

June 25, 1963

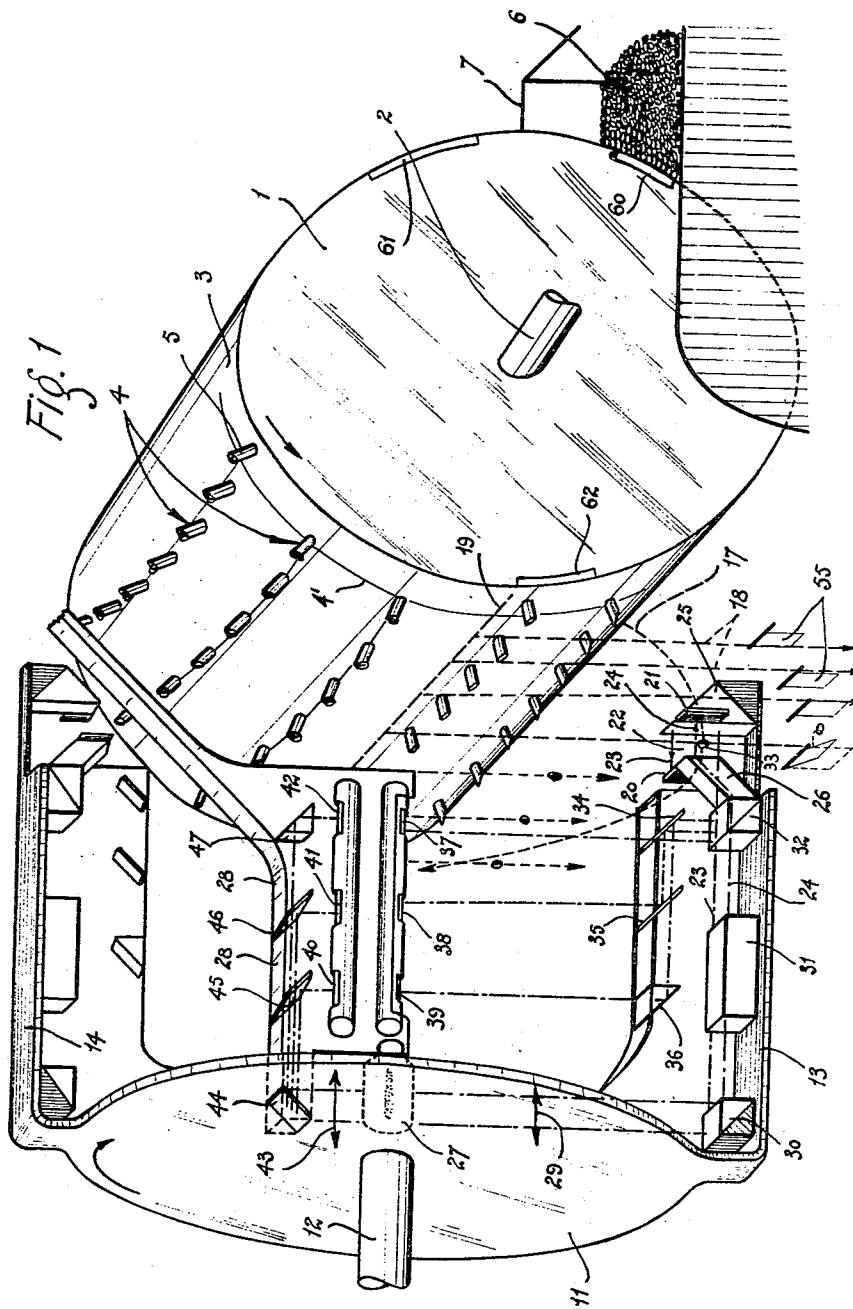
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3,095,090

