

[54] **COMPACT VIEWING ASSEMBLY FOR
LIGHT SENSITIVE SORTING MACHINE**

[75] Inventors: **Michael C. Hoover; William C.
Long**, both of Houston, Tex.

[73] Assignee: **Petty-Ray Geophysical, Inc.**,
Houston, Tex.

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[51] **Int. Cl.²**..... **H01J 5/16**

[58] **Field of Search** **250/226, 223; 209/111.6,
209/111.7**

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Primary Examiner—James W. Lawrence

Assistant Examiner—D. C. Nelms

Attorney, Agent, or Firm—Arnold, White & Durkee

[57]

ABSTRACT

In a light-sensitive sorting machine for sorting a succession of freely falling articles, a compact viewing assembly includes a passage through which the articles may fall, a housing surrounding the passage to define an enclosed viewing chamber, background members carried in the housing at spaced locations around the passage, optical viewing means disposed to view the background members and articles falling through the passage between the viewing means and the background members, and a plurality of lamps spaced in a plane around the passage to uniformly illuminate the background members and articles falling through the passage, each of the lamps being shielded to prevent direct illumination of the optical viewing means.

12 Claims, 4 Drawing Figures

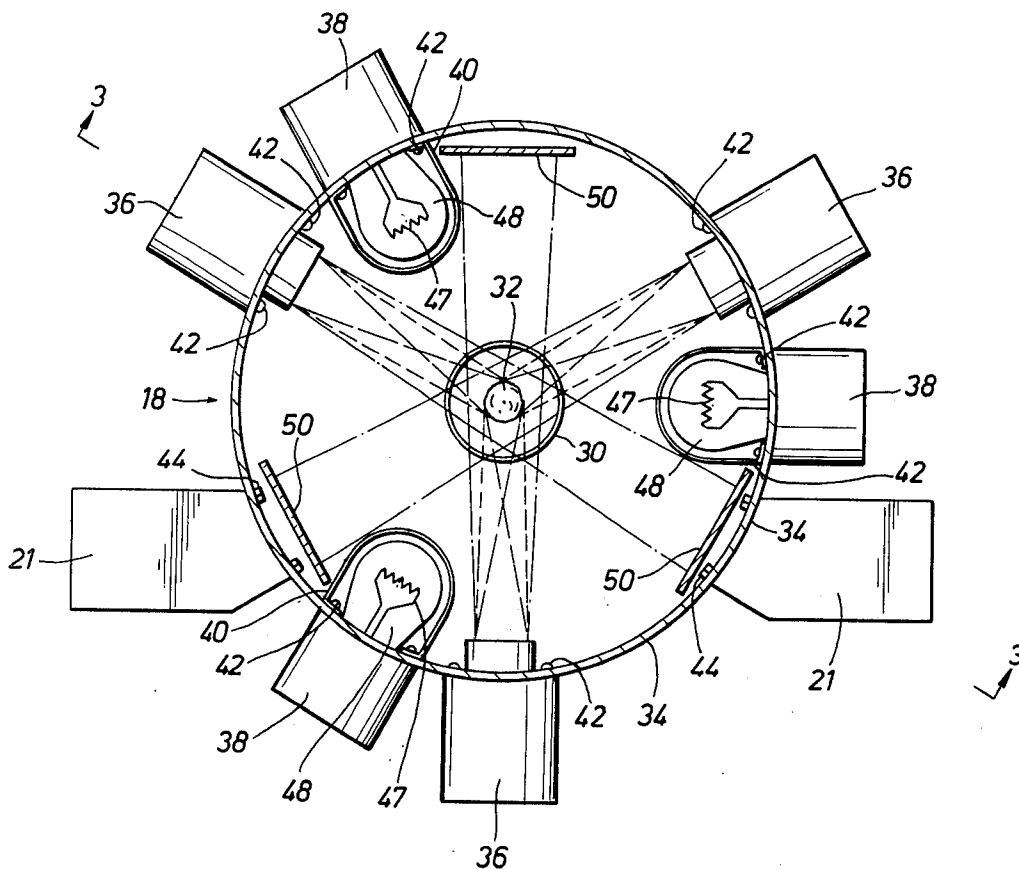


FIG. 1

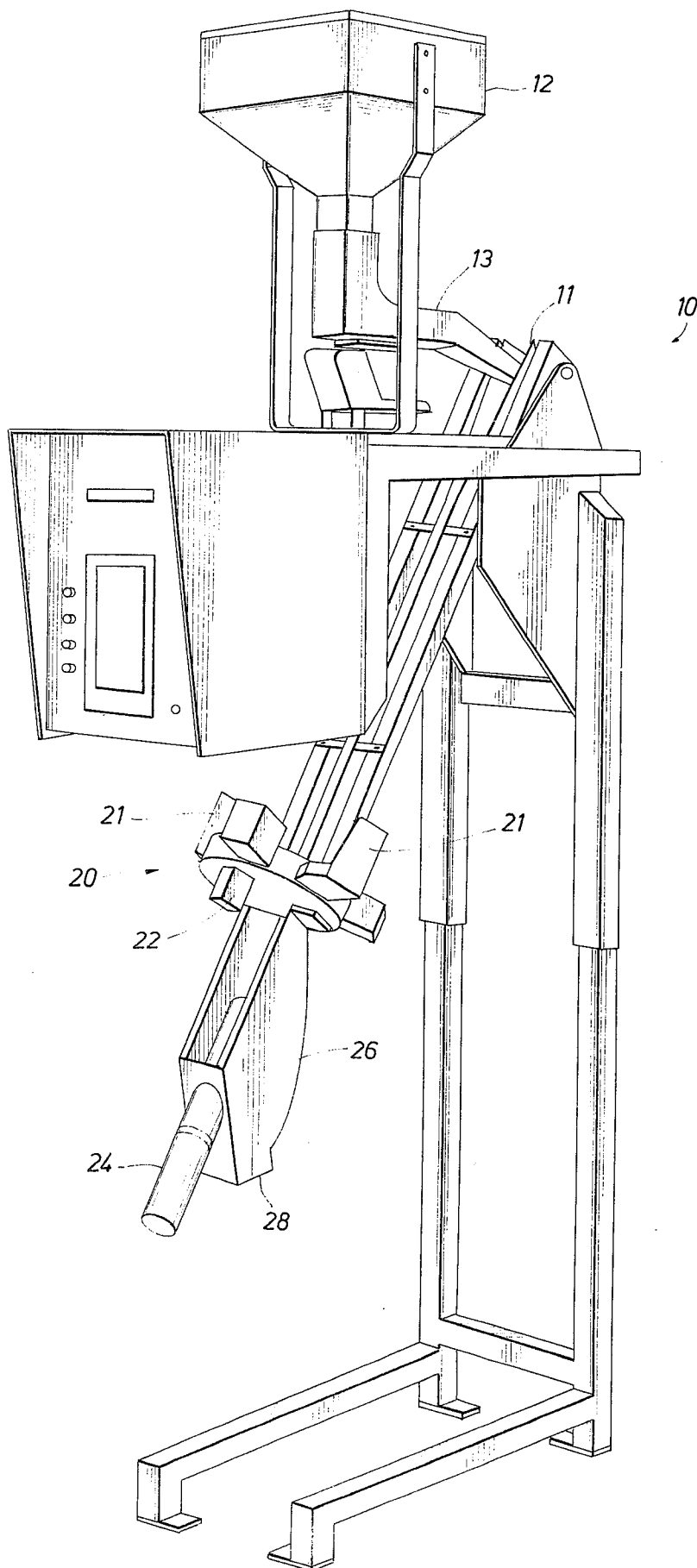


FIG. 2

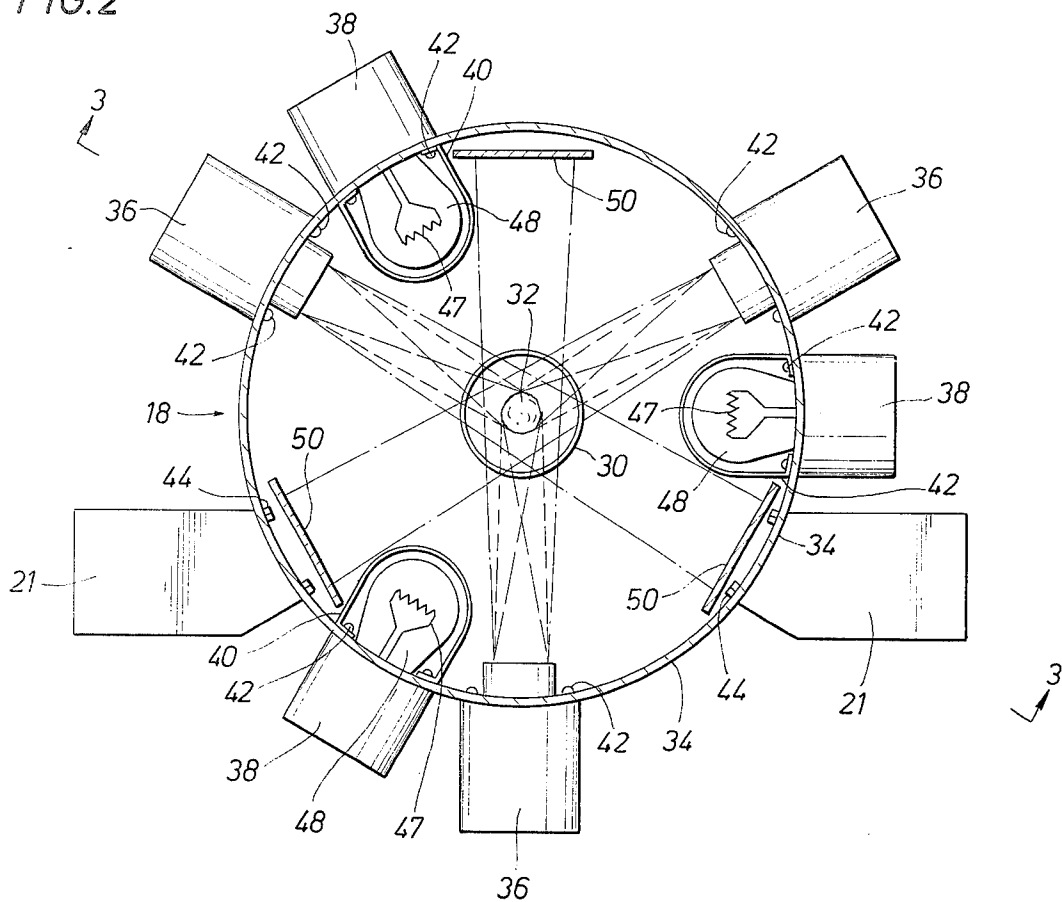
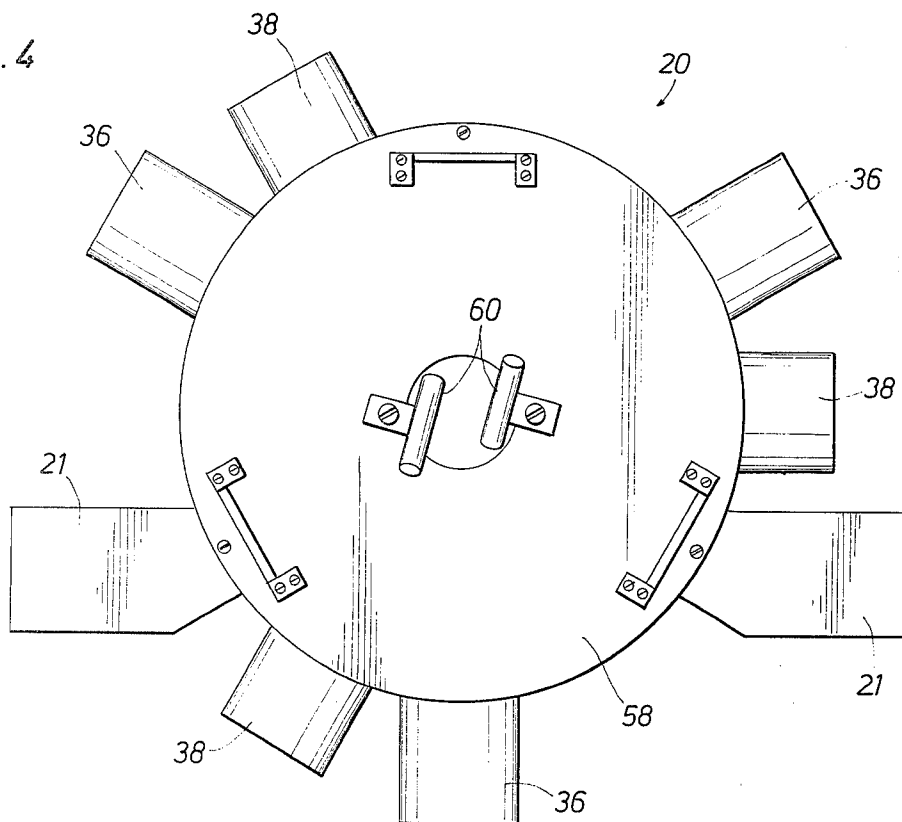


