Aug. 8, 1933. E. H. BICKLEY 1,921,862

AUTOMATIC SORTER

Filed Dec. 31, 1928 2 Sheets-Sheet 1

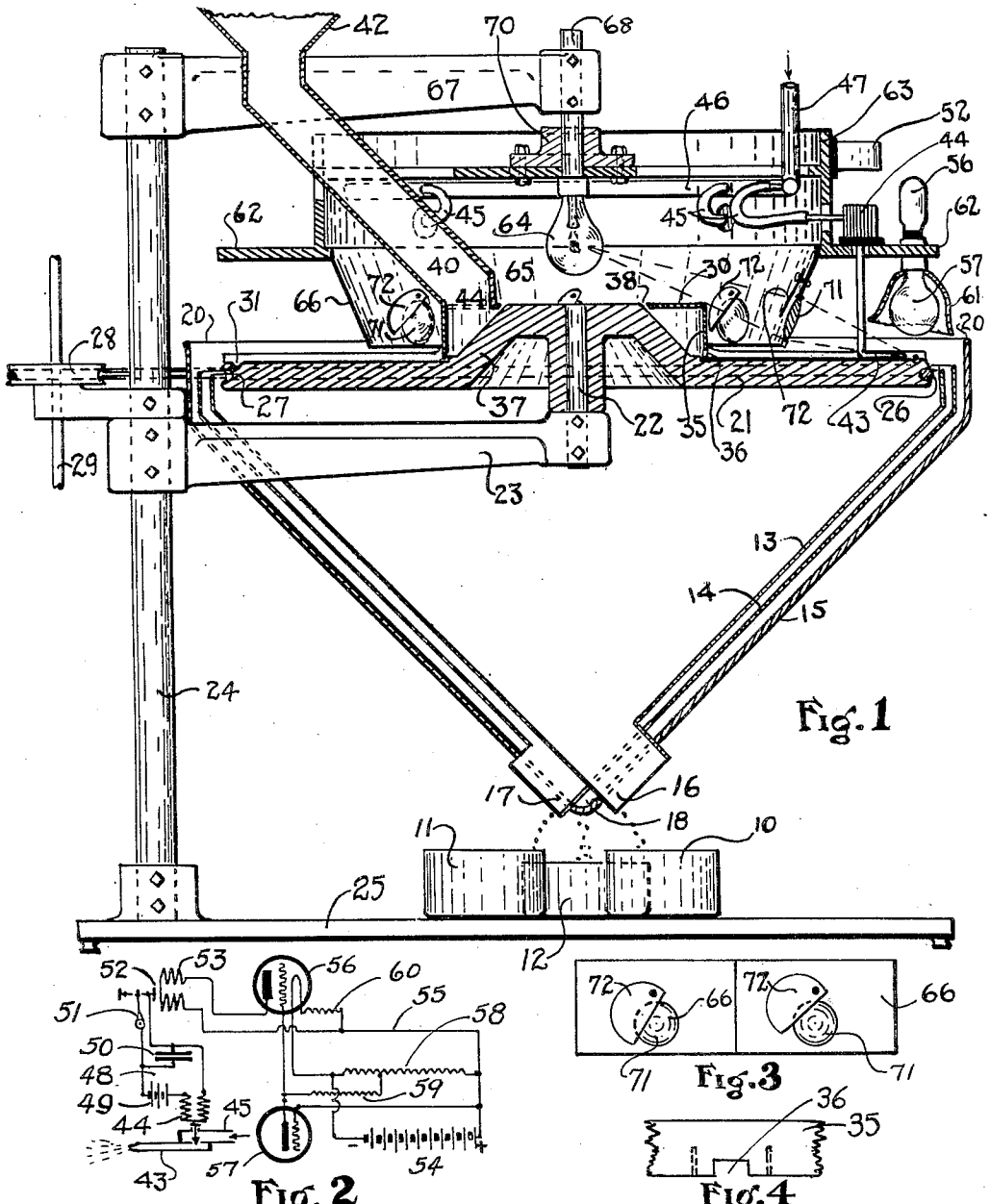



Fig. 1




Fig. 2




Fig. 3




Fig. 4

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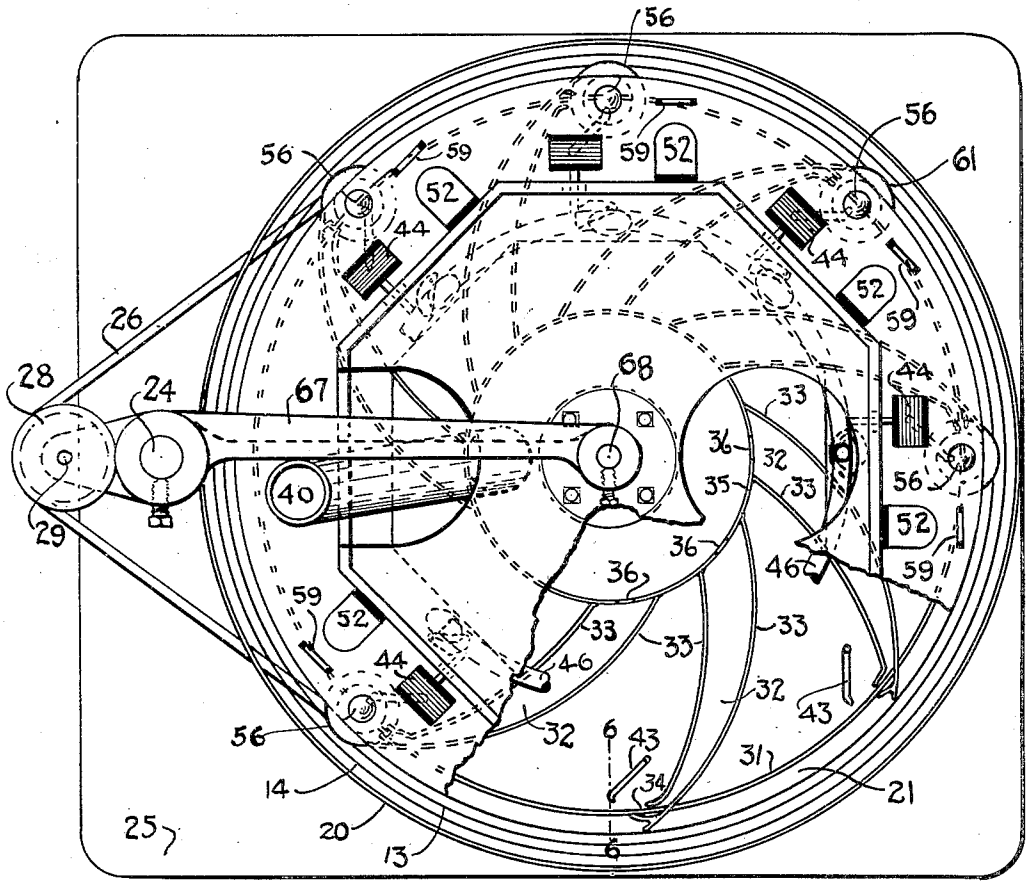



Fig. 5

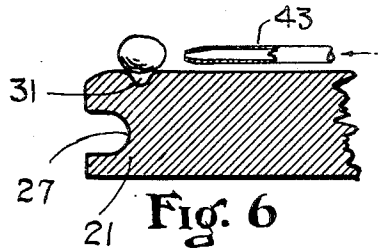



Fig. 6

INVENTOR.

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# UNITED STATES PATENT OFFICE

1,921,862

## AUTOMATIC SORTER

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26 Claims. (Cl. 209—111)

The present invention relates to a sorting machine and more particularly to a machine for automatically sorting objects by variation in color.