MACHINE FOR SORTING ARTICLES OF DIFFERENT GRADES

Filed Feb. 20, 1961

5 Sheets-Sheet 1



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5 Sheets-Sheet 2

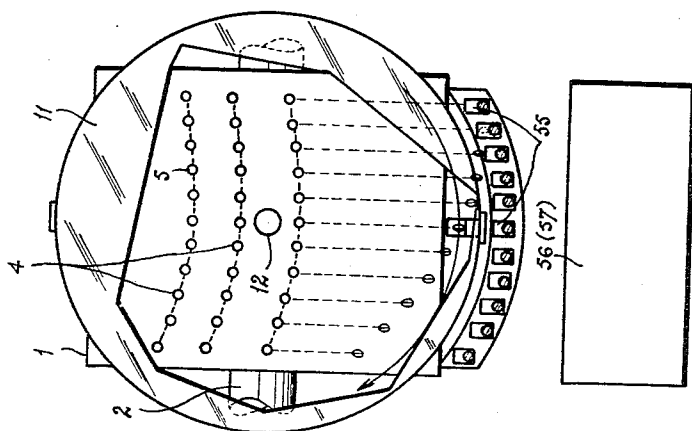
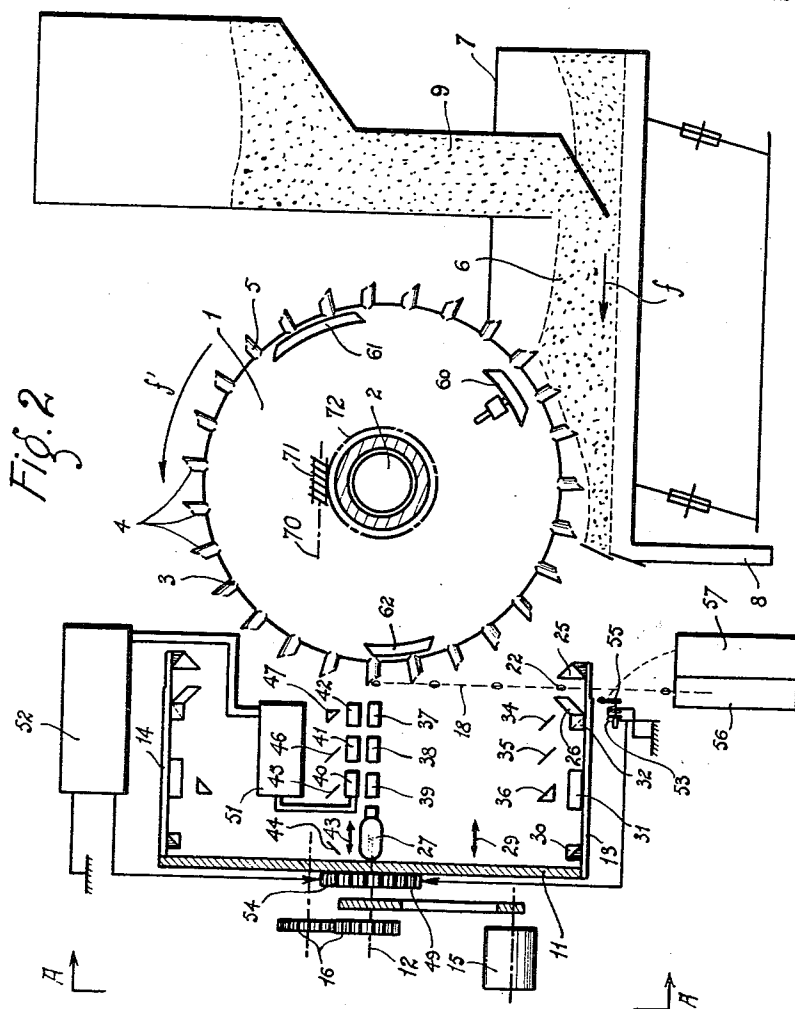