FIG. 4



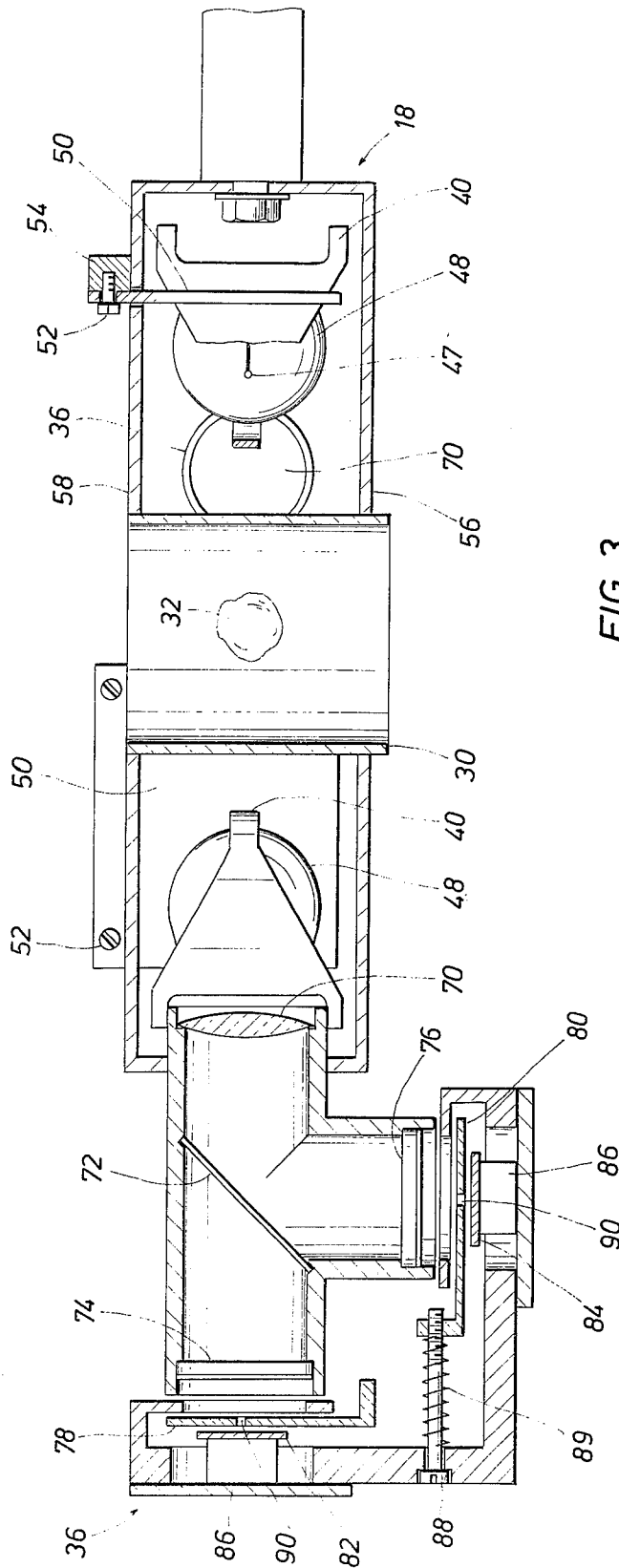


FIG. 3

COMPACT VIEWING ASSEMBLY FOR LIGHT SENSITIVE SORTING MACHINE

BACKGROUND OF THE INVENTION

This invention relates to sorting machines, and, more particularly, to light-sensitive sorting machines for sorting a succession of freely falling articles from one another responsive to color differences in the light energy reflected from the articles.

Previously, viewing assemblies for light-sensitive sorting machines have required sources of illumination located both above and below the viewing means in order to sufficiently illuminate the articles being sorted for high capacity color sorting. The complexity and bulk of such viewing assemblies has been such as to require an undue amount of space and unnecessary complexity of such sorters, particularly when it is desired to arrange a large number of such sorters in parallel to obtain a high sorting capacity in a minimum of floor space.

In addition, the shielding of illumination sources in prior machines has been inefficient, presenting tortuous paths for reflected light energy to follow before illuminating the item being sorted or producing undesirable shadows. A compact, efficient, viewing assembly which will provide illumination suitable for high speed bichromatic sorting has not heretofore been available.

SUMMARY OF THE INVENTION

The present invention provides a compact viewing assembly for use in light-sensitive color sorting machines. In particular, a highly efficient broad wavelength spectrum assembly especially suitable for high speed bichromatic sorting applications is provided.

In one embodiment of the present invention, a succession of articles to be sorted is provided to a viewing assembly by way of an elongated tapered slide adapted to receive the articles at its upper end and to singulate the articles for presentation to the viewing assembly. As each article leaves the bottom of the slide, it falls freely along a predetermined path through the viewing assembly.

