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SORTING DEVICE

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Fig. 1.

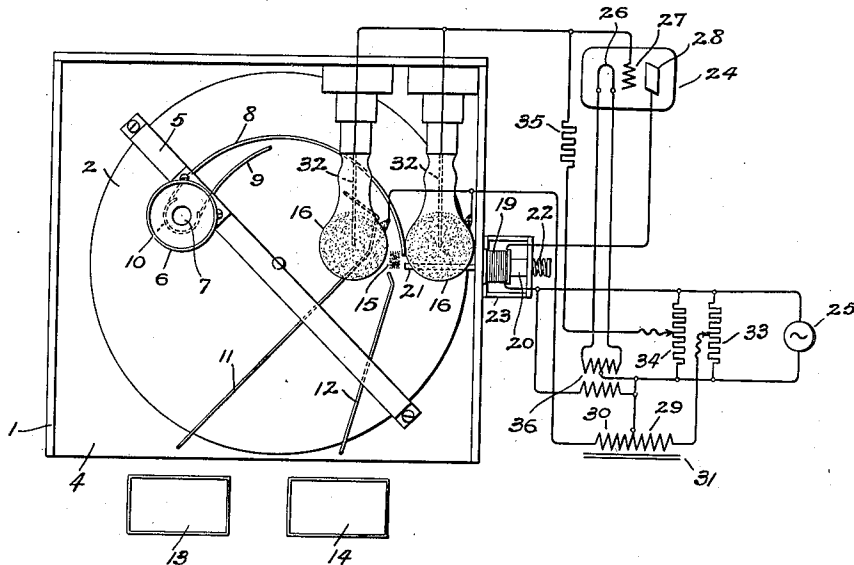
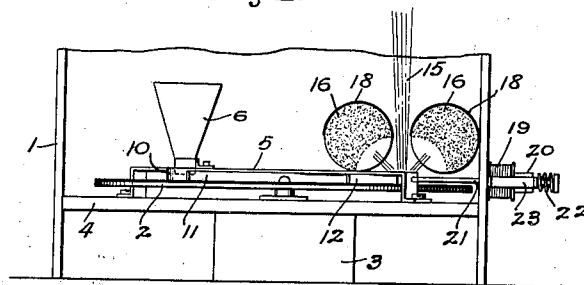


Fig. 2.



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SORTING DEVICE

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2 Claims. (Cl. 209—111)

The present invention relates to sorting apparatus and more particularly to devices for automatically sorting objects of various colors.

In the arts, there frequently arises the necessity of selecting from a given quantity of objects of various colors or representative colors or shades, objects which conform to certain color or shade standards. For example, in coffee bean grading, it is desirable to sort the good beans which prior to roasting may take on a green, yellow or other color according to the variety, from the bad beans which are often black or from foreign matter of various colors such as small pebbles, shells, etc. Moreover, the roasting process does not always lend the same color to each of the beans but gives to the majority a deep brown or chocolate appearance, while the remainder may take on any other hue or shade, lighter or darker than the other beans. Thus, it is necessary to sort out and reject from the mass of beans prior to roasting and, if desired, also subsequent to roasting, those beans or materials which do not conform to a given color standard indicative of a first quality assortment. Heretofore, the selecting process was performed entirely by hand which necessarily was slow and inaccurate inasmuch as the art of comparison with the color standard was a matter of personal judgment and experience.

An object of the present invention is to provide an improved means whereby objects may be automatically selected according to color or shade. Another object is to increase the speed and accuracy with which the objects may be selected on the color basis, while a more specific object is to sort from a miscellaneous quantity of beans, the beans whose color identifies them as being different in quality, i. e. superior, inferior or of equal quality with a predetermined standard.

In carrying out my invention, advantage is taken of the reflection light principle in that the objects are individually presented to a light beam and the quantity of light reflected by the surface which represents a measure of color is caused to impinge upon a photo-electric tube. The photo-currents may be amplified in any suitable manner but it is preferred to employ an electrostatically controlled arc discharge tube, a type of which is described in the G-E Review, April 1929, vol. 32, No. 4, pages 213-223, or a similar device for this purpose on account of the large amount of power that can be handled in one tube. In the output circuit of the amplifier, there is an electro-mechanical arrangement which responds to the photo-currents as amplified to reject the beans of inferior quality. A more complete understanding of the invention will be had when reference is made to the following description and the accompanying drawing in which Fig. 1 represents a plan view of the sort-

ing apparatus including a diagram of the electrical circuits; while Fig. 2 is an elevational view, partly broken away, of the apparatus.