Fig. 3

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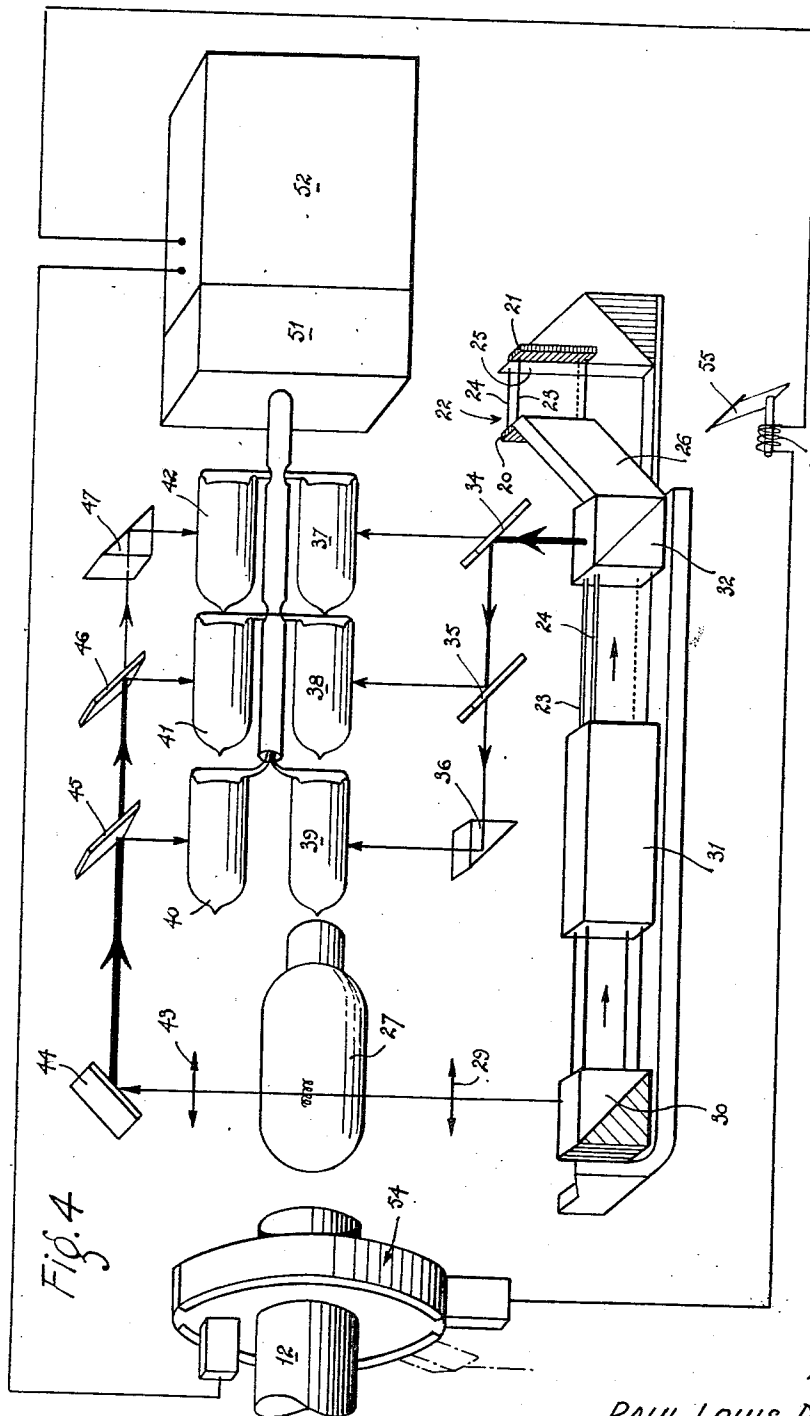
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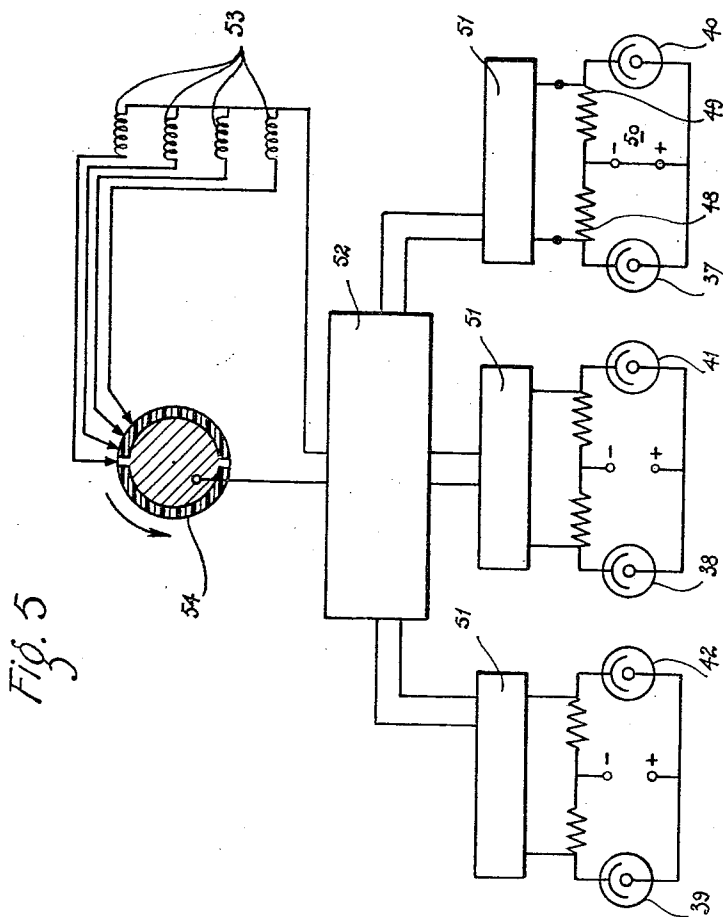
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5 Sheets-Sheet 4



