United States Patent

[11] 3,603,458

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[21] Appl. No 864,490
[22] Filed Oct. 7, 1969
[45] Patented Sept. 7, 1971

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[54] APPARATUS FOR THE DETECTION AND REMOVAL OF SELECTED FOREIGN MATTER FROM A MATERIAL

16 Claims, 3 Drawing Figs.

[52] U.S. Cl. 209/111.6, 250/218
[51] Int. Cl. G06m 7/00
[50] Field of Search 250/218, 222, 223, 226, 210; 356/180, 181, 183, 184; 209/74, 116

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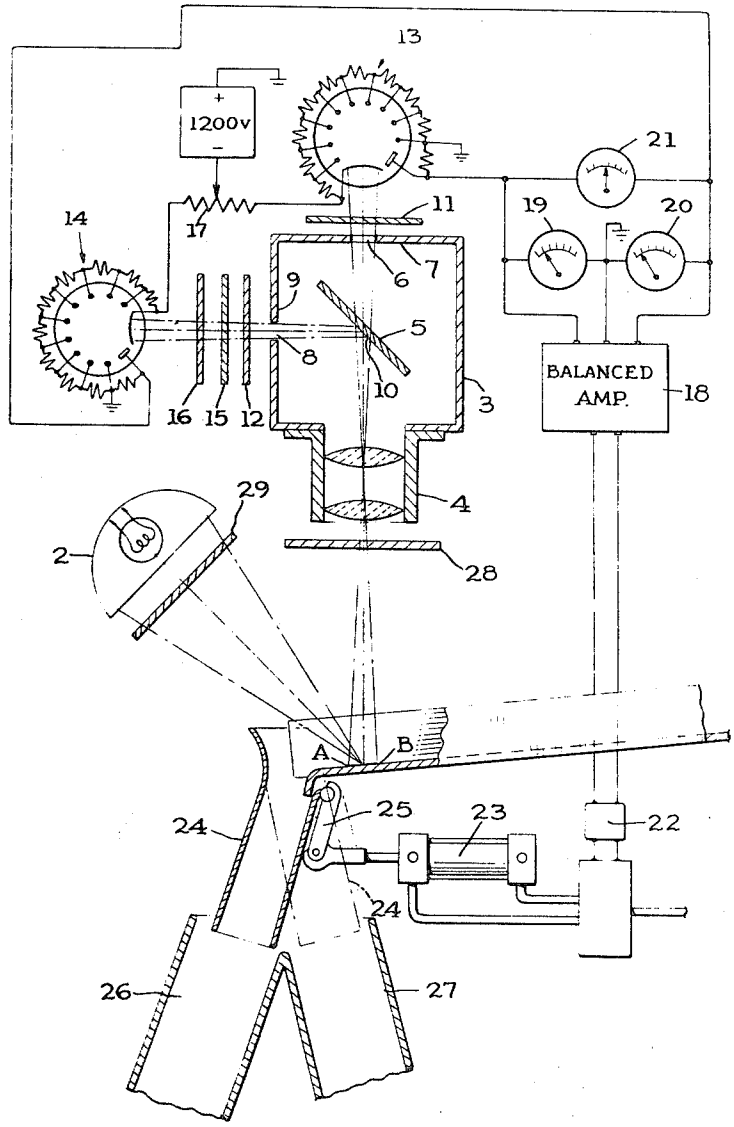
ABSTRACT: Apparatus to detect and remove yolk-contaminated albumen from uncontaminated albumen as it flows over a darkened area of a chute by means of a camera device focused on said area to receive rays on two focal planes through a beam splitter where photosensitive devices, one responsive to yellow light and the other blind to yellow light, create an imbalance when yolk is present, to operate a diverting mechanism downstream of the darkened area.



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SHEET 1 OF 2

FIG. 1.

