

[54] **AUTOMATIC GRADER**
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[51] Int. Cl. **B07c 5/342**
[58] Field of Search..... **209/111.6, 73, 115, 209/111.8; 198/68**

[56] **References Cited**

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[57] **ABSTRACT**
Apparatus for inspecting tobacco leaves, which comprises means for arranging a group of tobacco leaves into a stream, means for propelling each leaf of said stream in a ballistic path, a background plate mounted adjacent said ballistic path for establishing a predetermined color criteria, optical means mounted in spaced relationship with said ballistic path and said background plate for comparing each tobacco leaf while it is above background plate to the color criteria established by said background plate, and means for sorting the leaves in accordance with the results of the comparison thereof with said color criteria.

18 Claims, 5 Drawing Figures

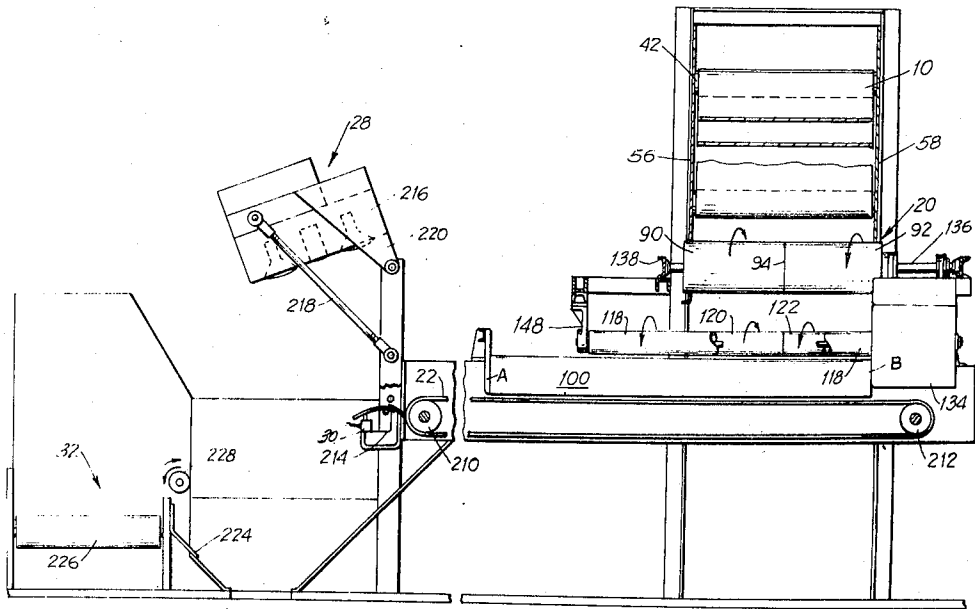
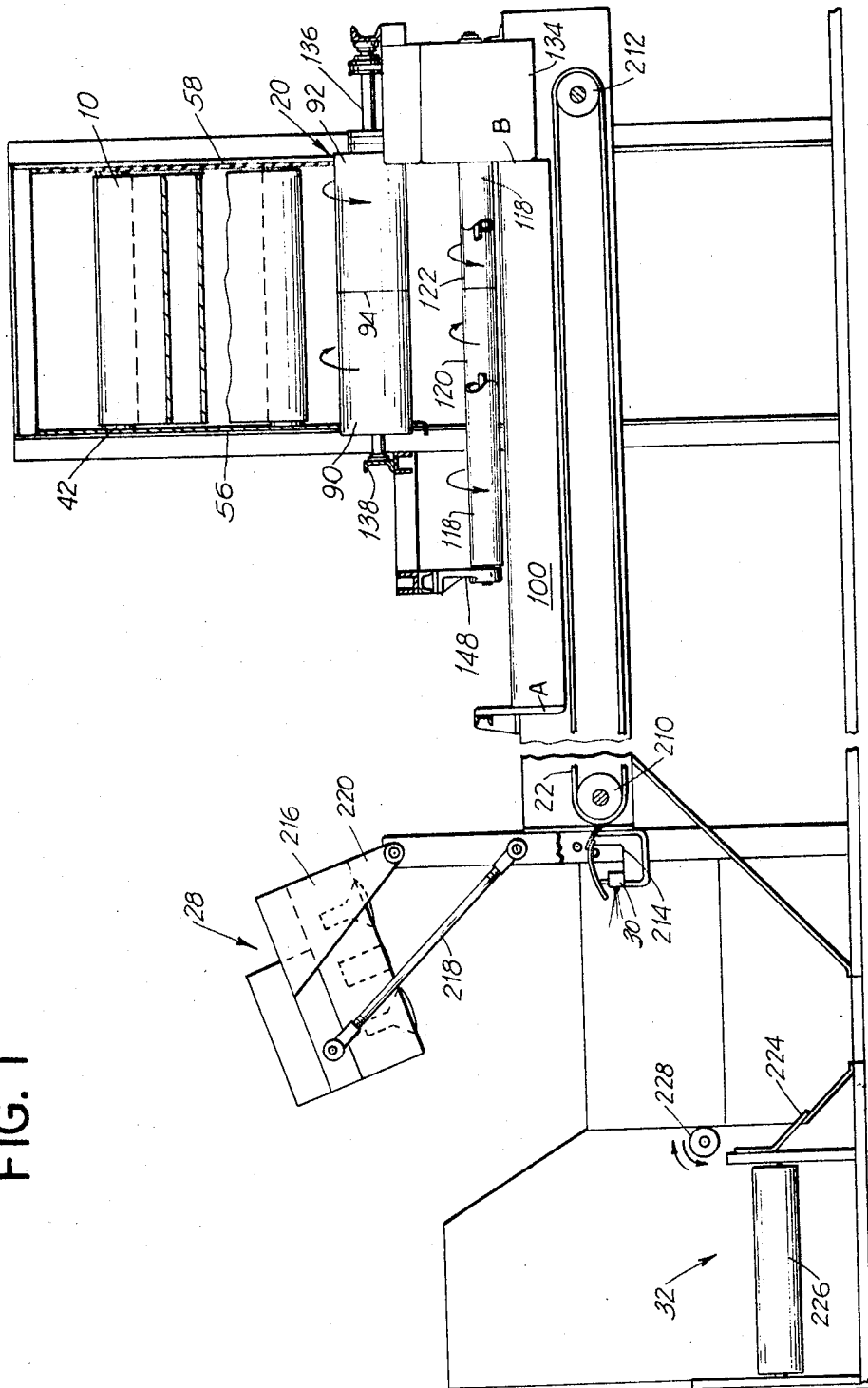
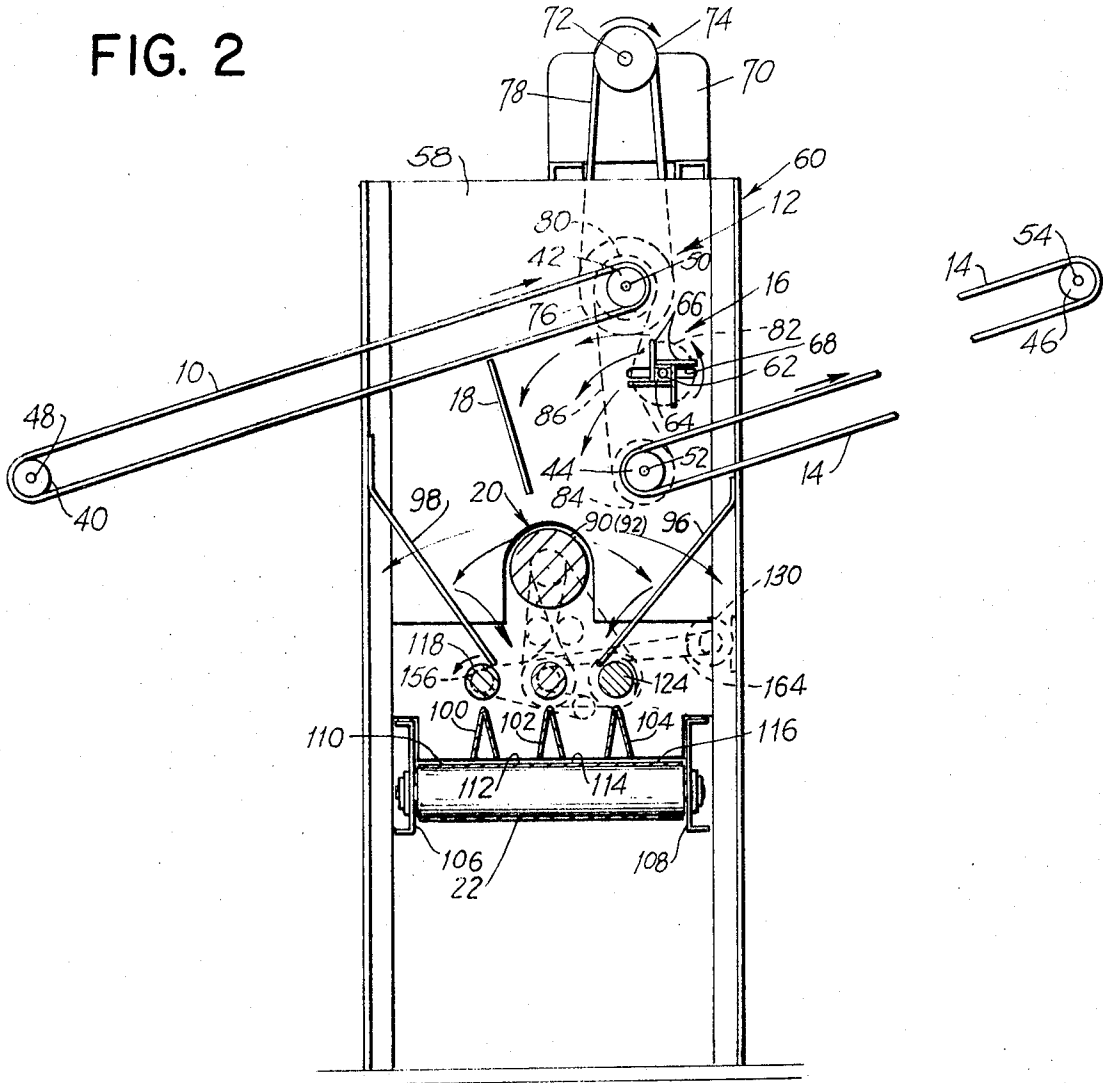