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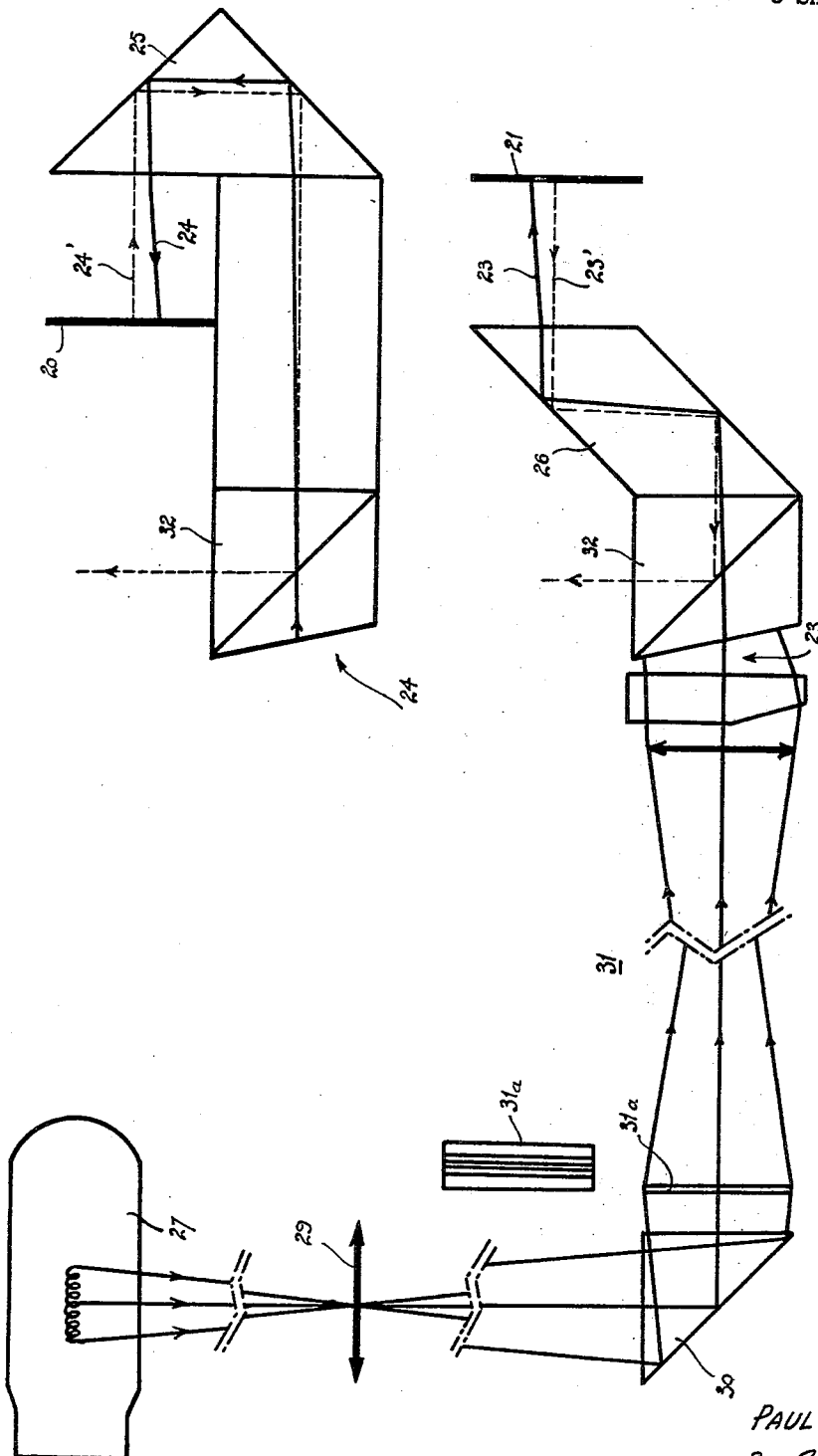


Fig. 6

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MACHINE FOR SORTING ARTICLES OF DIFFERENT GRADES

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7 Claims. (Cl. 209—111.5)

My invention has for its object a machine for sorting articles of different grades chiefly grains, fruit, mineral material having different magnetic or radioactive properties. Machines of such a type are already known which are constituted by a rotary disc provided with catching members operating under suction and adapted to take hold of the articles to be sorted and with ejecting members while stationary means for the photoelectric scanning of such articles cooperating with said rotary disc control the ejecting members.

The first object of my invention consists in producing a sorting machine, the speed of sorting of which is very high while its yields is higher than in the case of all known sorting machines.

A further object of my invention consists in a sorting machine of a simple and compact structure.

According to a main feature of my invention, the sorting machine comprises a cylinder adapted to rotate round a horizontal axis, a plurality of curvilinear rows of article-catching members carried by the peripheral surface of the cylinder, a rotary device for scanning said articles and provided with at least one scanning head revolving in synchronism with the rotary cylinder while the shape of the curvilinear rows of article-catching members is provided on the cylinder in a manner such that the articles enter in succession the field swept by the scanning head and furthermore, means distributing the articles examined in two different categories are operative under the action of said scanning means.

In a first embodiment, the articles are examined by the scanning means while they are still held by the article-catching members and the distributing means control said article-catching members with a view to releasing the articles examined for different positions of the cylinder corresponding to the different categories of articles. The result is that the examination is generally partial and that an anomaly in color for instance on the surface facing the article-catching members cannot be detected.

In a preferred embodiment, means are provided for producing during the circular sinking movement over the cylinder surface of said articles held by the article-catching members, a release of said articles in a manner such that they may pass in succession during their downwardly directed movement through the head of the scanning means while the distributing means provide upon energization the shifting of the articles out of their downwardly direct path along which they drop freely.

