in the direction of their conveyance along said path, first and second transistors connected in differential amplifier configuration having first and second inputs and an output for developing a signal proportional to the difference between signals at said inputs, a bias source, a third normally conducting transistor coupling said bias source in energizing relation to said first and second transistors, height and width sensing capacitors respectively connected between said first and second inputs and said bias source, a potentiometer having first and second sides respectively connected to said bias source and to said detector to receive said inspection signal and having a variable tap connected to said first input, a variable magnitude gated constant current source coupled to said second input, means coupling said inspection signal in gating relation to said constant current source whereby said pulses of said inspection signal gate said constant current source to supply current to said width sensing capacitor, a gate pulse generator coupled to receive said inspection signal and initiate a gate pulse of predetermined duration in response to the initiation of each pulse of said inspection signal and apply the gate pulse to said third transistor with a polarity to render same non-conducting, fourth and fifth normally non-conducting transistors respectively coupled in parallel with said height and width sensing capacitors, a gated oscillator coupled to said fourth and fifth transistors for generating pulses of a polarity to render same conducting, pulse stretching means coupled between said gate pulse generator and said oscillator to increase the duration of each of said gate pulses by a predetermined increment of time and apply the gate pulse of increased duration to said oscillator with a polarity to gate same off, an ejector disposed adjacent said unpitted product collection point to displace products thereto from the conveying means upon actuation of the ejector, means coupling said output in actuating relation to said ejector, and means disposed adjacent said pitted product collection point to displace products thereto from the conveying means as the products are moved adjacent said pitted product collection point.

7. A system according to claim 6 wherein said means coupling said output in actuating relation to said ejector includes a one shot multivibrator for generating eject pulses in response to pulses at said output, said eject pulses being of a predetermined duration sufficient for a product effecting generation of a pulse at said output to move from said inspection station to a position adjacent said unpitted product collection point.

8. A system for separating unpitted products from pitted products comprising a hollow rotatable conveyor wheel having a plurality of circumferentially spaced ferrules projecting therefrom and communicating with the interior thereof, means establishing a vacuum in the interior of said wheel, means coupled to said wheel for rotating same, a feed bowl carrying said products disposed adjacent said wheel for successive traversal by said ferrules with said products being individually picked up and retained on the tips of said ferrules by said vacuum, an inspection housing disposed adjacent said wheel for traversal by said products carried on the tips of said ferrules, a source of low energy X-rays disposed in said housing, a collimator disposed adjacent said source having a slit for collimating said X-rays into a beam of elongated rectangular cross section directed transverse to the path of travel of said products carried by said ferrules through said housing, a detector disposed in said housing on the opposite side of said path from said collimator in receiving relation to said beam to generate an electrical inspection signal proportional to the energy of said beam, said signal including pulses having heights proportional to the attenuation of said beam by said products and widths proportional to the dimension of said products in the direction of their conveyance along said path, normalizing means coupled to said detector for generating a height signal having a magnitude proportional to a normalized peak height of each of said pulses and a width signal having a magnitude proportional to a normalized width of each of said pulses, differential comparison means coupled to said normalizing means for comparing the magnitudes of said height and width signals and generating an eject pulse in response to the former exceeding the latter, an ejector angularly displaced from said housing in the direction of rotation of said wheel and coupled to said comparison means to receive said eject pulses and responsively release the product from an adjacent one of said ferrules, an unpitted product chute disposed adjacent said ejector to receive said products thereby released from said ferrules, product release means angularly displaced from said ejector in the direction of rotation of said wheel for releasing the product from adjacent ones of said ferrules, and a pitted product chute disposed adjacent said release means to receive said products thereby released from said ferrules.

9. A system according to claim 8, further defined by said normalizing means comprising height and width sensing capacitors, a potentiometer coupling said inspection signal to said height sensing capacitor to charge same to potentials proportional to normalized peak heights of the pulses of said inspection signal, a gated variable magnitude constant current source coupled to said width sensing capacitor, means coupling said inspection signal in gating relation to said constant current source whereby said pulses of said inspection signal gate said constant current source to supply current to said width sensing capacitor to charge same to potentials proportional to normalized widths of said pulses of said inspection signal, and sampling means coupled to said differential comparison means to momentarily actuate same for comparison of the potentials on said capacitors subsequent to each charging thereof responsive to each pulse of said inspection signal.

10. A system according to claim 9, further defined by said sampling means comprising switch means normally supplying operating bias to said differential comparison means, means for initiating a gate pulse of predetermined

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duration in response to the initiation of each pulse of said inspection signal and applying the gate pulse to said switch means to gate same off and thereby deactuate the comparison means for the duration of the gate pulse, and discharge means coupled between the gate pulse means and said capacitors for rapidly discharging same a predetermined delay time following termination of each of said gate pulses.

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References Cited

UNITED STATES PATENTS

3,095,090	6/1963	Duran	209—111.6
3,197,638	7/1965	Sinclair	250—83.3

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