Some of the objects of the present invention are to provide a machine for automatically sorting and grading objects by color; to provide a sorting machine automatically sensitive to variations of color; to provide a sorting machine capable of sorting objects of different color and different shades of the same color with extreme rapidity and accuracy; to provide a machine wherein a plurality of objects of varying color are fed in succession at high speed past a light sensitive device whereby those objects of the same color are automatically delivered to the same receptacle while objects of different color are delivered to a different receptacle or receptacles; to provide means including a photoelectric cell for automatically sorting objects, such as beans, peas, corn, rice, oranges, lemons and any other objects which are to be graded according to color variations; and to provide other improvements as will hereinafter appear.

In the accompanying drawings Fig. 1 represents a side elevation in part section of a sorting machine embodying one form of the present invention; Fig. 2 is a diagram of the preferred control circuits; Fig. 3 represents a detail in elevation of a portion of the lens mechanism; Fig. 4 represents a detail of the discharge member; Fig. 5 represents a plan, partly broken away, of the machine; and Fig. 6 represents a section of line 6—6 of Fig. 5.

Referring to the drawings, one form of the present invention is shown as applied to the sorting or grading of beans and removal of foreign matter by the variations in the color, the sorted beans being delivered in the present instance by the machine to three receptacles 10, 11 and 12 of which receptacle 10, for example, receives the dark colored or poor grade of beans and foreign matter, and the receptacles 11 and 12 receive the better grade of beans.

For delivering the sorted beans to the receptacles, three funnel-shaped collectors 13, 14 and 15 are provided in nested spaced relation which communicate respectively with outlets 16, 17 and 18 discharging respectively into the receptacles 10, 11 and 12. Additional collectors may be provided if more grades are desired. The outer collector 15 has its circumferential top portion of greater depth than the same portion of the other two collectors in order to form a boundary wall 20 in the path of the ejected beans.

In order to bring the beans to the point of delivery to the collectors and where the light sensitive mechanism can focus upon each bean, a table 21 of circular shape and preferably black or of dark colored material is provided to rotate concentrically within the mouth of the funnel member 13, the relative position being such that the bean receiving top of the table 21 lies in a plane preferably slightly above the plane of the inlets to the collectors 13 and 14. This table 21 is axially journalled upon a vertically disposed pin 22 fixed to an arm 23 carried by a standard 24 which rises from a base 25 serving as a support for the receptacles 10, 11 and 12. Motion is transmitted to the table 21 by a belt 26 riding in a circumferential grove 27 and receiving its rotary motion from a pulley 28 fixed to a shaft 29 which is driven from any suitable source. The motion of the table 21 serves to radially feed the beans from an auxiliary magazine 30 to a groove 31, formed circumferentially of the table top and in relatively close proximity to the outer edge thereof, by means of one or more ways 32. As here shown, the machine is provided with seven such ways, each formed by two outwardly converging upstanding guides 33 which converge to an outlet 34 in vertical alinement with the groove 31 and have their origin in the circumferential wall 35 of the auxiliary magazine 30. This wall 35 is provided with a plurality of discharge ports 36 about its lower marginal edge, each of which forms a passage connecting the interior of the magazine 30 with one of the ways 32, and it should be noted that these ports 36 are of a suitable size to permit a number of beans at a time to leave the magazine 30 and enter a way 32. The beans are automatically brought to a circumferential position and introduced through the ports 36 by providing the table 21 with an upwardly projecting hub 37 having a basal portion of the diameter slightly less than the internal diameter of the magazine 30 and from which portion the hub extends in the form of a truncated cone to its top or smaller diameter which in this instance is freely rotatable within a coaxial opening 38 in the top of the magazine 30.