In an application which is of particular interest, the scanning means are of a photoelectric type provided with a scanning head producing a plurality of light beams the angular setting and/or direction of which are different.

When examining an article during its downward movement by means of a plurality of luminous beams, it is possible to scan thus the major part of the outer surface of the article while retaining the high yield of the sorting machine provided with a distributing cylinder.

I will now describe a preferred embodiment of my improved machine selected by way of a mere example and by no means in a binding sense, reference being made to the accompanying drawings wherein:

FIG. 1 is a partial diagrammatic perspective view of my sorting machine,

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FIG. 2 is a diagrammatic cross-sectional view of said machine,

FIG. 3 is a view of the machine illustrated in FIG. 2 as seen in the direction of the arrows A—A, a part of the front-section of the machine being torn off,

FIG. 4 is a diagrammatic view of the optic system equipping the sorting machine,

FIG. 5 is a diagrammatic view of the electronic system equipping the sorting machine,

FIG. 6 is a more detailed view of the optic system.

In the embodiment selected and illustrated, the sorting machine includes a hollow fluidtight cylinder 1, revolvably carried round a tubular shaft 2 of which one end is connected with a source of reduced pressure.

The cylinder 1 carries on its peripheral surface 3 a plurality of series 4 of longitudinally aligned article-catching members 5 or suction members in the shape of small tubular sections communicating each through a small perforation with the inside of the cylinder 1 while the outer end of each tubular section forms a seat in the shape of a hemispherical cup provided with a perforation in its central point. These members are also distributed in a plurality of radial planes extending through the cylinder 1 so as to form annular series of members 4'. I will describe hereinafter with further detail, the shape of the alignments 4 of the article-catching or suction members 5 and also the spacing between two successive series. The lower part of the cylinder 1 engages the bulk of articles to be sorted such as grains 6 e.g. coffee grains which are carried inside a vat 7 which includes for instance a vibrating sieve out of which the dust may be removed through a suction channel 8, said sieve assuming a vibratory movement so as to produce a fluidization of the grains and their shifting out of the feed hopper 9 in the direction *f* towards the cylinder 1. Inside the cylinder 1 are arranged a number of shoes adapted to close the inner outlets of the suction members. Thus, when following the cylinder 1 in the direction of rotation *f'*, starting from the feed vat 7, the grains meet first a shoe 60 arranged above the normal level of the articles to be sorted in the vat 7, with a view to cutting out any removal of the grains during the starting stage of the machine until the drum has reached normal operative speed. Beyond said first shoe 60, a second shoe 61 is carried in a section of the cylinder 1 corresponding to the rising of the grains above the horizontal axial plane of the cylinder and a third shoe 62 is arranged adjacent a generating line of the cylinder 1 in its downwardly moving section to face the rotary disc 11 substantially at the same level as the horizontal axial plane 19. In proximity with the cylinder 1 and in registry with its surface the rotary disc 11 revolving round a horizontal shaft 12 carries two arms 13 and 14 in diametrically opposed relationship, each of said arms extending in parallelism with the rotary shaft 12 in a direction leading towards the cylinder 1. The cylinder 1 and the disc 11 are driven by a common motor 15 and by transmission gears 16 which drive shaft 70 connected to worm gear 71 which meshes with worm wheel 72 and which need not be described with any detail; this is performed in a manner such that, taking into account the shapes of the lines defining the series 4 of article-catching or suction members 5 and the spacing of said lines, one of the arms 13 (or 14) sweeps along a path 17 cutting the different paths 18 along which the grains released by the suction members are allowed to drop in a predetermined sequence as defined by the cutting out of the suction forces along a predetermined generating line of the cylinder 1, for instance the generating line extending in the horizontal axial plane 19.

Each arm 13, 14 carries at its end two interchangeable small plates 20 and 21 serving as reference surfaces of

which the color is selected in accordance with the reflecting capacity or the color of the article to be sorted; said plates 20 and 21 are arranged in parallelism with each other with a predetermined spacing so as to form between them a space 22 through which a grain fed by the distributing cylinder may drop freely, said plates being shifted or staggered with reference to each other in a direction parallel with the axis of the cylinder, so that they may be illuminated each by a luminous beam 23 or 24 produced by an optic system such as a prism 25 located in registry with the plate 21 and by a second prism 26 located in registry with the plate 21.