FIG. 1



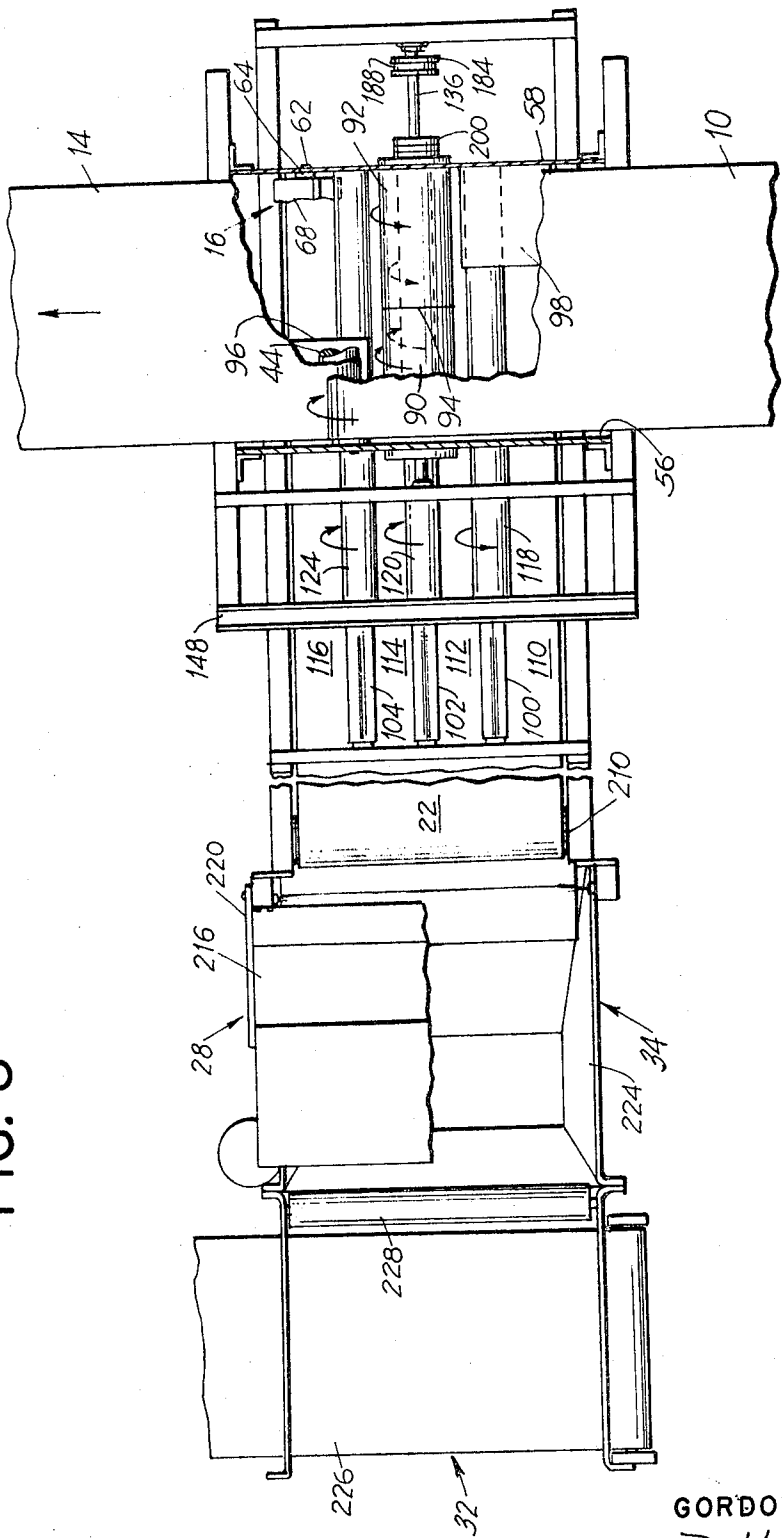
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FIG. 2