For feeding the beans to the magazine 30, a delivery chute 40 is secured to the top of the magazine 30 and communicates with the interior thereof by means of a port 41. The chute 40 is preferably outwardly inclined to bring its receiving end to one side of the machine where it is in communication with a hopper 42 which

is filled with a supply of beans. Thus as the beans leave the chute 40 and enter the magazine 30 they encounter the rotating cone-like hub of the table 21 and are caused to move around the magazine 30 substantially filling it, the ports 36 will continually discharge a flow of beans into the way 32 opposite to that particular port 36, the rotation of the table 21 then causes the beans to travel along between the converging guides 33 working the beans into single file by the time they finally pass out of the outlet 34 and rest in the groove 31. The beans are now in position for inspection by the automatic sorting mechanism forming part of the present invention, and in the present machine for purposes of increased rapidity of sorting a plurality of sorting units are provided, and since each of these is a duplicate of the others this description will be confined to a single unit and like parts of all units given the same identifying reference numeral.

In order to discharge a bean from the groove 31 to either the collector 13, 14 or 15, a compressed air mechanism is provided including an ejector pipe 43, the nozzle of which opens radially outward and lies in the plane of a bean in the groove 31 while its end terminates in close proximity to the inner side of the bean. The inlet end of the ejector pipe 43 terminates in an electro-magnetic valve 44 which controls the admission and cutting off of air from a flexible pipe 45 which is in communication with a manifold 46 which is connected to the main air supply pipe 47 through which air under pressure is supplied from a suitable air compressor not shown. For controlling the opening and closing of the valve 44, the winding of the valve is included in an electric circuit 48 including a source of current 49, a condenser 50, and a switch 51 controlled by a relay 52. The winding 53 of the relay 52 is energized by current from a battery 54 in a circuit 55 including a thermionic valve 56 whereby the current is duly amplified for the purpose of operating the relay 52 and the strength of this current is controlled by a photo-electric cell 57 included in the circuit. A resister 58 serves as a means for providing a negative bias for the thermionic valve 56 and the resister 59 limits the current in the photo-electric cell 57 and a fixed filament resistance 60 is provided for the thermionic valve 56. It will thus be evident that variations in the light to which the photo-electric cell is exposed will cause variations in the resistance of the circuit including the relay 52 and such variations will therefore cause the switch 51 to remain closed for different time periods, these time periods being infinitesimally small owing to the feeding rapidity of the beans which pass across the path of the cell 57. As here shown, the cell 57 is enclosed by a light absorbing casing 61 and each is suspended from a fixed annular flange 62 forming a horizontal extension of a fixed cylindrical head 63. The bottom of the casing 61 is open at a point above the groove 31 so that a bean located in the groove will be in the line of sight of the photo-electric cell 57.

As a means of illuminating each bean as it passes beneath the cell 57, an electric lamp 64 is mounted coaxially with the table 21 within the chamber 65 formed by the head 63 and by the lower annular converging wall 66 of the same. The lamp supporting means consists of an arm 67 attached to the standard 24 and receiving a post 68 to which the hub portion 70 of the head 63 is attached. The location of the lamp 64 is such that the rays of light emanating therefrom are directed through a condensing lens 71 so that the rays are directly focused upon the bean in the groove 31. The lens may be colored to have a filtering effect on the light, if desired. In order to vary the intensity of the beam of light passing through the lens 71 an adjustable shutter 72 is provided which may be swung to a position intercepting more or less of the light rays. When operating, the machine is protected from excessive exterior light.

In the operation of the machine the hopper 42 is filled with beans which travel by way of the chute into the auxiliary magazine 30, and since the table 21 is in motion the conical feeding head will cause the beans to substantially fill the magazine 30 and to travel circumferentially around within the magazine and abutting the inner wall thereof. The beans will feed through the ports 36 automatically and into the way 32 on the table 21 where they are delivered in single file to the groove 31 near the edge of the table. Since there are a plurality of the ports 36 and feeding ways, the groove 31 will have several series of beans located in it, each series passing beneath its light sensitive cell 57. As each bean intercepts the beam of light from the lamp 64, it will be viewed by one of the photo-electric cells 57, and if the color of the bean is that of a good bean the ionization of the cell 57 will be so varied as to cause the relay circuit 52 to be closed for a fraction of a second and sufficient to cause the discharge pipe 43 to emit a strong puff of air so that the bean is blown out of the groove 31 and drops into the collector 15 where it is received in the receptacle 12. In case the color of the bean however is slightly darker, the ionization of the cell 57 will be subject to a different variation such as to cause the relay 52 to hold the circuit of the electro-magnet 47 open a fraction as and thus emit a weaker puff of air so that the bean is expelled only beyond the collector 13 and enters the collector 14 from which it is dropped into the receptacle 11.