The prisms 25 and 26 are subjected to the impact of luminous beams passing out of a source of light 27 arranged along the axis of the shaft 12 carrying the disc 11 and carried by a stationary support 28. The light passing out of said source of light 27 is focalized by any suitable system 29 into a plane parallel with the disc 11 and is then reflected perpendicularly to the plane of the disc 11 by a prism 30. Said beam then passes through a collimator 31 which subdivides by means of a screen 31a with two slots the luminous beam into the two above-mentioned elementary beams 23, 24, parallel with each other, and through the agency of a prism 32, the beam 23 is directed towards the prism 25 while the beam 24 is directed towards the prism 26 so as to form the final elementary beams directed towards the plates 20, 21 referred to hereinabove. The grains to be sorted 33 pass between the plates 20 and 21 and their outer surface is swept by the two luminous beams while the plates 20 and 21 progress at a speed which is that of the arms 13 and 14 and is thus clearly higher than the speed with which the grains drop freely under the action of gravity. Each grain produces therefore as it passes in front of the reference plates or surfaces 20 and 21 an image of its front and rear surfaces which images being returned by the prisms 25 and 26 and reflected again by the prism 32 into a direction parallel with the plane of the disc 11.

The beams 23', 24' thus reflected impinge on a first dichroic mirror 34 which allows the blue component for instance of the images to pass while it reflects the other chromatic components of said images; the latter components reach then a second dichroic mirror 35 reflecting say the green component and allowing the passage of the remaining components towards a prism 36 reflecting now the red component in a direction parallel with the direction of reflection by the mirrors 34 and 35. The three reflected beams reflected by the mirrors 34 and 35 and the prism 36 are directed each towards a photocell respectively 37, 38 and 39. the electric currents produced by which are then compared with those of corresponding witness photocells.

The witness photocells are shown at 40, 41 and 42 and are similar to the cells 37, 38 and 39 and are illuminated by the source of light 27 through the agency of an optic system 43 suitably adjusting the illumination of a reference surface of a suitable color 44 corresponding to the reference color of the grains which are being investigated. Said surface 44 reflects the light towards three dichroic mirrors 45, 46, 47 playing the same part as the above-mentioned means 34, 35 and 36 respectively and which are associated with the photocells 40, 41 and 42.

Each pair of corresponding cells 37-40, 38-41 and 39-42 has its cells inserted in two arms of an electric bridge, the other arms of which are constituted by balancing resistances 48 and 49 while a supply of direct current 50 is inserted in the diagonal of the bridge (FIG. 5) and the voltage corresponding to the lack of balance of the bridge is fed to a preliminary amplifier 51, and thence into an amplifier 52 common to all the bridges. The resultant voltage which is thus suitably amplified is fed to one of the electromagnetic windings 53, the number of which is equal to the number of suction article-catching members 5 in a longitudinal row or series 4 through the

agency of a rotary switch 54 rigidly secured to the shaft carrying the disc 11.

Each electro-magnet 53 is intended for the operation of a flap 55 extending across the path 18 of a grain, slightly underneath the scanning arm 13 (or 14); the arrangement is such that when the flap is in its vertical position, the grain drops directly into a discharge channel 56 whereas for the sloping position of said flap corresponding to energization of the electro-magnet, the grain is projected into another adjacent discharge channel 57.

The operation of the above-described sorting machine is as follows:

At the start, the distributing cylinder 1 does not carry along any grain, since the shoe 60 cuts out the suction effect until the cylinder 1 has assumed its normal speed. The shoe 60 is then released and the suction members 5 hold the grains caught by them. As they pass in front of the next shoe 61 in registry with which the suction effect is cut out, those grains which are not accurately carried by the cup-shaped end of a suction member 5 or which are positioned in duplicate in a member, drop back into the vat 7. The grains which remain suitably held by the members 5 move with the downwardly moving section of the cylinder, down to the level of the shoe 62 where they drop one by one and in succession through the space 22 bounded by the small plates 20, 21 on the arm 13 or 14 which plates describe arcs of a circle cutting the paths 18 of the grains as disclosed precedingly.

It will be remarked that, according to the shape of the curves defining the rows 4 of suction members 5 illustrated in FIG. 3, the sequence of release of the grains may not correspond to the order of the scanning. As a matter of fact, the shape of said curves depends on numerous parameters, in particular on the height through which the grains drop before reaching the scanning head, the tangential speed of the cylinder and the speed of movement of the scanning head.

If the color of the grain corresponds substantially to that of the reference surface 44, the different bridges remain balanced and no current passes through the electromagnets 53 controlling the flaps 55. In contradistinction, if a grain shows a spot or a different color, at least one of the photo-cells 37, 38 and 39 is energized in a different manner, and at least one of the bridges is subjected to a lack of balance which leads to the energization of the electro-magnet 53 of the flap 55 corresponding to the annular row 4' of article-catching members operated through suction, on which the grain which is being examined was located. The flap 55 assumes its sloping position and the grain considered is projected into the channel 57. Of course the duration of complete response including operation of a flap should be sufficiently small so that the grain which is to be selectively removed may impinge on the flap in its final sloping position in a manner such that the bouncing effect may be practically the same for all the grains thus selected.