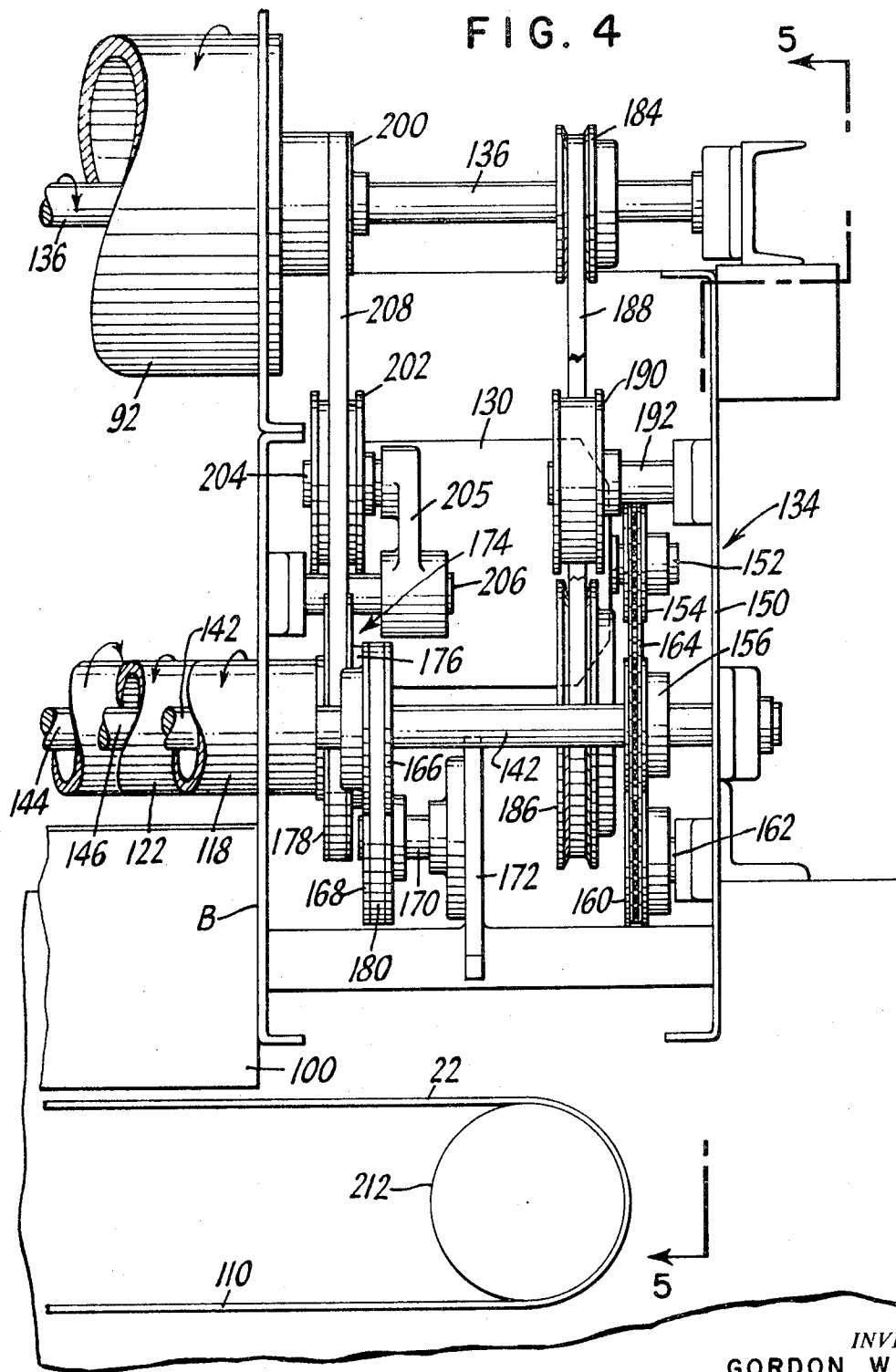
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FIG. 3



