

Nov. 6, 1934.

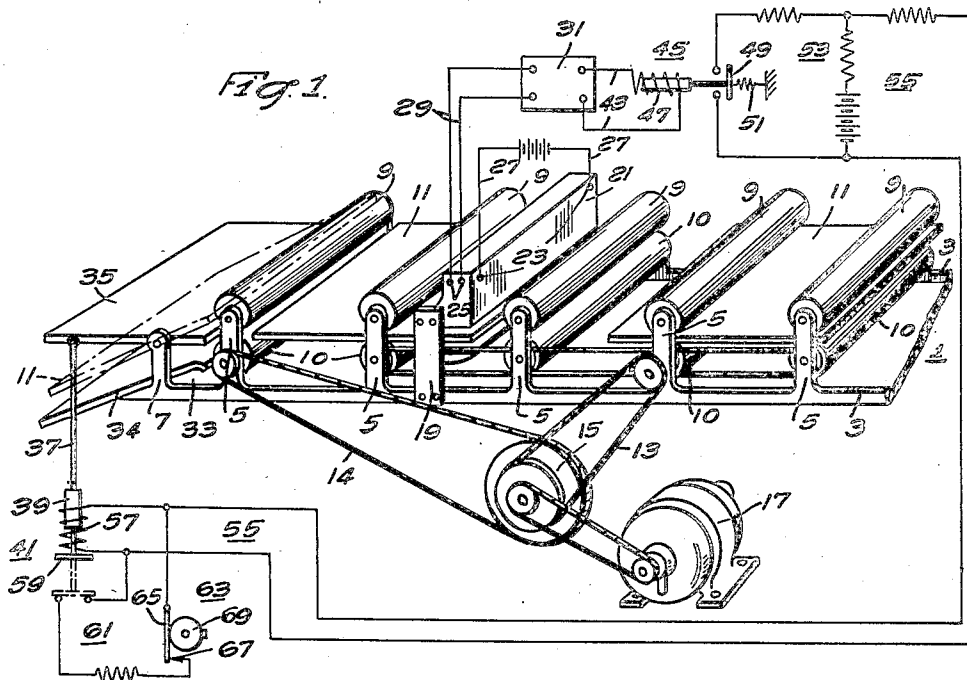
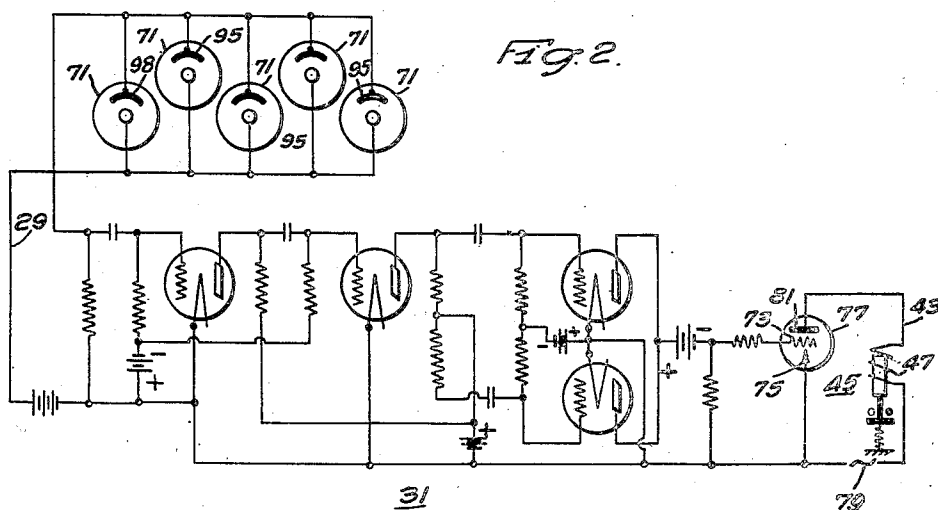
V. K. ZWORYKIN

1,979,722

SORTING APPARATUS

Filed July 30, 1930

3 Sheets-Sheet 1



INVENTOR:

Vladimir K. Zworykin.

BY
Charles E. Bass
ATTORNEY

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3 Sheets-Sheet 2

Fig. 3.