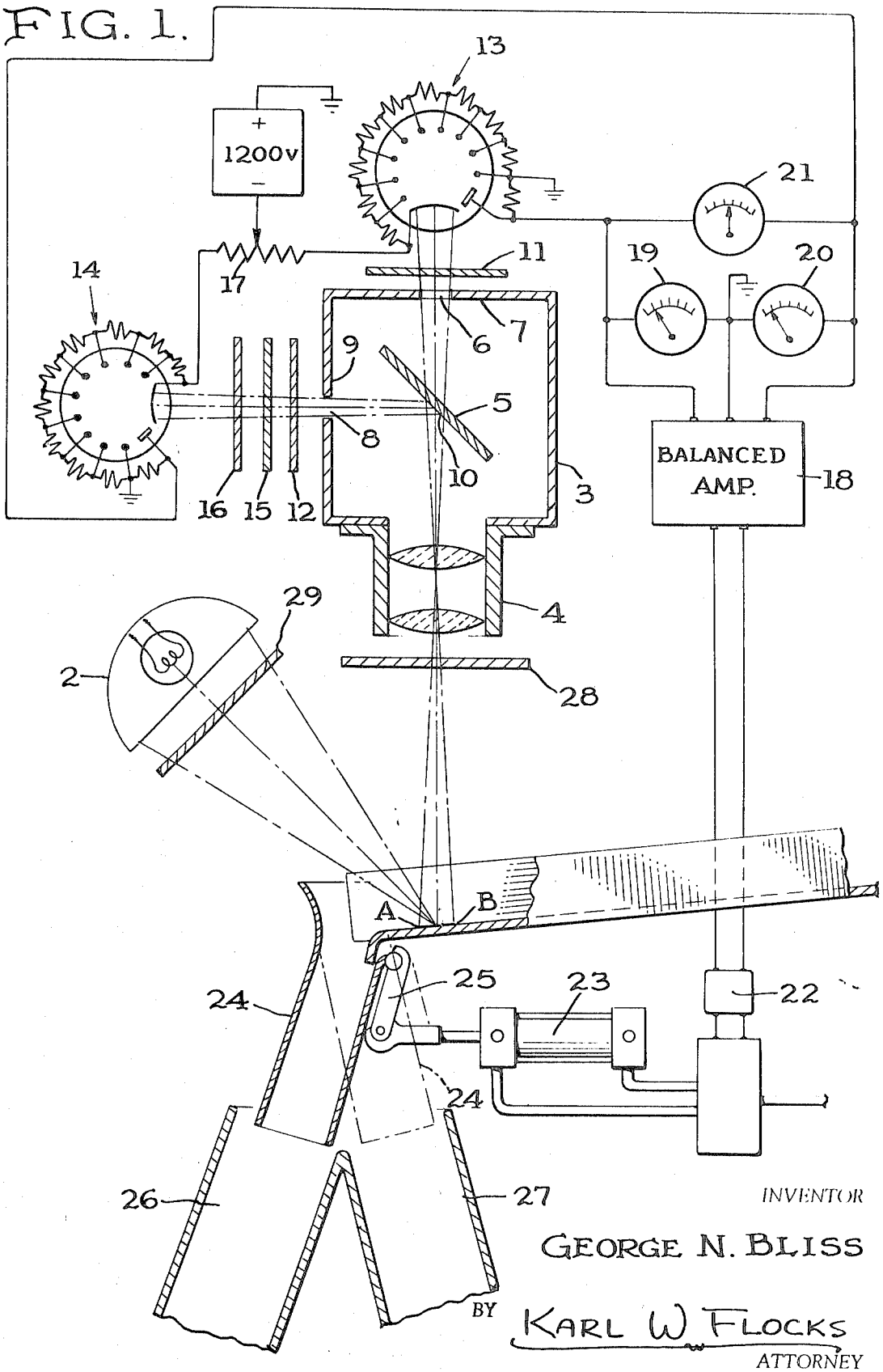

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FIG. 2.