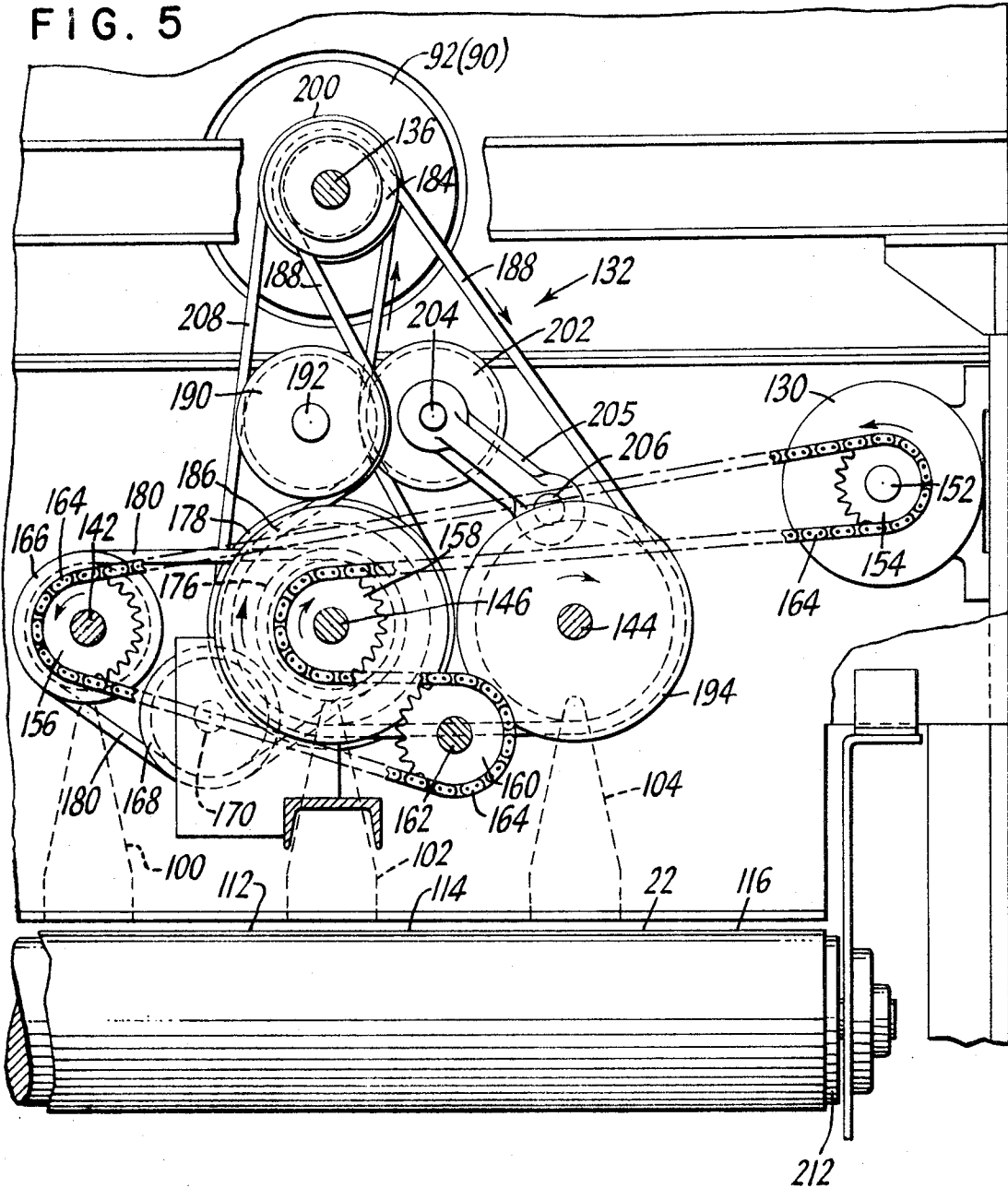
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FIG. 4



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FIG. 5



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AUTOMATIC GRADER

BACKGROUND

This invention relates generally to the processing of tobacco leaves and more particularly to apparatus for sorting tobacco leaves to locate and remove those with colors which are deemed objectionable.

Tobacco leaves are harvested at a desired degree of maturity and are subsequently cured, usually with the circulation of air, and/or with applied heat and moisture. This curing process alters the color of the leaves generally from a shade of green to a shade of yellow or light brown, depending on the type of tobacco. However, because of the variability in the natural grown plants, and due to the uncertainty of the exact degree of maturity of the leaves when harvested, the effect of the curing process on a random group of leaves is such that all leaves do not achieve the desired color. Those leaves which do not achieve the desired color are considered objectionable for use in the subsequent manufacture of smoking articles for reasons of appearance or of taste. Therefore, the tobacco leaf processor will normally sort the leaves procured from the markets in order to remove the leaves with objectionable color in order that the largest bulk of remaining leaves is of higher quality.

In the currently accepted mode of sorting, the tobacco leaves are conditioned by adding moisture to make them suitably pliable and resistant to breakage from mechanical handling and are then conveyed to a flow splitting device to separate the total flow into lesser rates of flow to permit searching for quality. Generally the lesser flow rate is between 400 and 600 pounds of leaves per hour. This reduced flow is diverted to a conveyor belt which conveys the flow of tobacco at a suitable speed and height past human sorting personnel who visually observe the leaves and manually pick objectionable leaves and foreign matter out of the flow.

Tobacco is grown in many different areas, and in several varieties. In addition, the leaves of a particular variety grown in a particular area, while generally graded at the time of harvest according to relative location on the stalk of a plant, frequently require additional grading for color quality of the leaf. Variables in the crop, as well as the quality specified by the manufacturer eventually manufacturing the intended smoking article, determine the degree of perfection required in the sorting function in the leaf processing plant. As a result, the number of sorters required per unit of flow may vary. In the sorting process described above, each of the sorting conveyor belts may have from one to four sorters searching the diverted lesser flow, with two sorters per belt being most common.

It can be seen that this method of leaf sorting entails a considerable amount of hand labor which is not only expensive but is somewhat inaccurate and unreliable.