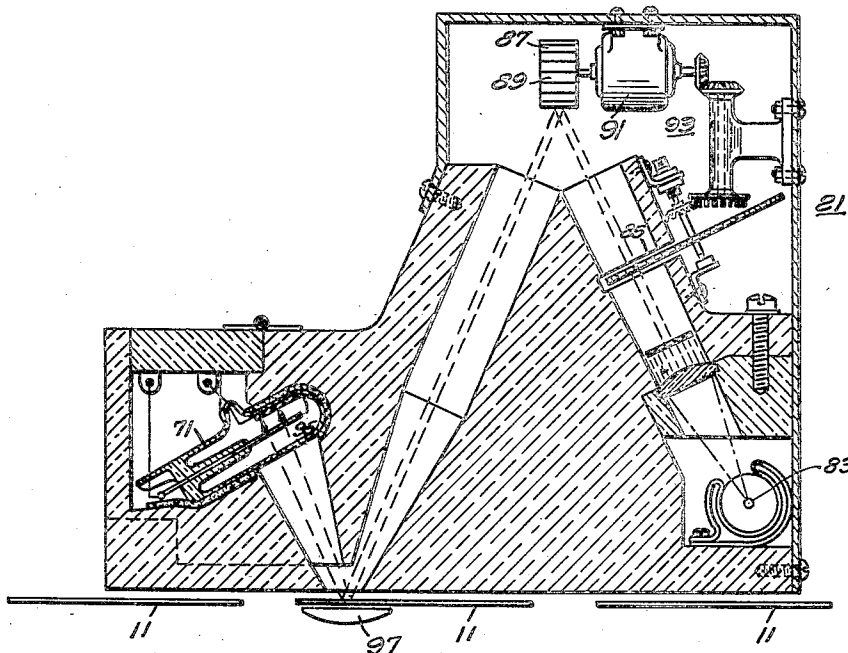


Fig. 5.

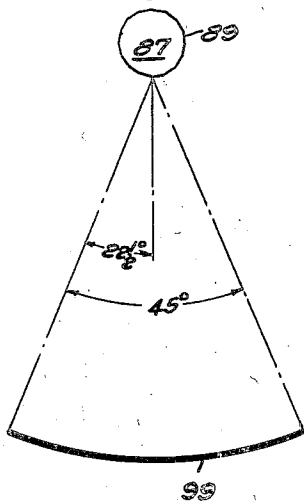
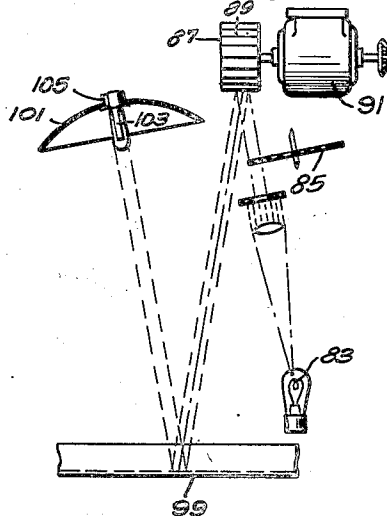


Fig. 4.



INVENTOR

Vladimir K. Zworykin.

BY *Herbert F. Carr*
ATTORNEY

UNITED STATES PATENT OFFICE

1,979,722

SORTING APPARATUS

Vladimir K. Zworykin, Collingswood, N. J., assignor to Westinghouse Electric & Manufacturing Company, a corporation of Pennsylvania

Application July 30, 1930, Serial No. 471,668

5 Claims. (Cl. 209—111)

My invention relates to article-sorting apparatus and has particular relation to photo-sensitive sorting systems.

Photo-sensitive sorting apparatus constructed and operated according to the teachings of the prior art, with which I am familiar, comprises a source of light, to the radiations from which the articles which are sorted are exposed. The light, reflected from the articles, or transmitted through the articles, impinges on the cathode of a photo-sensitive cell. The cells are so disposed in the circuit of an amplifying system that an inhomogeneity in the specular surface of the article, that is under test, causes the system to respond by actuating a relay that regulates the course of the defective article.