In the case of articles liable to showing irregular spots on their surfaces, the luminous beams are adjusted in a manner such that their breadth may correspond to the average diameter of the spots to be detected, so that said spot may occupy a maximum surface with reference to the total cross-section of the luminous beam.

In order to obtain a more accurate detection of small spots, a supplementary optic system is fitted on the prism 32 with a view to subdividing into three areas the image of the narrow illuminated strip on the article; the light of each of said areas is directed towards the corresponding cell and the surface of the spot is thus multiplied by three with reference to the total cross-section of the luminous beam.

Of course, my invention is by no means limited to the embodiment described and illustrated, and it covers all the modifications thereof falling within the scope of the accompanying claims, in particular those wherein the

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number and/or direction of the luminous beam are different. Also the means for shifting the grains laterally may be different and the machine may even be used with a single cell.

What I claim is:

1. A machine for sorting articles of different grades, chiefly grains of different outer appearances, comprising a cylinder having horizontal axis, a plurality of rows of article-catching members carried by said cylinder along curvilinear lines extending from one end of the cylinder to the other and in which said members are distributed substantially in successive transverse planes, said members being adapted to catch the articles near the lower end of the cylinder and to allow their dropping freely out of the cylinder along a generating line of the downwardly moving section of the latter, a rotary scanning system extending laterally of the cylinder and revolvable round a horizontal axis substantially perpendicular to the cylinder axis, means for rotating simultaneously with a predetermined speed relationship the cylinder and scanning system to make the latter scan in succession the articles dropping freely off the cylinder and means controlled by the scanning system to sort the scanned articles.

2. A machine for sorting articles of different grades, chiefly grains of different outer appearances, comprising a cylinder having a horizontal axis, a plurality of rows of article-catching members carried by said cylinder along curvilinear lines extending from one end of the cylinder to the other and in which said members are distributed substantially in successive transverse planes, said members being adapted to catch the articles near the lower end of the cylinder and to allow their dropping freely out of the cylinder along a generating line of the downwardly moving section of the latter, a rotary disc extending laterally of the cylinder and revolvable round a horizontal axis substantially perpendicular to the cylinder axis, a plurality of mirror surfaces carried by said disc and revolving therewith to face transiently the articles dropping off the cylinder, means illuminating said mirrors to illuminate said articles and sort them optically, means for rotating simultaneously with a predetermined speed relationship the cylinder and the disc, and means controlled by the light projected on the articles by the mirrors to sort the scanned articles.

3. A machine for sorting articles of different grades, chiefly grains of different outer appearances, comprising a cylinder having a horizontal axis, a plurality of rows of article-catching members carried by said cylinder along curvilinear lines extending from one end of the cylinder to the other and in which said members are distributed substantially in successive transverse planes, means subjecting the inside of the cylinder to suction and adapted to operate the article-catching members by subjecting them to suction, means controlling the suction exerted on said members to make them catch the articles near the lower end of the cylinder and release them thereafter to allow their dropping freely out of the cylinder along a generating line of the downwardly moving section of the latter, a rotary disc extending laterally of the cylinder and revolvable round a horizontal axis substantially perpendicular to the cylinder axis, a plurality of mirror surfaces carried by said disc and revolving therewith to face transiently the articles dropping off the cylinder, means illuminating said mirrors to illuminate said articles and sort them optically, means for rotating simultaneously with a predetermined speed relationship the cylinder and the disc, and means controlled by the light projected on the articles by the mirrors to sort the scanned articles.

4. A machine for sorting articles of different grades, chiefly grains, fruit, ore and the like showing different magnetic, radioactive, optic and the like properties, comprising a cylinder having a horizontal axis, a plurality of rows of article-catching members carried by said cylinder along curvilinear lines extending from one end of the cylinder to the other and in which said members are dis-

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tributed substantially in successive transverse planes, said members being adapted to catch the articles near the lower end of the cylinder and to follow the upward movement of the upwardly moving section of the cylinder and then the downward movement of the downwardly moving section of the cylinder down to a predetermined level, means constraining said members to release the articles which they reach said level to cause them to drop in succession in a predetermined plane, a rotary scanning system extending laterally of the cylinder and revolvable round a horizontal axis substantially perpendicular to the cylinder axis to face transversely the articles dropping off the cylinder, means for synchronously driving the cylinder and the scanning system into rotation, and means controlled by the scanning system and shifting the articles of a predetermined grade scanned by the latter out of the plane along which they are dropping.