Apparatus to automatically sort leaf by color has previously been developed. In U.S. Pat. No. 3,380,460 entitled Tobacco Strippers and/or Graders by F. Fuis, Jr., et al., issued Apr. 30, 1968, an apparatus is disclosed for feeding individual tobacco leaves to a roller conveyor mounted on a horizontal surface with one or more exit gates between the rollers and a grading area at the entrance to the conveyor. A light sensitive device records the color of the leaves and triggers the appropriate gate so that a conveyed tobacco leaf can be ex-

ited to a collector positioned under the gate. Such a device is limited in capacity since the leaves must be conveyed in single file and the speed of the device is limited by practical mechanical considerations.

U.S. Pat. No. 3,368,568, entitled Method and Apparatus for Orienting, Aligning and Conveying Tobacco Leaves discloses a method and apparatus consisting of a rotating carrier or turntable for conveyor leaves for subsequent sorting and processing. To convey a large quantity of leaves per unit time requires, however, that the turntable be driven at high enough speed to obtain a high linear velocity of the periphery of the turntable. At high speeds, there is an appreciable centrifugal force acting on the leaves positioned on the vertical surface at the rim of the table. Consequently, the ejection means for selectively removing leaves from the rim of the turntable must apply an appreciable force to the leaves to overcome the centrifugal force. This damages the leaves particularly in the breaking off of particles of the lamina. In addition, the high peripheral speed of the turntable requires that the ejection means be able to respond in a small fraction of a second.

SUMMARY

It is, accordingly, an object of this invention to provide an improved system for sorting articles.

It is a further object of this invention to provide apparatus for rapidly sorting articles such as tobacco leaves in accordance with the color thereof.

It is a still further object of this invention to provide a method of and apparatus for dividing a flow of articles such as tobacco leaves into first and second groups by diverting from the first group of certain leaves in accordance with color criteria.

It is another object of this invention to provide apparatus for dividing a random grouping of articles such as tobacco leaves into flow lanes for individual inspection as to the color thereof.

It is a still further object of this invention to provide apparatus for dividing a random flow of articles such as tobacco leaves into single file streams preparatory to inspection as to their color characteristics.

It is yet still further an object of this invention to provide apparatus for projecting a succession of articles such as tobacco leaves in a ballistic path over a background plate for inspection as to their color characteristics.

Briefly, one aspect of the invention comprises means for dividing a large bulk flow of tobacco leaves into units of flow sufficiently small in quantity so that when placed on a moving belt the leaves will be spread for scanning by an optical/electronic unit, which is the subject of co-pending application S.N. 277,499 filed Aug. 3, 1972 which is a continuation of application S.N. 145,444 filed on even date herewith and which is now abandoned. A diverting mechanism coupled to the optical/electronic unit operates to separate objectionable leaves from the flow path of the good leaves.

In accordance with the objects, apparatus according to the invention may comprise means for arranging a group of tobacco leaves into a stream, means for propelling each leaf of said stream in a ballistic path, a background plate mounted adjacent said ballistic path for establishing a predetermined color criteria, optical means mounted in spaced relationship with said ballistic path and said background plate for comparing each tobacco leaf while it is above background plate to the

color criteria established by said background plate, and means for sorting the leaves in accordance with the results of the comparison thereof with said color criteria.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevation view of a preferred embodiment of the invention.

FIG. 2 is an end view of the apparatus shown in FIG. 1.

FIG. 3 is a plan view of the apparatus shown in FIGS. 1 and 2.

FIG. 4 is an enlarged side elevation view of a portion of the drive mechanism for the preferred embodiment.

FIG. 5 is an end view of the drive mechanism viewed from line 5—5 of FIG. 4.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIGS. 1-3 of the drawings, a preferred embodiment of the invention generally comprises an upwardly inclined infeed conveyor 10 for transporting a flow of unsorted articles, such as tobacco leaves, in the direction indicated. The leaves fall of the end 12 of conveyor 10 and fall towards a second upwardly inclined conveyor 14 disposed below conveyor 10 and in position to receive tobacco leaves falling therefrom.

A diverting mechanism 16 is mounted between conveyors 10 and 14 and is disposed to intercept a predetermined proportion of the tobacco leaves falling from the first to the second conveyors and propel them towards a baffle 18, which arrests the horizontal component of the velocity of each leaf and causes it to fall in a substantially vertical path to a flow dividing unit 20.

The flow dividing unit 20 operates to divide the flow of tobacco leaves into four approximately equal streams, each stream being approximately one tobacco leaf wide. The streams fall onto a high speed conveyor belt 22, which is driven at approximately 500 feet per minute so that the leaves in each stream falling thereon are spaced out therealong. Thus, the leaves falling onto conveyor 22 are arranged in four single file streams.

The high speed of the conveyor causes each leaf to be hurled off the end thereof in a ballistic path that is initially substantially horizontal. A background plate 26 is mounted beneath the ballistic path and an optical/electronic unit 28 is disposed above the ballistic path in a position to view the leaves as they pass over the background plate. The background plate establishes a color criteria for the leaves and the substantially horizontal path of the leaves provided by conveyor belt 22 permits the background plate to be mounted in very close proximity to the path of the leaves without undue errors from shadows, optical range variations and the like. The optical/electronic unit 28 examines the color of each leaf and compares it to the criteria established by the background plate.