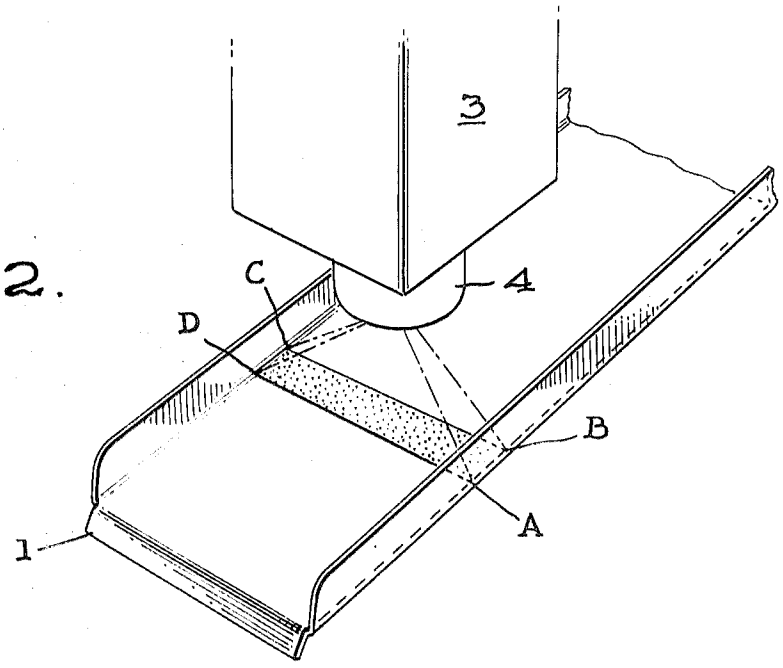
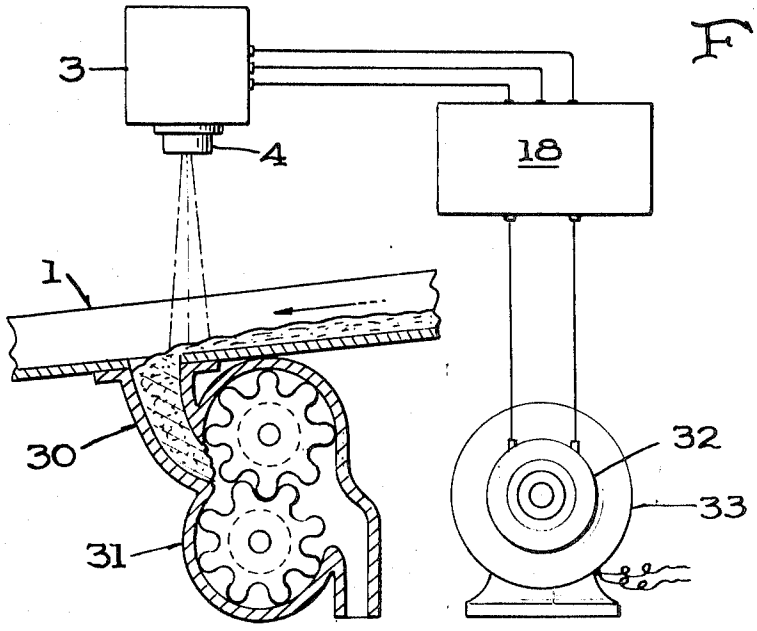


FIG. 3.



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APPARATUS FOR THE DETECTION AND REMOVAL OF SELECTED FOREIGN MATTER FROM A MATERIAL

BACKGROUND OF THE INVENTION

The present invention relates to means for detecting and removing small amounts of foreign matter from material as it passes along a chute or conveyor and more particularly to the automatic detection and separation of albumen contaminated with yolk from clear albumen by analysis of reflected light rays.

With each passing year an increasing percentage of the total egg production goes to large scale breaking plants which sell egg products, either dried or frozen, to the food industry for such things as noodles, cake mixes, candy and prepared foods. Many products such as cake mixes and toppings require pure egg white, which is virtually free of yolk. Whites contaminated by yolk exceeding 0.03 percent will not whip properly and are thus unacceptable to the industry.

Most breaking is done on machinery in which the eggs pass along in a series of cups. The yolks pass along nested in a row of small cups, the whites having run off into a series of larger cups directly beneath. An operator inspects the row of cups as it passes in front of her, and upon seeing a broken yolk, either removes said cup or codes it for dump into mixed egg products which can be sold for certain other purposes.

Since the operator is occasionally unable to spot a broken yolk, or a yolk which may be seeping slowly, a second operator is usually stationed at the discharge end of the machine. She is provided with a spatula; her duty being to scrape out any residual bits of yolk from the albumen as it flows by her on a tray. The present invention is designed to eliminate the need for this second operator, by removing the yolk automatically.