In the drawing, numeral 1 designates a box-like container in which the apparatus is located, the front side and top of the container being open in order to view the operation and to supply the device with objects to be sorted. Within the container there is mounted in any suitable manner, a flat, circular disc 2 which is adapted to rotate conveniently by an electrical motor as in a phonograph or other mechanism, indicated generally by a rectangle 3. The disc may be supported upon a false bottom 4 to give space underneath for the driving mechanism. Diametrically across the disc and affixed to the bottom 4, there is positioned a metallic strip frame member 5 which carries the guide appurtenances for constraining the objects to paths suitable for inspection purposes. These guide members consist in a funnel or hopper arrangement 6 which may be filled with a miscellaneous assortment of beans or other objects to be graded according to color or shade and terminates in an opening 7 which is large enough for a few of the objects to drop through at a time; the lower edge of the funnel is located above the disc with sufficient clearance to allow an object freely to move between the surface of the disc and the funnel. The frame 5 also provides a support for members 8 and 9 which may comprise metal strips placed edgewise over the disc with minimum clearance to preclude contact with the latter. The outer strip 8 is bent roughly into semicircular shape of relatively large radius, while the inner strip 9 is short and forms a channel with the outer strip, the entrance of which is at the lower opening in the funnel member 6. At the funnel end, the channel is closed by a guard strip member 10 which constrains the objects to a position within the channel. At the other end the channel tapers down to a width only large enough to accommodate one object, or one bean in the case of a bean sorter, thereby cooperating with opening 7 in the funnel to restrict the objects or beans to a single file with a predetermined spacing between the objects as they pass the examining light beam; a thorough examination of each bean is thus assured. While the funnel and tapered guideway operates satisfactorily to distribute the beans on the disc, it is evident that other mechanism may be employed for this purpose. For example, the combination of a moving belt and chutes or a seed drill so-called may be utilized. In the case of a funnel or seed drill, it may be desirable to vibrate or shake these members in any suitable and well known manner in order to prevent the beans from clogging. The member 5 also carries guides 11, 12, of strip metal which are rectilinear for the most part and bent

for a short distance at the end nearer the strip member 8, the straight portions being directed toward receiving hoppers 13 and 14.

The light source for illuminating the individual beams as they pass along the inner surface of guide member 8 on their way to one of the receiving hoppers due to the rotation of the disc 2 may comprise an electric lamp (not shown) focussed through a suitable lens system for producing a rectangular or other suitably shaped light spot 15. The lamp conveniently may be secured to the container 1 directly above the disc 2 or the light may be directed on to the disc from an externally located lamp by means of mirrors. The light beam 15, after striking the surface of each bean, is thereupon reflected and impinges upon one or more light-sensitive devices shown as a pair of photo-electric tubes 16, 16 rigidly positioned at opposite sides of the downwardly projected light beam in order to view two sides of the bean and it will be apparent that a photo-electric tube shaped as a toroid would be particularly advantageous for this purpose. The photo-electric tubes may be of the usual type except that the upper surface of the tubes are shielded from direct illumination by the lamp by means of a material opaque to light which may be applied to the envelope in the form of a dark paint, black enamel or other covering 18. To the exterior wall of the container, there is secured an electromagnetic device comprising a solenoid 19 and a plunger 20, the latter having an extension 21 which passes through an opening (not shown) in the box and terminates near the light spot. In order to restore the plunger to its normal position after actuation in the manner stated hereinafter, there is provided a compression spring 22 attached to an extension of the plunger and supported by a rectangular frame member 23 in the manner shown. The minute photo-currents are amplified to a magnitude sufficient for operating the electromagnetic device 19 by means of a thermionic device 24 of well known construction termed a "thyatron" although it is to be understood that my invention contemplates all types of amplifiers, mechanical and electrical. However, in a strict sense, when an arc discharge tube is employed, the photo-currents serve merely to trigger the arc discharge tube in a manner explained hereinafter.