In the embodiment under consideration, a clear or transparent plastic tube surrounds this path and is in turn surrounded by a generally flat cylindrical housing. This housing contains background members against which the articles are viewed by optical viewing means and also contains a plurality of tungsten filament lamps spaced around the tube to uniformly illuminate articles falling therethrough with the background members with a broad spectrum of light wavelengths. The optical viewing means and the lamps are centered in a single plane within the housing to permit a compact assembly.

The background members are located near the outer side wall of the cylindrical housing, and the lamps are located to one side of the backgrounds. The lamps project into the housing and provide sources of illumination which are closer to the path of the articles than are the background members. Narrow, ribbon-like lamp guards are provided around each of the lamps to prevent direct illumination of the viewing means. These lamp guards and the lamp filaments are aligned to prevent projection of the lamp filaments onto the articles and backgrounds. The plane in which the lamps are centered is normal to the path of the articles through the viewing assembly. Also, a compact bichromatic optical viewing device is provided and includes adjustable

frame means for presenting the same viewed area to each of two photosensitive elements.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a single channel sorting machine in accordance with one embodiment of the present invention.

FIG. 2 is a top view of the viewing assembly of FIG. 1.

FIG. 3 is a side view of the optical unit as shown in FIG. 2, partly in section and partly in schematic, illustrating one embodiment of a compact optical viewing means in the present invention.

FIG. 4 is a top view of an alternate embodiment of the viewing assembly of FIG. 2.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to FIG. 1, the sorting machine 10 includes an elongated tapered slide 11. The slide 11 is inclined from the vertical to provide gravity assisted singulation of the articles to be sorted as the articles slide downwardly thereon. Above the slide 11 are mounted a stationary hopper 12 and a vibrating chute 13 for feeding articles to be sorted from the hopper to the upper end of the slide.