Normal albumen as it comes from a breaker contains numerous bits of foreign matter such as, pieces of chopped off chalaza and shell fragments. These may easily be filtered out during processing by means of a screen. Since any type of gate or deflecting device would necessarily remove amounts of good albumen along with foreign particles, it is desirable that any detector or scanning device be sensitive only to yolk.

SUMMARY OF THE INVENTION

The objects of the present invention are to:

- provide means of detecting small amounts of foreign matter in a material as it passes along a chute or conveyor;
- provide means of discriminating between several types of foreign matter according to color;
- provide apparatus operable under various ambient light conditions;
- provide apparatus unaffected by density of flow on the conveyor or chute;
- provide apparatus for removing said foreign matter while removing as little good material as possible along with it;
- provide means of removing residual amounts of egg yolk from albumen; and
- provide apparatus to accomplish the above which is simple, inexpensive and easy to clean and maintain.

The present invention comprises apparatus for the detection and removal of foreign matter from a substance comprising detection means inspecting the substance being conveyed thereby and diverting means located downstream from the detection means with the detection means including a scanned area on the conveying means and a means to separate reflected light from the substance into separate beams to separate light-sensitive means which are connected to detect differences in light strength received and thus operate the diverting means.

The present invention further utilizes a black or a dark colored trough through which the albumen flows as it is simultaneously scanned by two phototubes. The light reaches one phototube through a blue filter and the other through a green filter. Since the albumen is essentially transparent, and flowing over a dark background, even a small amount of opaque yellow material, such as yolk, passing the scanned area will reflect light which is focused through the two filters simultaneously by means of a beam splitter mirror. Light passing the green filter causes an increased current in the associated phototube. Since the blue filter blocks the yellow image, its phototube current remains unchanged. The state of imbalance thus caused is amplified, and a gate or diverting device is actuated to remove the immediate material containing the yolk. Pieces of white foreign matter on the other hand, such as shell or chalaza, transmit images of equal intensity through both filters, retaining a state of balance between the phototubes and therefore do not activate the diverting device.

BRIEF DESCRIPTION OF THE DRAWINGS

These are well as further advantages which are inherent in the invention will become apparent from the following description, reference being had to the accompanying drawings wherein:

FIG. 1 is a diagrammatic view of an embodiment of the apparatus to detect yolk in albumen after opening of an egg and separation of yolk and albumen;

FIG. 2 is a detail view of a portion of the chute over which the albumen travels; and

FIG. 3 is a partial sectioned view of a second embodiment of diverting mechanism for albumen mixed with yolk.

DESCRIPTION OF PREFERRED EMBODIMENTS

Egg yolk, when viewed through a blue filter, that is a filter essentially blocking all wavelengths longer than 500 mmu., such as, Wratten 047B or a Corning 05562, will appear black. An egg broken out on a flat tray or a plate will appear to have a black yolk, while any pieces of chalaza or shell fragments will offer no contrast.

Albumen, however, in larger quantities has a definite yellow cast. Viewed through a blue filter it appears to have varying amounts of ink dissolved in it, making small amounts of yolk very difficult to distinguish. Further refinement of the principle is used to gain the performance of the present invention.

Referring first to FIG. 1, albumen flows down gravity chute 1, and is illuminated by light source 2. Mounted directly over the illuminated area is camera 3, comprising lens 4, and beam splitter 5, a semireflecting mirror which transmits half the light to focal plane 7 and reflects the other half to focal plane 9. Focal planes 7 and 9 are equidistant from reflecting surface 10 of beam splitter mirror 5, lens 4 being focused so that the image of any object passing beneath camera 3 is projected simultaneously on focal planes 7 and 9. Centered in focal plane 7 is a rectangular slit 6. Only light projected between points A and B on chute 1, is transmitted by slit 6. More specifically, referring to FIG. 2, only light transmitted from the rectangular area ABCD of chute 1 is transmitted through the slit. Area ABCD is hereinafter referred to as the scanning area. Centered in focal plane 9 is a similar rectangular slit 8 and centered so that it also receives light from area ABCD. Thus the narrow precise scanning area ABCD is simultaneously kept under surveillance by both phototubes at all times. Even a small object passing the scanning area will have a marked effect on both phototubes. Light reflected from any object within scanning area ABCD is transmitted through rectangular opening 6, and through blue filter 11, energizing phototube 13. The image is also reflected by beam splitter 5, focused through rectangular opening 8, and through green filter 12, energizing phototube 14. Filter 12, while not necessary, is desirable since it transmits wavelengths immediately adjacent to blue area of the spectrum while being unaffected by yellow. Thus the device is rendered virtually insensitive to variations in color temperature of light source 2, and other ambient light conditions. In order to balance the phototubes when a white object is within the scanning area, variable apertures or similar devices, may be placed in front of one or both photocells, such as twin Polaroid discs 15 and 16. When these discs are turned in relation to each other, the light reaching