It often happens that the articles under test have an elongated geometric structure and, consequently, when they are undergoing a test in a photo-sensitive system, the surface of the article that is under immediate observation must be illuminated by an elongated beam. To attain the length of beam desirable, it has been customary, according to the teachings of the prior art, to utilize an elongated source of light or a cylindrical lens system.

One type of sorting apparatus that, in particular, comes under this category is commonly known as plate-sorting apparatus. As the designation indicates, apparatus of this type is used to separate plates, having various properties, from each other, and is, therefore, a rather widely used article-sorting apparatus.

One of the principal disadvantages associated with the above-described sorting apparatus is particularly evident when the apparatus is utilized for sorting elongated objects, such as plates. It is ordinarily difficult to provide a source of light having the characteristics that are necessary to adapt it for illuminating an elongated surface. The utilization of a comparatively narrow source of light, in combination with a cylindrical lens system, is, under ordinary circumstances, a rather expensive matter, and, in addition, is inefficient and provides a rather weakly illuminated surface, unless the source of light has comparatively high intrinsic brightness.

Another and more notable disadvantage of equipment of the above-mentioned type resides in the fact that the light emitted to the photo-sensitive device originates at all points of the surface of the article that is under test. Consequently, the effect produced on the photo-sensitive device by a decrease in the illumination arising from a heterogeneity in the surface of a

test article is rather small. In experimenting with apparatus of this type, I have experienced considerable difficulty in obtaining the desired effects and have found a satisfactory system of this type is substantially out of the question.

It is, accordingly, an object of my invention to provide photo-sensitive sorting apparatus wherein only the illumination immediately affected by a point on the surface of an article under inspection shall impinge on a photo-sensitive device.

An additional object of my invention is to provide article-sorting apparatus wherein a simple light source and a simple lens system are utilized.

Another and more specific object of my invention is to provide sorting apparatus for treating articles of an excessively elongated geometric structure.

A further specific object of my invention is to provide sorting apparatus for treating articles of an elongated geometric structure wherein the illumination is supplied by substantially a point source.

A still further specific object of my invention is to provide sorting apparatus for treating articles of an elongated geometric structure wherein the ordinary spherical lenses and reflectors are utilized in the optical system.

Still another specific object of my invention is to provide sorting apparatus, for the treatment of elongated objects of a type wherein the photo-sensitive surface presented to the radiations emanating from the objects under test is attenuated in the direction of the length of the objects.

An ancillary object of my invention is to provide apparatus for sorting subdivisions of an article.

More concisely stated, it is an object of my invention to provide article-sorting apparatus of a simple and inexpensive structure that has universal adaptability and high sensitivity.

According to my invention, I provide a sorting system of a type wherein the article that is treated is scanned by light emanating from a source and converged on the optical plane of a scanning device. The resultant light emitted from the test article impinges on the cathode of a photo-electric cell that is adapted to effect a change in the condition of the exciting elements of a relay when an inhomogeneity is present in the immediate portion of the surface of the article under observation. The mechanical parts of the relay are so related to the parts of

the apparatus motivating the article under test that the future course of the article is dependent on the condition of the exciting element thereof.

According to a modification of my invention, 5 apparatus is provided for the sorting of subdivisions of an article wherein the complete article is subjected to the influence of the scanning device and is marked at points, corresponding to regions wherein its surface is not homogeneous, in such manner that the subdivision 10 containing the inhomogeneity may be separated from subdivisions having completely homogeneous surfaces.

It is to be noted, that in apparatus constructed 15 according to my invention, the light that impinges on the photo-sensitive device at any given instant comes from only one spot in the surface of the article that is inspected and not from all points on the surface.

20 The novel features that I consider characteristic of my invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof, will best 25 be understood from the following description of specific embodiments, when read in connection with the accompanying drawings, in which:

Figure 1 is a view, in perspective, showing a 30 preferred embodiment of my invention,

Fig. 2 is a schematic view showing the amplifying system utilized in apparatus of the type shown in Fig. 1,

Fig. 3 is a view, in section, showing the principal elements of apparatus of the type shown 35 in Fig. 1,

Fig. 4 is a schematic view, in front elevation, showing the principal elements and the arrangement of apparatus constructed and operated according to a modified embodiment of my invention, 40

Fig. 5 is a view, in end elevation, of certain elements of the system shown in Fig. 4, and

Fig. 6 is a view, in perspective, of a second 45 modification of my invention.