At the bottom end of the slide 11, the articles to be sorted shoot out with considerable velocity on a predetermined trajectory which is substantially a straight prolongation of the slide for a short distance. At the bottom of the slide 11, viewing assembly 20 is supported by structural mounts 21 to receive the articles to be sorted as they leave the bottom of the slide 11. Ejector 22 is mounted immediately beneath viewing assembly 20 for deflecting undesired articles as they exit the viewing assembly. The desired articles continue their predetermined path and exit the machine through an exit tube 24, while the unacceptable articles are deflected into collector 26 from which they may be removed through discharge opening 28.

Referring now to FIG. 2, one embodiment of the viewing assembly of the present invention is illustrated in detail. The viewing assembly includes a transparent tube 30 through which articles 32 may fall for inspection. A housing 18 surrounds a portion of the tube 30 and includes an upper plate 58, a lower plate 59, and an outer wall 34 joining the peripheries of the plates to describe a generally flat cylinder having a central passage therethrough. Outer wall 34 of the viewing assembly 20 supports optical viewing means such as viewing assemblies 36, lamp bases 38, and lamp guards 40, by means of mounting screws 42. The structural mounts 21 by which the viewing assembly 20 is attached to the sorting machine 10, are attached to side wall 34 of the viewing assembly by screws 44. Background members 50 are supported by the upper surface of the viewing assembly by conventional means such as screws 52 and blocks 54 (FIG. 4). Lamps 48 are mounted in lamp bases 38 in conventional fashion.

Lamps 48 are arranged to define a plane. The filaments 47 of the lamps 48 are preferably oriented in this plane to facilitate most efficient shielding of the lamps, as will be discussed. In addition, by centering the optical viewing means 36 and the backgrounds 50 in this same plane, an extremely compact and highly efficient viewing assembly is achieved. Narrow ribbon-like lamp guards 40 are provided around each of the lamps 48 to prevent direct illumination of the viewing means 36 by

the lamps. In addition, the lamp guards 40 prevent the projection of shadows corresponding to the lamp filaments 47 on the article to be sorted 32 and the backgrounds 50. However, by utilizing the ribbon-like lamp guards 40, the upper and lower regions of the interior of the housing are directly illuminated. The interior surfaces of the viewing assembly, as well as the lamp guards 40, are painted with a flat white paint to minimize specular reflection and provide a substantially uniform level of diffused light throughout the area viewed by the optical viewing means 36.

By locating the background members 50 proximate the side wall 34 of the viewing assembly, and locating the lamps 48 more closely to the center of the viewing assembly, and adjacent the background members, the background members are thereby provided with uniform illumination of the adjacent lamp, and the light energy reflected from each of the background members is substantially unaffected by the passage of articles to be sorted through the viewing assembly. The paths of light energy reflected from articles 32 and backgrounds 50 and sensed by the optical viewing means 36 are shown schematically in FIG. 2.

It will be appreciated that the leading and trailing edges of the articles to be sorted 32 passing through the viewing assembly represent the most difficult areas of such articles to inspect for sorting purposes. By use of the narrow ribbon-like lamp guards 40 oriented with the lamp filaments 47 in the plane defined by the optical viewing means 36, the leading and trailing edges of articles 32 are well illuminated by apparatus in accordance with the present invention.

Optical viewing means 36 include conventional lens and frame means for focussing the light energy reflected from the corresponding background 50 and the articles to be sorted 32 on an appropriate photosensitive element or elements through respective color filters.

One embodiment of a compact optical viewing means adapted for use in the present invention is illustrated more fully in FIG. 3. Reflected light energy is collected by lens 70 and focussed on respective solar cells 82,84 through beam splitter 72, color filters 74,76 and frames 78,80. The frames 78 and 80 each contain a narrow slit 90 effectively limiting the area of view in a direction normal to the path of travel of the articles to be sorted. While frame 78 is fixed with respect to the light beam incident on solar cell 82, frame 80 is adjustable by means of adjustment screw 88 and spring 89 so that the slit 90 in frame 80 may be located to pass the same image to solar cell 84 as that passed to solar cell 82 by frame 78.