In case a piece of foreign matter or discolored bean, broken bean, mouldy, diseased or blighted bean comes under the photo cell, the relay does not operate at all and the piece remains in the groove until it is scraped off into the collector 13 by the next succeeding guide 33 and discharged into the container 10.

In order to set the machine for any particular quality of a "good" bean and to accommodate differences in photo-cells, the shutters 72 are individually adjusted to vary the intensity of the beam of light from the lamp 64 until each sorting element works uniformly according to the sorting desired.

While in the foregoing, particular reference has been made to the sorting of beans, it is to be understood that this term is generic in scope and not to be taken as limiting the machine in any way to the specific object here sorted by way of example.

On account of the shape, size and color of beans, and in consideration of the character of the imperfections, the machine is designed to operate at a maximum with a maximum of light reflective power, the beans resting on a dark background. For other objects or materials, it might be desirable or necessary to reverse any of these elements, that is, have the relay close the circuit (instead of open) when the light in-

tensity drops, and have the objects examined resting on a white or other colored background, (rather than a black or dark colored surface) or even be inspected by the photo cell during a free fall, without departing from the scope of my invention.

By directing the beam of light high, only objects exceeding a certain size will be selected, and where objects are of uniform color, the device will automatically sort according to size.

By varying the color of the background, the color and adjustment of the light, the composition and construction of the photo-cell, setting of relay and pressure of the air, the height of the edge of the collector, and the number of collectors, many different kinds of sorting may be accomplished.

Where the word "color" is used in the foregoing, it is to be interpreted with a generic meaning because in the present invention it comprehends variations of hue and shades of the same generic color, and it is to be understood that the automatic sorting can equally as well segregate like shades of any color as well as like colors themselves.

Having thus described my invention, I claim:

1. In a sorting machine, an alining support provided with means for restricting lateral motion of objects to be sorted, a device for feeding said objects to said alining support, a distributing means cooperatively arranged with respect to said support to arrange said objects in spaced single file on said support adjacent to said restricting means for sorting, and means including a photoelectric cell for automatically sorting said objects whereby all objects of like color are collected together.

2. In a sorting machine, a photo-electric cell, means for rendering said cell operative, a device for feeding objects past said cell, a means for ejecting energy cooperatively associated with said feeding means, including variable means controlled by said photo-electric cell, the energy of said ejection being proportioned by the color of said objects.

3. In a sorting machine, the combination of a photo-electric cell, and means for ejecting a fluid medium, including variable means actuated by said cell for controlling the ejection of the fluid medium to automatically segregate objects according to variations in the color thereof.

4. In a sorting machine, the combination of a photo-electric cell, and means for ejecting a fluid medium, including variable means, actuated by said cell for controlling the ejection of the fluid medium to automatically segregate objects according to their light reflecting characteristics.

5. In a sorting machine, the combination of a photo-electric cell, means rendering said cell operative, a conveyor arranged to feed objects successively past said cell, means for reflecting light from each object to said cell, a compressed air ejecting device, and means responsive to said photo-electric cell for controlling the ejections of air by said ejecting device according to variations in the color thereof.

6. In a sorting machine, the combination of a photo-electric cell, means rendering said cell operative, a conveyor arranged to feed objects successively past said cell, means for reflecting light from each object to said cell, a compressed air ejecting device, means responsive to said photo-electric cell for controlling the ejections of said ejecting device according to variations in the color of the objects, to segregate the objects according to the variations of color, and an automatic control connection with photocell and last said means for varying the operation of said ejecting device.