As exemplified in Fig. 1, the photo-electric tubes and the electric discharge device are each energized by alternating current preferably from a common source 25 of commercial voltage and frequency. The photo-electric tubes are connected in parallel across the grid circuit of the arc discharge tube thereby to constitute a variable resistance whose value changes in accordance with the variations of light impinging on the tubes 16, 16. The electric discharge device, which may be considered as an electrostatically controlled arc rectifier is characterized by being able effectively to control large amounts of current whereby only one stage of amplification of the photo-currents is necessary for direct actuation of the electromagnetic device. An amplifier of this sort is described in the General Electrical Review, vol. 32, No. 4, April 1929, p. 213-223, and in one of its various forms may consist of an evacuated envelope containing a cathode 26, a grid 27 and an anode 28 immersed in a gas or vapor at a pressure sufficient to support an arc-like discharge at the impressed potentials. While the device may be energized by direct cur-

rent, it is usually more convenient to employ alternating current in each of the filament, grid and plate circuits, in which case, the grid determines the point in each cycle at which the plate current shall start to flow. After the arc discharge has been initiated, the grid loses control and the current ceases only by reason of the plate voltage having passed through zero. Inasmuch as the grid controls the initiation of the discharge, the average value of plate current over a number of cycles may be determined in this manner. It is apparent that the electric discharge device passes current only when plate 28 is positive. During this portion of the cycle, it is necessary to bias the grid negatively in order to prevent discharge and this is conveniently accomplished by means of an auto-transformer having a portion 29 connected in the plate circuit and a portion 30 in the grid circuit, the respective coils being arranged on the same core 31 and wound in such a direction that when the plate is positive the current induced in coil 30 renders the grid negative. The grid of the arc discharge tube is connected to the anodes 32 of the photo-electric tubes 16, the cathodes being connected to the secondary coil 30 of the auto-transformer. The latter is energized preferably by a resistance 33 provided with an adjustable tap and arranged directly across the source 25. There is another resistance 34 in shunt to the source of electromotive force and having an adjustable tap which is connected in series with the grid resistor 35 to the control member 27 of the arc discharge tube. The function of the grid resistor will be explained presently. The filament 26 of the arc discharge device is energized through a voltage step-down transformer 36 supplied with energy from the common source 25. The electromagnet 19 is connected serially in the output circuit which is completed through the source of alternating current and the mid-tap on the filament transformer secondary to the electric discharge device.

It is evident that when a bean or other object whose light reflecting power is to be determined intercepts the light beam, the light reflected from the bean impinges on the photo-electric tubes 16, 16. The disc 2 is preferably covered with a substance or material whose color approximates that of an object of standard appearance so that the effective amount of light impinging on the photo-electric tubes represents solely that which is reflected by the surface of the bean or other object under inspection. The portion of the plunger which intercepts the light beam should also be coated with this material. The photo-electric tube if fabricated in the ordinary manner contains an alkali metal cathode, for example caesium in the form of a compound film adhering to the envelope and serving as a cathode, also a centrally disposed rod-like anode 32 and sometimes, an inert gas. The effect of the reflected light is to cause the cathode to give up electrons which travel toward the anode and render the impedance between the electrodes much lower than when the tube is inactivated, i. e., when it is in the dark. Negative current from the coil 30 will then flow to charge the grid 27 negatively. The grid is also subjected to a positive charge by reason of the current flowing through the resistor 35 and it is evident that the relative magnitudes of these opposite charges may be adjusted, for example by moving the tap along each slide wire resistor 33, 34 until the net charge of the grid is sufficiently negative to preclude an arc dis-