phototube 14 is thereby reduced. If multiplier phototubes are used, as illustrated, they may be balanced electrically by varying the dynode voltage by means of balancing potentiometer 17. The output voltages of the two phototubes are fed to balanced amplifier 18. They may be independently read on meters 19 and 20, meter 19 indicating the amount of blue light striking phototubes 13, and meter 20 indicating the amount of green light striking phototube 14. Meter 21 indicates the difference of imbalance. Amplifier 18, when in a state of imbalance, energizes solenoid valve 22, actuating air cylinder 23, causing diverter chute 24 to move into the dashed position by means of crank 25.

The operation of the apparatus of FIGS. 1 and 2 is as follows. Albumen flows by gravity down chute 1, passing over scanning area ABCD and flows through diverter chute 24, into clear chute 26. When even a small amount of yolk enters area ABCD its image is projected simultaneously through rectangular slits 6 and 8. Since yellow light is blocked by blue filter 11, no extra light is received by phototube 13. Thus meter 19 remains stationary. Light projected through slit 8, however, is transmitted by filter 12, causing an increase in voltage from phototube 14, causing meter 20 to rise. Meter 21 will also rise indicating a state of imbalance in amplifier 18. Solenoid valve 22 is then energized, actuating air cylinder 23, and moving deflector chute 24 into the dotted position shown, causing contaminated albumen to flow into contaminated chute 27.

The image of a white object entering the scanning area ABCD is transmitted equally by filters 11 and 12 to their respective photocells. The voltages from phototubes 13 and 14 will increase by an equal amount causing meters 19 and 20 to rise by an equal amount. Meter 21, however, will remain stationary indicating a state of balance in amplifier 18. The albumen will therefore continue to flow through chute 24 into clear chute 26.

Since albumen flowing from an egg-breaking machine often contains certain amounts of foam and bubbles which might have a disturbing influence on the detector, Polaroid disc 28 may be inserted in front of camera lens 4, and Polaroid disc 29 may be inserted in front of light source 2. Discs 28 and 29 are turned so that their planes of polarization are at right angles to each other. Thus disc 28 filters out light from the direct reflection of any bubbles which may be present on the surface of the albumen.

Various types of gating devices may be used for diverting the flow of contaminated albumen, that is albumen mixed with yolk. Another device differing from that shown in FIG. 1 is shown in FIG. 3 wherein an unbalance signal from amplifier 18, obtained as described before, energizes magnetic clutch 32, causing motor 33 to momentarily drive positive displacement pump 31. Contaminated matter is thus sucked down pipe 30 through an opening in the chute 1. Pump 31 is operated only long enough to remove contaminated albumen from the chute 1 but not necessarily to empty pipe 30 since the contaminated albumen in pipe 30 cannot reenter the chute and also forms a surface at the entrance to pipe 30 over which the clear albumen can pass.

While the invention is shown in its preferred embodiments it should be understood that variations are possible both in use and structure without departing from the scope of the invention.

For instance, any type of phototubes or photocells may be used which are sensitive in the blue-green area.

Also, green filter 12 shown in FIG. 1, while desirable, does not necessarily have to be used to obtain good results.

In addition, Polaroid balancing discs 15 and 16 need not be used if the phototubes are balanced electrically.

Furthermore, a beam splitter prism may be used in place of beam splitter mirror 5.

Other variations of the above nature and also uses inherent in such a device will be found within the scope of the invention.