The optical/electronic unit 28 is the subject of co-pending application S.N. 277,499 filed Aug. 3, 1972 as a continuation of the now abandoned application S.N. 145,444 filed on even date herewith, and is fully described therein.

A reject unit 30 is mounted adjacent the ballistic path and is operable by the optical/electronic unit 28 to divert leaves found by the unit 28 to be not in conformance with the criteria established by the background plate from the ballistic path for a secondary collection

area 32. Those leaves that are in conformance with the established criteria fall into a primary collection area 34.

More specifically, the first and second conveyors 10 and 14 are mounted over pairs of spaced rollers, designated 40 and 42, and 44 and 46 respectively, each of the rollers being mounted on a shaft, designated 48, 50, 52 and 54 respectively. Shafts 50 and 52 are mounted between spaced walls 56 and 58 which form part of a housing 60 for the conveyors and the dividing unit 20.

The diverting mechanism 16 includes a shaft 62 mounted between walls 56 and 58, a sheave 64 mounted thereon and a plurality of paddles 66 mounted on the shaft 62. The shaft 62 is actually mounted in opposed slots 68 in the walls 56 and 58 and the unit is translatable in the slots 68 by conventional means (not shown) to vary the proportion of leaves diverted from the second conveyor 14.

The two conveyors 10 and 14 and the diverting mechanism 16 are driven by a motor 70 having an output shaft 72 and a sprocket 74 mounted on the shaft 72. A corresponding sprocket 76 is mounted on shaft 50 and a chain 78 drives the latter from sprocket 74. A second sprocket 80 is mounted on shaft 50 and a pair of sprockets, 82 and 84, are mounted in spaced relationship therewith on shafts 62 and 52 respectively. A chain 86 drives the latter two shafts from sprocket 80.

The flow dividing unit 20 includes a pair of counter-rotating rollers 90 and 92 disposed to receive the flow of leaves from baffle 18 and mounted end to end and in axial alignment with each other (FIG. 1). The action of the counter-rotating rollers 90 and 92 is to divide the flow of leaves in half at the juncture points 94 of the two rollers with half being driven to the left as seen in FIG. 2 and half to the right by the action of the rollers on the leaves. The juncture point 94 is half way between walls 56 and 58 and thus can be described as occurring half way along the width of the flow of leaves from baffle 18.

The divided flow of leaves from rollers 90 and 92 is divided again by a pair of baffles 96 and 98. The baffles are located in the path of the flow from the respective rollers and are half the width thereof. Baffle 96 is disposed in the path of the flow from roller 92 and diverts half of that flow to the right as seen in FIG. 2 and baffle 98 is disposed in the flow from roller 94 and diverts half of that flow to the left as seen in FIG. 2.

With this arrangement, the initial flow from baffle 18 is divided into four substantially equal portions along the width thereof, or stated in another way, the original shower of leaves that was substantially uniform between walls 56 and 58 due to the uniform diverting action of paddles 66 acting on the substantially uniform distribution of the main flow across the width of conveyor 10 is directed downward and is divided into four parts at three points equally spaced between the walls 56 and 58.

Three channel members, 100, 102 and 104 are mounted between walls A and B just above conveyor belt 22, as seen in FIGS. 2 and 5. These channel members, in co-operation with side wall members 106 and 108 of housing 60, guide the four respective flows onto the conveyor belt 22. The channel members also define four zones of flow, or streams, or lanes on the conveyor belt, designated 110, 112, 114 and 116 respectively. The three channel members are spaced equidistantly apart such that the four lanes are of equal width, that

width being selected being approximately the width of a tobacco leaf.

Those leaves that float toward the tops of the respective channels are driven to one of the respective lanes by rollers mounted adjacent the top of each of the channel members and designated 118, 120, 122 and 124 respectively. Roller 118 is mounted above channel 100 and is driven in a counter-clockwise direction as seen in FIG. 2 to urge leaves into lane 110. Roller 124 is mounted above channel 104 and is driven in a clockwise direction to urge leaves into lane 116. Rollers 120 and 122 are mounted end to end and in axial alignment and above channel 102 and are driven so as to be in counter-rotation with each other. Roller 120 is driven in a clockwise direction and urges leaves into lane 112 and roller 122 is driven in a counter-clockwise direction and urges leaves into lane 114.

Referring now to FIGS. 4 and 5, the rollers 90, 92, 118, 120, 122 and 124 are driven from a motor 130 through a drive arrangement generally designated 132 and mounted on and within a drive housing 134. More specifically, rollers 90 and 92 are mounted along the axis of a shaft 136 that is mounted for rotation between spaced channels 138 and 140, rollers 118 and 124 are mounted on shafts 142 and 144 respectively and rollers 120 and 122 are mounted along the axis of a shaft 146. The shafts 142, 144 and 146 are mounted for rotation between a horizontally disposed beam 148 and a wall 150 to drive housing 134.