The apparatus shown in Fig. 1 comprises a frame 1, of substantially transverse C-section, the flanges 3 of which are equipped with a plurality of ears 5 and 7, between which a plurality of rollers 9 and 10 are rotatably supported. The ears 5 are mounted in pairs on 50 the frame 1, and each pair of ears supports two rollers axially separated from each other by such distance that a plate 11, under test, is capable of passing between them. 55

The lower rollers 10 are belted together and certain of them are driven, through belts 13 and 14, from a system of pulleys 15 that is, in turn, belted to a prime mover 17. The test plate 11, 60 disposed between the rollers 9 and 10, makes contact with both sets of rollers and is advanced as the lower set is rotated by the system of belts.

A bracket 19 is fastened to the base plate 1, between two sets of rollers, and has fixed thereon 65 an enclosure 21, wherein are disposed the elements of a photo-sensitive system, as will be explained hereinafter.

The enclosure 21 is equipped with a plurality of openings 23 and 25 through which the necessary leads 27 and 29, for supplying power to the elements disposed therein, and for impressing the output of the photo-sensitive devices disclosed therein on an amplifying system 31, 70 are connected to the necessary points.

A slot 33 is milled near one end of the base 75

plate 1, and two guide plates 34 and 35 are disposed adjacent thereto. The former plate 34 is fixed in an inclined position in the slot 33, while the latter plate 35 is pivotally mounted between 80 the pair of ears 7, projecting from the section of the flanges 3, adjacent to the slot. The test plates 11 are fed, by the drive rollers 9 and 10, into the channels provided by the guide plates 34 and 35, and the angular position of the plate 35 predetermines the course that the test plate 11 85 takes. If the plate 35 is in a horizontal position, the test slab 11 is projected, over its surface, into one container while, if it is in an inclined position, (as indicated by the broken lines in Figs. 1 and 6) the slab 11 is projected between 90 it and the lower guide plate 34.

The guide-plate 35 is automatically pivoted by a rod 37 rigidly fastened to the movable core 39 of a relay 41, the electro-magnetic condition of which depends upon the condition of the amplifier 31 associated with the photo-sensitive eye, 95 whereby the plates 11 are scrutinized. Under normal circumstances, the guide plate 35 is in a horizontal position. When, however, an optical heterogeneity comes under the scrutiny of the photo-sensitive inspection device 21, the current 100 in the output circuit 43 of the amplifier 31 is increased. A relay 45, the exciting coil 47 of which is disposed in the circuit 43, is energized and a contactor 49, associated with the relay 45, is urged, against the action of a tension spring 51, attached thereto, to close a circuit 53, in parallel with the circuit 55 which contains the exciting coil 57 of the relay 41, whereby the guide-plate 35 is motivated. The current through the 110 exciting coil 57 of the guide-plate relay 41 is thus decreased, and the core 39 drops, moving the plate 35 from its horizontal position to its inclined position and thus providing for the passage of the plate 11 to the receptacle provided 115 for the defective articles.

It is to be noted, however, that the contactor 49, motivated from the output circuit of the amplifier 31, is closed only for the instant during which the heterogeneous spot passes under the 120 scrutiny of the photo-sensitive device, and, consequently, a lock-in must be provided in the exciting circuit of the guide-plate relay 41.

For this reason, the guide-plate relay 41 is equipped with a contactor 59 that closes an impedance circuit 61, shunting the exciting coil 57 of the relay 41, and thus provides for the maintenance of the current through the exciting coil 57 of the relay 41 at the low level required. 125

To provide for the return of the guide-plate 35 to its normal position, a switch 63, comprising a resilient member 65, a fixed contact 67 and a rotating cam 69 for disengaging the member 65 from the fixed contact 67, is added in the impedance circuit 61 to shunt the exciting coil 57, of the guide-plate relay 41. The motion of the rotating cam 69 is synchronized with the movement of the plates 11 in such manner that the guide-plate 35 is always tilted to a horizontal position just after a defective slab has 130 passed thereunder. 135

In Fig. 2, the electrical circuit associated with the system is illustrated.