What is claimed is:

1. Apparatus for the detection and removal of selected foreign matter from a liquid substance containing several types of foreign matter comprising:
- means to convey the substance;
- detection means located in operative relationship with said conveying means to inspect the substance;
- diverting means located downstream of the flow of the substance from said detection means;
- said detection means including
  - a scanned area delineated on said conveying means and said area being dark so as to minimize the reflection of light,
  - a light source directed at said scanned area,
  - receiving means adapted to receive light reflected from the liquid only within the scanned area, including:
    - means to separate the received light into at least two separate beams,
    - light sensitive means located in the path of each separate beam of light and sending a signal in proportion to the amount of light received by each of said light-sensitive means,
    - one said light-sensitive means sensitive to light reflected from all foreign matter and the other of said light-sensitive means being insensitive to foreign matter to removed while being sensitive to remaining foreign matter to be retained;
  - and means to detect a differing signal strength between each said light-sensitive means and connected between each said light-sensitive means and having an output connected to said diverting means.

2. The apparatus of claim 1, further characterized by
- means to balance the inputs to the said light-sensitive means.

3. The apparatus of claim 2, further characterized by
- said means to balance the inputs to said light-sensitive means including a pair of polarizing discs rotatable in relation to each other located in the path of at least one said separate beams of light.

4. The apparatus of claim 1, further characterized by
- said diverting means including
  - a signal-activated means activated by an output signal from said means to detect differing signal strength,
  - and a movable chute positioned by said signal-activated means in accordance with said output signal.

5. Apparatus for detecting and removing yolk contaminated albumen from a mass of albumen uncontaminated by yolk comprising
- conveying means through which said albumen flows having a dark area over which the albumen passes;
- detection means focused on said dark area including
  - a lens focusing light reflected only from the dark area onto one focal plane having an aperture to pass light therethrough from said dark area,
  - a beam splitter diverting a portion of said reflected light onto a second focal plane having an aperture to pass light therethrough received from said dark area,
  - photosensitive means at each of said apertures, one of said photosensitive means being responsive to yellow light, the other of said photosensitive means being substantially nonresponsive to yellow light,
  - and balance-detecting means connected to said photosensitive means to detect an unbalancing of signals received from both said photosensitive means;
- and a diverting means located downstream of the flow of albumen from said dark area operable by signal from said balance-detecting means when said balance-detecting means detects a state of unbalance between said photosensitive means.

6. The apparatus of claim 5, further characterized by
- said photosensitive means being substantially nonresponsive to yellow light including a blue filter in the path of said reflected light.

7. The apparatus of claim 6, further characterized by

said photosensitive means being responsive to yellow light including a green filter in the path of said reflected light.

8. The apparatus of claim 5, further characterized by

a pair of polarizing discs rotatable in relation to each other located in the path of said reflected light to said photosensitive means which is responsive to yellow light.

9. The apparatus of claim 5, further characterized by

a source of light directed toward said dark area,

a first polarizing disc in the path of light from said light source,

and a second polarizing disc in the path of light reflected from said dark area.

10. The apparatus of claim 5, further characterized by

said diverting means including

solenoid means connected to said balance-detecting means and activated when said balance-detecting means detects an unbalancing of signals received from said photosensitive means,

and a movable conveying means to divert contaminated albumen from the path travelled by uncontaminated albumen having means connecting it to said solenoid means.

11. The apparatus of claim 10, further characterized by

said means connecting said movable conveying means to said solenoid means including

a fluid-operated piston means operated by said solenoid means,

and lever means connecting said movable conveying means to said solenoid means to move said movable conveying means between alternate positions.

12. The apparatus of claim 5, further characterized by

said diverting means including

pump-operating means connected to said balance-detecting means and activated when said balance-detecting means detects an unbalancing of signals received from both said photosensitive means,

pumping means operatively connected to said pump-operating means and activated thereby,

and conduit means connected to said pumping means and connected to receive contaminated albumen from said conveying means upon operation of said pumping means.

13. The apparatus of claim 12, further characterized by

said pumping means being a positive displacement pump connected to suck the contaminated albumen into said conduit means.

14. The apparatus of claim 5, further characterized by

said photosensitive means and said balance detecting means respectively including multiplier phototubes connected to a balanced amplifier.

15. The apparatus of claim 14, further characterized by

potentiometer means connected between said multiplier phototubes to balance the outputs from said photosensitive means to said balance-detecting means.

16. The apparatus of claim 5, further characterized by

at least one of said apertures being variable in size.