7. In a sorting machine, the combination of a rotatable table having a groove therein, a hopper arranged to feed objects to said table, means for guiding said objects one at a time to said groove, a lamp, means for focusing a beam of light from said lamp on a point in said groove, a photo-electric cell arranged to receive the reflected beam from an object, a device for ejecting said objects from said groove, and means controlled by said photo-electric cell for actuating said ejecting device in a predetermined manner whereby said objects are segregated according to color.

8. In a sorting machine, the combination of a rotatable table having a groove therein, a hopper arranged to feed objects to said table, means for guiding said objects one at a time to said groove, a lamp, means for focusing a beam of light from said lamp on a point in such groove, a photo-electric cell arranged to receive the reflected beam from an object, a mechanism for discharging compressed air to blow said objects out of said groove and off of said table, and means controlled by said photo-electric cell for varying the discharge of said air according to color variations of said objects, whereby said objects are segregated according to color.

9. In a sorting machine, the combination of a light sensitive element, means for feeding objects into an illuminated position with respect to said light sensitive element, and an air nozzle and valve means connected with the nozzle and operated by said light sensitive element for segregating said objects according to their respective color.

10. In a sorting machine the combination of a light sensitive element, means for feeding a plurality of objects into operative association with said element to cause variations thereof corresponding to variations of color of said objects and fluid nozzle segregating device, a means for creating a movement of fluid in said nozzle simultaneously responsive to the action of said sensitive element for sorting said objects according to color.

11. In a sorting machine for beans and the like, with a pneumatic segregating device including an electrically controlled valve, in combination a photoelectric cell, a thermionic valve adapted to receive signals from said photoelectric cell, a source of electric potential energizing said cell and valve, and means cooperating with said photoelectric cell and thermionic valve whereby electric signals from said photoelectric cell cause variations in the plate current of said thermionic valve for energizing said valve to operate pneumatic segregating device.

12. In a sorting machine, a means for focusing a beam of light at a point, a photoelectric cell adapted to receive light from an object located at the said point, an air nozzle and means for creating a movement of fluid in said nozzle actuated by said cell in accordance with the light received by said cell to automatically segregate objects according to the variations in color thereof.

13. In a sorting machine, a means for focusing a beam of light at a point, a photoelectric cell adapted to receive light from objects located at the said point, an air nozzle and means for

creating a movement of fluid in said nozzle actuated by said cell in accordance with the light received by said cell to automatically segregate objects according to their light reflecting characteristics.

14. In a sorting machine in combination a feeding member, a distributing member associated with said feeding member to give increasing space between objects to be sorted, an alining means cooperatively associated with said distributing member, means for actuating the distributing members so as to present said objects to a light sensitive element in single file for color sorting, and means actuated by said light sensitive element for automatically sorting objects according to their light reflecting surfaces.

15. In a sorting machine in combination, a light sensitive element, a feeding member, a distributing member associated with said feeding member and light sensitive element and an alining element cooperating therewith to separate the objects on the said distributing member to form an alined series on said distributing member for exposure to the said light sensitive element and means actuated by said light sensitive element to segregate objects fed by said feeding member in accordance with markings on the surface of said objects.

16. In a sorting machine, a light sensitive element, a movable alining support provided with means for restricting lateral motion of objects to be sorted cooperatively associated with said light sensitive element, a device for feeding said objects to said support, a positioning means cooperatively associated with said support to arrange objects so that all objects present substantially the same surface to light sensitive element, and ejecting means controlled by said light sensitive element for segregating objects according to their light reflecting characteristics.

17. In a sorting machine a light sensitive element, a movable support provided with means for restricting lateral motion of objects to be sorted cooperatively associated with said light sensitive element, a device for feeding said objects to said support, a positioning means cooperatively associated with said support and feeding means to arrange objects within said restricting means so that all objects present substantially the same surface to said light sensitive element and ejecting means controlled by said light sensitive element for segregating objects according to their light absorbing characteristics.