While the foregoing discussion of optical viewing means 36 has been directed to a single embodiment utilizing solar cells, it will be appreciated that other photosensitive elements may be utilized. In addition, other lens arrangements may be used to locate an optical frame ahead of the beam splitter, or the optical viewing means may incorporate only a single photosensitive element for monochromatic color sorting. The selection of various optical color filters for use in monochromatic or bichromatic color sorting is understood by those familiar with the art to be dependent on the colors of the articles being sorted and the wavelength spectrum of the illumination means available. Various means for defining discriminating signals are described in U.S. Pat. No. 3,012,666 and others.

When there is no object 32 within the field of view of the optical viewing means 36, the viewing means 36 senses the light energy reflected from the backgrounds 50. As an article to be sorted 32 falls through the transparent tube 30, the article reflects certain wavelengths of the illumination produced by lamps 48 depending upon the color of the article. This reflected light energy is sensed by optical viewing means 36, and, if the article is not acceptable, a signal is generated to fire the ejector 22 when the article 32 reaches the ejection point below the viewing assembly 20. If no ejection signal is generated, the article 32 continues along its predetermined path to the acceptable article discharge tube 24.

In an alternative embodiment of the present invention illustrated in FIG. 4, air nozzles 60 are mounted in the upper surface 58 of the viewing assembly by brackets 62 and screws 64. The nozzles 60 are connected to a source of compressed air (not shown), and may be periodically actuated in conventional fashion to provide air blasts inside the transparent tube to remove dust or debris which may have settled therein.

Although the viewing assembly of the present invention has been described in an embodiment having three lamps, three backgrounds, and three optical viewing means, it will be appreciated that this number may be varied depending on the size of the assembly and the sorting machine sensitivity dictated by the colors of the products being sorted. For example, a two-view assembly may be provided by removing one of the backgrounds and one of the optical viewing means, retaining the three lamps. Further modifications and variations within the scope of the present invention will be appreciated by those of skill in the art and may be made without departing from the spirit thereof.

What is claimed is:

1. In a light-sensitive sorting machine for sorting a succession of articles freely falling along a predetermined path, a compact viewing assembly comprising:

a transparent tube through which articles to be sorted may fall along said path;

a housing surrounding a portion of said tube to define an enclosed viewing chamber;

a plurality of background members disposed at spaced locations in said housing, each of said background members being equidistant from said path;

a plurality of optical viewing means disposed in a plane normal to said path to view articles falling along said path against respective of said background members;

a plurality of lamp means disposed in said plane to illuminate said articles and said background members, each of said lamp means being equidistant from said path; and

shield means disposed proximate each of said lamp means to prevent direct illumination of said optical viewing means by said lamp means.

2. In a light-sensitive sorting machine for sorting a succession of articles freely falling along a predetermined path, a compact viewing assembly as recited in claim 1 wherein each of said lamp means includes a lamp filament and said shield means comprises a ribbon-like element disposed to prevent the projection of images of the lamp filaments on the viewed area of the articles and the viewed area of the background members by the respective lamp means.

3. In a light-sensitive sorting machine for sorting a succession of articles freely falling along a predeter-

mined path, a compact viewing assembly as recited in claim 2 wherein said ribbon-like shield elements are disposed in the plane of said lamp means.

4. In a light-sensitive sorting machine for sorting a succession of articles freely falling along a predetermined path, a compact viewing assembly as recited in claim 3 wherein one of said lamp means is disposed adjacent each of said background members to uniformly illuminate said background members.