The current from a system of photo-cells 71, connected in parallel and arranged in staggered 145 relation to each other, for reasons that will be explained hereinafter, feeds into the resistance-coupled amplifier 31 of a type well known to those skilled in the art. The output voltage of the amplifier 31 is impressed between the control 150

electrode 73 and the anode 75 of a grid-glow tube 77. The tube 77 is excited from an alternating-current source 79, and its cathode 81 is connected to its anode 75 through the exciting coil 47 of the relay 45, that initiates the motivation of the mechanical elements of a sorting system, and through the source 79.

Under ordinary circumstances, at least one of the cells 71 is in a state of excitation, and the grid-glow tube 77 is, therefore, unexcited. However, if the impedance of the cells is increased by reason of the fact that the light impinging thereon is decreased, the drop in potential between the control electrode 73 and the anode 75 of the grid-glow tube 77 is decreased, and a discharge through the tube 77 is initiated. The relay 45, associated with the tube 77, is then energized, and the circuit 53 shunting the exciting coil 57 of the guide-plate relay 41 is closed, thus causing the plate 35 to be moved to its angular position.

In Fig. 3, the essential elements of the photo-sensitive scrutinizing system are shown. As can be seen from the view, the elements are all contained in the enclosure 21 supported on the base plate over which the test plates 11 are moved.

The inspection eye comprises a substantially point-source of light 83 the rays from which are interrupted by a light chopper 85, collimated and projected upon the surface of a rotating drum 87 of plane mirrors 89. The light chopper 85 is motivated from the same prime mover 91 as produces the rotation of the drum 87, through a system of gears 93.

As the drum 87 rotates, the mirrors 89 thereon rotate the beam of light which they reflect through a varying angle, the maximum value of which depends upon the number of mirrors on the drum, and may be varied from a small value to 180°, in accordance with the requirements of the article that is under inspection.

The rotating beam of light traverses the width of the test-plates 11 and is reflected to the cathodes 95 of the cells 71, connected in parallel, as has been described.

To eliminate the disturbing effect arising from the interruption in the amplifying current occasioned by the passage of the light between individual cells 71, the cells are arranged in staggered relationship to each other in such manner that the cathodes 95 thereof overlap, as is illustrated in Fig. 2 and has been explained. Under normal circumstances, therefore, uniform pulsations, the frequency of which is regulated by the chopper 85, are fed into the input 29 of the amplifier 31.

The light reflected to a particular cell is decreased when a defective spot in the surface of the test-plate comes under the beam of light reflected to the particular cell at a certain instant. The current feeding into the amplifier is thus decreased, and the relay 45 associated with the amplifier is motivated.

Since, under ordinary circumstances, a space is left between the individual plates 11 that pass before the light beam of the inspection device, a reflector 97 is provided directly below the plates 11 and in such position, relative to the elements of the inspection device, that it reflects the inspection beam into the photo-cells 71 during the intervals between the passage of the plates 11 under the beam.

I have found that, in lieu of the individual staggered photo-sensitive cells 71 that have been

described and illustrated, it is possible to utilize a single photo-sensitive cell with an elongated cathode. When such a cell is utilized, it is of considerable advantage to increase the sensitivity of the system by locating a reflector adjacent to the cells. The reflector is, of course, of an elongated geometric structure but need not necessarily have highly specular properties. It may, in fact, have a surface of an optically diffuse character. Consequently, the problem of providing such a reflector is not at all serious. The feature can apparently be incorporated with considerable facility in the above-described system and lies within the scope of equivalents of my invention.

In Figs. 4 and 5, the principal details of apparatus of a type that can, at times, be applied with less expense than the apparatus discussed above, is illustrated.

It is sometimes rather difficult to provide a plurality of cells such as the cells 71, discussed above, having substantially the same response for a predetermined illuminating excitation. The production of a single elongated cathode having a uniform response over its surface is also not a simple matter. Consequently, apparatus of the type shown in the last-mentioned views, wherein a single small photo-sensitive cell may be utilized, is of considerable interest.