charge from forming in the electric discharge device when the plate is positive. Under these conditions, the electromagnet 19 remains unenergized due to the failure or lack of plate current and the bean or other object is allowed to pass in front of the plunger without having its direction altered. These would be the conditions under which an object of proper light reflecting power and hence conforming to the predetermined color standard, would be examined by the light beam and forwarded by the rotating disc and guide member 11 to the receiving hopper 13. However, when a bean of inferior quality and hence of different color and light reflecting power or foreign material passes the light beam, the light reflected therefrom is less than in the case of the bean of proper color and the activation of the photo-electric tubes becomes less, the latter now offering more impedance to the flow of negative current from the coil 30 to the grid. However, the positive charge derived through resistor 35 remains the same as before and the net effect is to charge the grid of the arc discharge tube more positive or less negative to a degree sufficient to enable an arc discharge to start. Plate current of several amperes will then flow through the solenoid 19 and the plunger 20 actuated to push the bean or other object of inferior quality away from its normal path toward the receiving hopper 14 into a second path suitably shaped by the guide 11 which may lead to the second hopper 13. The hoppers 13 and 14 thus receive the respective classes of beans which have been sorted according to color as based upon their individual light reflecting powers. In the case specifically described, the beans falling in hopper 13 would be considered of inferior quality and hence would be rejected although it is to be understood that this hopper contains beans of less light reflecting power than those of the other hopper and if the treatment is accorded to the beans after roasting in which case the first quality bean reflects little or no light, the rejected beans which may reflect more light would normally fall in hopper 14. Under certain conditions, it may be desirable to modify the operation of the device particularly in regard to the manner of charging the grid of the arc discharge tube in order to push the good beans, prior to roasting, instead of the rejected beans, out of their normal path by the plunger. In general, the operation of the apparatus should be designed to cause the least number of actuations of the plunger and hence to remove that class of objects conforming to a certain color or colors which has the least number.

Apparatus of the character described is entirely automatic in its operation and is accurate of selection. The speed of operation depends on many factors including the speed of rotation of the disc and the facility with which the electromagnet or other selecting mechanism may be operated, also the efficiency of the device which distributes the objects on the disc. It is evident that the presentation of the objects to the light beam may be accomplished in many ways and at various speeds of operation depending upon the size and nature of the objects handled, as well as the amount of color variation present. For example, a system of conveyor belts moving at different velocities upon which the objects are carried and spaced, may sometimes be used to advantage.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. Means for automatically selecting beans of a predetermined color from an assortment of coffee beans of various colors, said means comprising a source of light and a pair of parallel connected photo-electric tubes arranged on opposite sides of the light beam, means comprising a rotatable disc for presenting the beans individually to the light beam whereby the light reflected from opposite sides of each bean is caused to impinge upon the respective photo-electric tubes and whereby photo-currents having amplitudes which vary in accordance with the light reflecting powers of the respective surfaces are generated, guides for normally directing each bean toward a receiving hopper after being subjected to the light beam, an arc discharge device having a grid connected to the photo-electric tubes in cascade relation, an alternating current circuit for energizing each of the photo-electric tubes and the grid of the arc discharge device being normally biased to prevent an arc discharge from forming except when a bean is presented to the light whose light reflecting power is different than a predetermined amount and means connected in the output circuit of the arc discharge device and responsive to the arc discharge for automatically rejecting beans whose color fails to conform to the standard color, said means comprising an electromagnetic device provided with a plunger armature which is adapted to push a bean whose reflecting power differs by a predetermined amount from the standard out of the normal direction of travel which leads to the receiving hopper.

2. Means for automatically selecting beans of a predetermined color from an assortment of coffee beans of various colors, said means comprising a source of light and a pair of parallelly connected photo-electric tubes arranged on opposite sides of the light beam, means comprising a flat rotatable disk for presenting the beans individually to the light beam whereby the light reflected from opposite sides of each bean is caused to impinge upon the photo-electric tubes and whereby photo-currents having amplitudes which vary in accordance with the light reflecting powers of the respective surfaces are generated, said beans resting directly on the flat portion of the disk, guides for normally directing each bean toward a receiving hopper after being subjected to the light beam, a thermionic relay having a grid connected to the photo-electric tubes in cascade relation, a common energization supply for the photo-electric tubes and the relay, the grid of the relay being normally biased to prevent flow of space current through the relay except when a bean is presented to a light beam whose light reflecting power is different than a predetermined amount and means connected in the output circuit of the relay and responsive to the space current for automatically rejecting the beans whose color fails to conform to the standard color, said means comprising an electromagnetic device provided with a plunger armature which is adapted to push a bean whose reflecting power differs by a predetermined amount from the standard out of the normal direction of travel which leads to the receiving hopper.

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