5. A machine for sorting articles of different grades, chiefly grains, fruit, ore and the like showing different magnetic, radioactive, optic and the like properties, comprising a cylinder having a horizontal axis, a plurality of rows of article-catching members carried by said cylinder along curvilinear lines extending from one end of the cylinder to the other and in which said members are distributed substantially in successive transverse planes, suction means subjecting the inside of the cylinder to suction and acting on the article-catching members to render them operative, a stationary shoe engaging inwardly a generating line of the downwardly moving section of the cylinder to cut off the action of the suction means, and thereby allow the articles to drop off the cylinder in succession when they reach the level of said shoe, a rotary disc extending laterally of the cylinder and revolvable round a horizontal axis substantially perpendicular to the cylinder axis, a plurality of photoelectric scanning means carried by said rotary disc to face transiently the articles dropping off the cylinder, means for synchronously driving the cylinder and the rotary disc into rotation and means controlled by the scanning means and shifting the articles of a predetermined grade scanned by the latter out of the plane along which they are dropping.

6. A machine for sorting articles of different grades, chiefly grains, fruit, ore and the like showing different magnetic, radioactive, optic and the like properties, comprising a cylinder having a horizontal axis, a plurality of rows of article-catching members carried by said cylinder along curvilinear lines extending from one end of the cylinder to the other and in which said members are distributed substantially in successive transverse planes, said members being adapted to catch the articles near the lower end of the cylinder and to follow the upward movement of the upwardly moving section of the cylinder and then the downward movement of the downwardly moving section of the cylinder down to a predetermined level, means constraining said members to release the articles when they reach said level to cause them to drop in succession in a predetermined plane, a rotary disc extending laterally of the cylinder and revolvable round a horizontal axis substantially perpendicular to the cylinder axis, at least one arm carried by said disc, scanning means carried by each arm and including two interchangeable reflecting surfaces, the paths followed by which lie to either side of the plane in which the articles drop off the cylinder, optical means including a source of light extending along the axis of the disc, means forming with the light from said source two beams impinging on the corresponding reflecting surfaces, two chromatic selecting means subjected to the action of the light reflected by the corresponding reflecting surfaces, a photo-cell subjected to the action of each monochromatic beam of light produced by each chromatic selecting means, a reference reflective surface illuminated by said source of light, further chromatic selecting means subjected to the action of the light reflected by the reference surface, a further photo-cell subjected to the

action of each monochromatic beam of light produced by said further chromatic selecting means, at least one electric bridge fed by the currents passing out of the cells illuminated by light of a same color, means for synchronously driving the cylinder and the disc, a plurality of article-shifting means extending each in registry with the line along which the articles drop off one transverse plane of the cylinder when released, an electromagnet controlling each shifting means, means associating and amplifying the currents produced by lack of equilibrium in the bridges and feeding them into the electromagnets, and a rotary switch rigid with the disc and controlling last-mentioned means to feed that electromagnet which corresponds to the transverse plane in which the scanning of the dropping articles is being performed.

7. A machine for sorting articles of different grades, chiefly grains, fruit, ore and the like showing different magnetic, radioactive, optic and the like properties, comprising a cylinder having a horizontal axis, a plurality of rows of article-catching members carried by said cylinder along curvilinear lines extending from one end of the cylinder to the other and in which said members are distributed substantially in successive transverse planes, said members being adapted to catch the articles near the lower end of the cylinder and to follow the upward movement of the upwardly moving section of the cylinder and then the downward movement of the downwardly moving section of the cylinder down to a predetermined level, means constraining said members to release the articles when they reach said level to cause them to drop in succession in a predetermined plane, a rotary disc extending laterally of the cylinder and revolvable round a horizontal axis substantially perpendicular to the cylinder axis, at least one arm carried by said disc, scanning means carried by each arm and including two interchangeable

reflecting surfaces, the paths followed by which lie to either side of the plane in which the articles drop off the cylinder, optical means including a source of light extending along the axis of the disc, means forming with the light from said source two beams impinging on the corresponding reflecting surfaces, two chromatic selecting means subjected to the action of the light reflected by the corresponding reflecting surfaces, a photo-cell subjected to the action of each monochromatic beam of light produced by each chromatic selecting means, a reference reflective surface illuminated by said source of light, a further chromatic selecting means subjected to the action of the light reflected by the reference surface, a further photo-cell subjected to the action of each monochromatic beam of light produced by said further chromatic selecting means, at least one electric bridge fed by the currents passing out of the cells illuminated by light of a same color, means for synchronously driving the cylinder and the disc, a plurality of flaps registering substantially with each transverse plane of the cylinder and adapted to be shifted each out of its normal vertical position into an oblique position for which it shifts the corresponding dropping article out of the plane in which it drops, an electromagnet controlling each flap, means associating and amplifying the currents produced by lack of equilibrium in the bridges and feeding them into the electromagnets, and a rotary switch rigid with the disc and controlling last-mentioned means to feed that electromagnet which corresponds to the transverse plane in which the scanning of the dropping article is being performed.

References Cited in the file of this patent

UNITED STATES PATENTS

2,625,265	Cox	Jan. 13, 1953
2,690,258	Cox	Sept. 28, 1954
2,937,750	Wohlrahe	May 24, 1960