The apparatus shown in these views includes substantially the same elements as the apparatus shown in Figs. 1 and 3. However, in this case, the test plate 99 is deflected along its width and presents a cylindrical surface to the inspection beam. The light reflected from the test-plate 99 is converged thereby in the direction in which it has been spread by the scanning mirrors 89 and the converged beam impinges on a cylindrical or even a spherical reflector 101 of relatively small dimension, whereby it is focused on the cathode 103 of a photo-sensitive cell 105, disposed in the vicinity of the converging region of the rays.

The plates 99, tested in this machine may be of a normally curved structure. However, they may also be deflected by the action of a deflecting member disposed in the vicinity of the inspection system. If, for the further processing of the plates 99, it is desirable that they be plane, provisions must be made for removing the deflection after they have been inspected.

Apparatus for deflecting the plates and for removing the deflection thereof, after inspection, is well known to the art and has, therefore, not been described in detail herein.

Apparatus of the type provided for sorting subdivisions 107 of a slab 109, that is inspected as a unit, is shown in Fig. 6.

The apparatus shown in this view comprises a system of driving rollers 9 and 10, a prime mover 17, an inspection device 21 and an amplifying system 31 similar to the apparatus shown in Fig. 1. In addition, however, the system is equipped with a cutting edge 111 periodically operated, through a centrally pivoted lever 113, from a power-driven pinion 115 to which the lever 113 is joined by a rod 117, eccentrically and pivotally supported on the pinion 115 and reciprocated thereby.

The sheet 109, from which the individual plates 107 are cut, passes under the inspection device 21 before it passes under the cutter 111. If a defect exists in the surface of the sheet, the relay 45 associated with the amplifying system

31 is energized, and a second relay 119 is energized.

The core 121 of the second relay 119 is fastened to an arm 123 controlling the condition of a valve 125, that regulates the flow of an insulating fluid from a container 127, adjacent to the sorting system. Under normal circumstances, the valve 125 is held closed by the action of the arm 123, which is urged to its lowermost position by a compression spring 129 fastened to the core 121. When, however, the exciting coil 131, associated with the core 121, is energized, the valve 125 is opened, and the edge of the test sheet 107 is sprayed with an insulating fluid at a point corresponding to the position of an inhomogeneous condition of the surface.

Adjacent to the cutter 111, and on the opposite side thereof to the inspection device 21, a conducting roller 133 is located to pass over the edge of the plates 107 that have been cut from the plate. The roller 133 is supported on a metallic bar 135 mounted in a dielectric bearing 137 and connected to one terminal of a battery 139 through the exciting coil 57 of a relay 41, similar to the device illustrated in Fig. 1 and described above. The remaining terminal of the battery 139 is connected to the metallic bracket 141 whereon the roller 133 is supported. The bracket 141 is in contact with the plates 107.

Under normal circumstances, the circuit through the battery 139 is completed, and the exciting coil 57 of the relay 41, associated therewith, is energized. However, when an insulated spot comes into contact with the roller 133, the circuit is broken, and the exciting coil 57 is deenergized. The core 39 actuated, by the exciting coil, drops, under gravity, pivoting a guide-plate 35, similar to the plate incorporated in the apparatus of the type shown in Fig. 1, and also closing an auxiliary circuit 61 through a resistor 143 that provides for holding the relay coil 57 in a comparatively deenergized position until the test plate 107 has passed between the guide-plates 34 and 35.

The apparatus shown in Fig. 6, just as the apparatus shown in Fig. 1, is equipped with a switching system comprising a flexible contactor 65 and a rotating cam 69. The latter rotates in synchronism with the movement of the plates 107 and opens the auxiliary circuit through the resistor when a specked test plate has completely passed between the guide-plates 34 and 35, thus preparing the apparatus for the next test-plate. It should be noted that the cam 69 makes one revolution in the interval between the instant when the front end of the test plate 109 moves under and the instant when the rear end of the plate 107 moves out of the enclosure between the plates 34 and 35.

My invention has been shown as applied to a specific form of sorting machine. That it may be applied with equal facility to a sorting machine of any other type is apparent. Its scope should, therefore, not be limited to the specific form described above.