5. In a light-sensitive sorting machine for sorting a succession of freely falling articles, a compact viewing assembly comprising:

a cylindrical housing having an upper plate, a lower plate spaced from said upper plate, and a cylindrical side wall joining said plates, each of said plates having respective concentric openings there-through defining a central passage through which articles to be sorted may fall;

a plurality of background members disposed within said housing at spaced locations about said central passage proximate said side wall;

a plurality of optical viewing means disposed within said housing at spaced locations about said central passage, each of said viewing means being disposed to view one of said background members and articles passing through said housing between said background members and said viewing means;

a plurality of lamp means disposed about said central passage in said housing to illuminate said background members and said articles falling through said passage;

said viewing means and said lamp means defining a plane normal to said passage; and

shield means disposed proximate each of said lamp means to prevent direct illumination of said optical viewing means by said lamp means.

6. In a light-sensitive sorting machine for sorting a succession of freely falling articles, a compact viewing assembly as recited in claim 5 wherein said background members are supported by at least one of said plates and said optical viewing means and said lamp means are supported by said side wall.

7. In a light-sensitive sorting machine for sorting a succession of freely falling articles, a compact viewing assembly as recited in claim 5 wherein said central passage is defined by a length of cylindrical transparent tube passing through said housing.

8. In a light-sensitive sorting machine for sorting a succession of freely falling articles, a compact viewing assembly as recited in claim 5 wherein one of said lamp means is disposed adjacent to each of said background members to uniformly illuminate said background members.

9. In a light-sensitive sorting machine for sorting a succession of freely falling articles, a compact viewing assembly as recited in claim 5 wherein each of said optical viewing means includes a lens disposed to receive light energy reflected from respective of said background members and from said articles to be sorted and to form a corresponding light beam, a beam splitter disposed to divide said light beam into first and second optical paths, first and second color filters disposed in respective of said paths, first and second optical frame members disposed proximate said respective filters, and first and second photosensitive elements disposed to receive light energy passing through respective color filters and optical frames and to produce electrical sig-

nals representative of the respective energy levels of said paths.

10. In a light-sensitive sorting machine for sorting a succession of freely falling articles, a compact viewing assembly as recited in claim 9 wherein at least one of said optical frame members is adjustable with respect to the corresponding light path to vary the image incident on the corresponding photosensitive element.

11. In a light-sensitive sorting machine for sorting a succession of articles freely falling along a path, a compact viewing assembly comprising:

a housing surrounding said path to define an enclosed viewing chamber through which articles to be sorted may freely fall;

background means disposed within said viewing chamber at spaced locations around said path;

a plurality of lamp means disposed within said viewing chamber in a plane normal to said path for illuminating said background means and the articles falling through said viewing chamber;

shield means disposed proximate each of said lamp means for preventing the projection of a lamp filament image onto said background means and onto the articles falling through said viewing chamber; and

a plurality of optical viewing means disposed within said viewing chamber in said plane for viewing the articles falling through said viewing chamber against said background means.

12. In a light-sensitive sorting machine for sorting a succession of articles freely falling along a path, a compact viewing assembly comprising:

a housing surrounding said path to define an enclosed viewing chamber through which articles to be sorted may freely fall;

background means disposed within said viewing chamber at spaced locations around said path;

a plurality of lamp means disposed within said viewing chamber in a plane normal to said path for illuminating said background means and the articles falling through said viewing chamber;

shield means disposed proximate each of said lamp means for preventing the projection of a lamp filament image onto said background means and onto the articles falling through said viewing chamber; and

a plurality of optical viewing means disposed within said viewing chamber in said plane for viewing the articles falling through said viewing chamber against said background means, each of said optical viewing means including a lens disposed to receive light energy reflected from said background means and the articles falling through said viewing chamber and to form a corresponding light beam, a beam splitter disposed to divide said light beam into first and second optical paths, first and second color filters disposed in respective of said optical paths, first and second optical frame members disposed proximate respective of said filters, and first and second photosensitive elements disposed to receive the light energy of the corresponding optical paths to produce electrical signals representative of the respective light energies, at least one of said optical frame members being adjustable with respect to the corresponding light path to vary the image incident on the corresponding photosensitive element.

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