18. In a sorting machine a color sensitive element, means for continuously moving objects to be sorted cooperatively associated with said color sensitive element, a device for feeding said objects to said support, a positioning means cooperatively associated with said means, a fluid ejecting device and means for creating a movement of fluid thru said device controlled by said color sensitive element for sorting objects according to color.

19. In a sorting machine in combination a movable support for objects to be sorted, a feeding and distributing means cooperating with said support for arranging objects in single file on said movable support, adjustable means for directing a beam of light on an object on said support, a photoelectric cell, and an air nozzle sorting means associated with the photoelectric cell acting on said objects and positioned with reference to said movable support to selectively segregate said objects according to variations in size.

20. In a sorting machine a moving support, guiding means cooperating with said support for separating and feeding objects at increasing speed, alining and arranging said objects so that all objects occupy the same relative position in single file on said support and means including photoelectric cells for automatically sorting said objects while in said position whereby all objects of like color are collected together.

21. In a sorting machine, a photo-electric cell, means for rendering said cell operative, means for feeding objects past said cell, a means for ejecting energy located adjacent said feeding means and said cell, valve means for controlling the ejections of said ejecting means, a circuit connecting said photo-electric cell and said valve, to actuate said valve in accordance with the color of objects presented to said cell.

22. In color sorting apparatus, the combination of a light source and a cooperating light-sensitive member whose resistance changes in accordance with the degree of light activation, means for presenting a plurality of objects to be sorted according to color individually to the light beam whereby light is reflected by each object in a degree according to its color onto the light sensitive member, the normal direction of travel of the objects being toward a receiving compartment, means for energizing the light sensitive member and means responsive to changes of current in the same light-sensitive member for diverting an object away from the normal path when its light reflecting power is different from a predetermined standard, said last mentioned means comprising a chamber containing air under pressure, a valve mechanism in said chamber for releasing the air as a jet which strikes the object whose direction is to be diverted, means whereby the pressure of the compressed air on the valve mechanism is counter-balanced, and means for operating the valve when the light reflecting power of the object presented to the light beam is different from the said predetermined amount.

23. In color sorting apparatus, the combination of a light source and a cooperating light-sensitive member whose resistance changes in accordance with the degree of light activation, means for presenting a plurality of objects to be sorted according to color, individually to the light beam whereby light is reflected by each object in a degree according to its color onto the light-sensitive member, the normal direction of travel of the objects being toward a receiving compartment, means for energizing the light-sensitive member and means responsive to changes of current in the said light-sensitive member for diverting an object away from the normal path when its light reflecting power is different from a predetermined standard, said last mentioned means comprising a source of compressed air, a device for releasing the air as a jet which strikes the object whose direction is to be diverted and electromagnetic means for actuating the air releasing device when the light reflecting power of an object is different from the said predetermined standard.

24. In a sorting apparatus, the combination of a conveyor, an air nozzle disposed to discharge across said conveyor, a valve for said nozzle, an electro-magnet for opening said valve, a photo-electric cell focused on said conveyor in the path of the air discharged from said nozzle and a control means for said electro-magnet operatively associated with said photo-electric cell.

25. In a sorting machine, the combination of a rotary table, a hopper arranged to feed objects to said table, a light source directing a beam of light at a point over said table, guiding means disposed over said table, the latter cooperating with said guiding means to direct said objects therealong one by one in spaced relation so as to present said objects successively for illumination by said beam, a photo-electric cell arranged to receive the beam reflected from said objects, means actuated by said photo-electric cell for selectively deflecting said objects from their path to discharge the same into one receptacle, and guiding means to sweep into another receptacle those objects which are not selected by said photo-electric cell.

26. In a sorting machine, a light sensitive element, a means for continuously moving objects to be sorted cooperatively associated with said light sensitive element, a device for feeding said objects to said means, a fluid ejecting device and means for creating a movement of fluid thru said ejecting device controlled by said light sensitive element for segregating objects according to markings on the surface of said objects.

EVERETT H. BICKLEY.