Furthermore, it is well to mention herein, that the type of amplifier that is utilized in the above-described embodiments of my invention is only one of a number of types of amplifiers that may be utilized with success in this connection. Thus relays of magnetic or mechanical types may be employed to multiply the power originating in the photo-electric current; and

the light chopper may be dispensed with in cases where radio-frequency amplifying systems are not desired, or where oscillation generators are used to introduce energy into the amplifier circuits. My invention, therefore, is not to be restricted by the specific form of thermionic amplifier that is shown.

More specifically, it should be remembered that, although I have shown and described a scanning device of the reflection type, any one of a group of well known contrivances of this nature is usable with my invention. For example, an oscillating system of mirrors, particularly, a mirror which oscillates back and forth about its own axis and so causes the scanning beam to have a single point of origin, or to approximate thereto, or a rotating system of lenses may be applied with the same facility as rotating drums of mirrors. My invention, therefore, should not be restricted in its scope to a specific scanning device.

Finally, it should be remembered that, although my invention has been shown as specifically applied to the inspection of opaque articles it is equally as well applicable to inspection of transparent or translucent articles. In apparatus of the latter type, the light is, of course, transmitted through the articles.

The employment of radiation of other types for the scanning beam, such as ultra-violet or infra-red rays, is within the scope of my invention.

Although I have shown and described certain specific embodiments of my invention, I am fully aware that many modifications thereof are possible. My invention, therefore, is not to be restricted, except insofar as is necessitated by the prior art and by the spirit of the appended claims.

I claim as my invention:

1. Article sorting apparatus comprising means for producing a beam of radiant energy, means for deflecting said beam to and fro through a predetermined angle with a predetermined periodicity to scan an article to be sorted and means to be controlled by the beam emitted by said article for separating imperfect articles from perfect articles, said last-named means including a plurality of photo-sensitive devices to be excited by the radiant energy emitted by said articles to be sorted and unitary means to coact with said photo-sensitive devices to respond to variations in the total radiant flux impinging on at least one of said devices.

2. Apparatus for sorting articles which when perfect have a uniform surface, and when imperfect have a surface marred with spots of various dimensions which have the property of modifying radiant energy impinging thereon to various degrees, comprising means for producing a beam of radiant energy, means for deflecting said beam to and fro through a predetermined angle with a predetermined periodicity to scan an article to be sorted and means to be controlled by the beam emitted by said article for separating imperfect articles from perfect articles, said last-named means including a photo-sensitive device and optical means fixed relative to said photo-sensitive device and so positioned relative thereto as to converge thereon all radiant beams emitted by said article to be sorted, as said scanning beam is deflected to move over its surface, and means to coact with said photo-sensitive device to respond to varia-

tions in the total radiant flux impinging on said device.

3. Apparatus for sorting articles which, when perfect, have a uniform surface, and when imperfect have a surface marred with heterogeneities of various dimensions and various optical properties, said apparatus comprising means for producing a beam of radiant energy, means for deflecting said beam to and fro through a predetermined angle with a predetermined periodicity, means for projecting said beam on an article to be sorted to scan said article and means responsive to the beam of radiant energy emitted by said article for separating the imperfect articles from the perfect articles.

4. Apparatus for sorting articles all points of the surfaces of which reflect radiant energy uniformly when said articles are perfect, but certain points of which reflect radiant energy with various degrees of non-uniformity when said articles are imperfect, said apparatus comprising means for producing a beam of radiant energy, means for deflecting said beam to and

fro through a predetermined angle with a predetermined periodicity, means for projecting said beam so deflected on the surfaces of said articles to be sorted to scan said articles and means responsive to the radiations reflected from all points of said surfaces for separating the imperfect articles from the perfect articles.

5. Apparatus for sorting articles which when perfect have a uniform surface and when imperfect have a surface spotted with heterogeneities having the property of modifying radiant energy to various degrees, means for producing a beam of radiant energy, means for deflecting said beam to and fro through a predetermined angle with a predetermined periodicity, means for projecting said beam so deflected on an article to be sorted to successively illuminate small elements of the surface of said article and means responsive to the illumination emitted by said elements for sorting out said articles in accordance with the intensity of the radiations emitted thereby.

VLADIMIR K. ZWORYKIN.

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