Motor 130 is provided with an output shaft 152 and a sprocket 154 is mounted thereon and driven in a counter-clockwise direction as seen in FIG. 5. A pair of sprockets, 156 and 158, are mounted in spaced relationship with sprocket 154 on shafts 142 and 146 respectively. Another sprocket, 160, is mounted on an idler shaft 162 journaled in wall 150 of the drive housing 134. A chain 164 is mounted over sprockets 154, 156, 158 and 160 to drive shaft 142 in a counter-clockwise direction and shaft 146 in a clockwise direction. Roller 118 is mounted directly on shaft 142 and is thus driven therewith in a counter-clockwise direction. Roller 120 is mounted directly on shaft 146 and rotates therewith in a clockwise direction.

A pulley 166 is fixedly mounted on shaft 142. An idler tensioning pulley 168 is mounted in spaced relationship with pulley 166 on a stub shaft 170 rotatably mounted in a bracket 172 affixed to the floor of housing 134. A double pulley unit 174 having two pulleys, 176 and 178, fabricated in one integral unit is rotatably mounted on shaft 146 such that it can counter-rotate with respect thereto. Pulley 178 is disposed in spaced relationship to pulleys 166 and 168 and a belt 180 drives the pulley unit 174 in a counter-clockwise direction from pulley 166 through pulley 176. The roller 122 is directly mounted to pulley 174 and thus rotates therewith in a counter-clockwise direction, the opposite direction of rotation to roller 120.

A pulley 184 is mounted on shaft 136 in spaced relationship with a pulley 186 mounted on shaft 146. A belt 188 is mounted over pulleys 184, 186, a tensioning pulley 190 mounted on a stub shaft 192 rotatably mounted in wall 150, and a pulley 194 mounted on shaft 144. Thus, shafts 136 and 144 are driven in a clockwise direction from shaft 146. Roller 90 is mounted directly to shaft 136 and thus is driven in a clockwise direction therewith and roller 124 is mounted on shaft 144 and is driven in a clockwise direction therewith.

A pulley 200 is rotatably mounted on shaft 134 in spaced relationship with pulley 178 and a pulley 202 mounted on shaft 204 journaled in an arm 205 that is supported by a stud shaft 206 affixed to housing 134. A belt 208 drives pulley 200 from pulley 178 in a counter-clockwise direction. The roller 92 is affixed to pulley 200 and thus rotates in a counter-clockwise direction therewith, in the opposite direction of rotation of roller 90.

The high speed conveyor 22 is mounted between spaced rollers 210 and 212 and driven by a motor (not shown). The leaves thereon are propelled over the background plate 26, which is mounted by a bracket 214 to the machine frame.

The optical/electrical unit 28 is mounted in a housing 216 supported on the machine frame by opposed extensible struts 218 and hinged brackets 220 such that the direction of view of the unit can be adjusted for proper viewing of the leaves as they pass over the background plate.

The reject unit 30 is mounted just underneath the trailing end of the background plate and is operable to direct a puff of air onto leaves rejected by the unit 28 and lift them out of the ballistic path toward secondary collection area 32. The unit 30 may include conventional air jets, connected through valves to a source of compressed air. The unit 28 opens the valves upon detection of an unacceptable leaf.

The primary and secondary collection areas, 34 and 32, are mounted downstream of the conveyor 22. The primary collection area is shown as a chute 224, through which acceptable leaves will fall for transport to a further handling process.

The secondary collection area is shown as a conveyor 226 for conveying those leaves found unacceptable by the unit 28 and diverted thereto by a puff of air from reject unit 30 to a further processing area. A roller 228 is mounted in front of the conveyor 226 and can be driven in either direction to assist leaves falling thereon either into the primary or secondary areas, depending on which leaves are impinging thereon. Of course, the nature of the collection areas 32 and 34 are not critical and they could be reversed or both could be chutes or both conveyors.

Having now fully set forth both structure and operation of preferred embodiments of the concept underlying the present invention, it may be that various other embodiments as well as certain variations and modifications of the embodiments herein shown and described will occur to those skilled in the art upon becoming familiar with said underlying concept. All such embodiments, variations, and modifications as incorporate the spirit of the invention and depend upon its underlying concept are consequently to be considered as within the scope of the claims appended herebelow, unless the claims by their language expressly state otherwise.

I claim:

1. Apparatus for inspecting articles, which comprises:
 - means for arranging a group of articles in a stream,
 - means for propelling each article of said stream in a substantially horizontal ballistic path,
 - means disposed adjacent said ballistic path for establishing a predetermined color criteria,
 - means mounted in spaced relationship with said ballistic path and said means disposed adjacent

thereto for comparing each article while it is in said ballistic path to the established color criteria, and means for sorting the articles in accordance with the results of the comparison thereof with said color criteria.

2. Apparatus according to claim 1, wherein the means disposed adjacent the ballistic path is a background plate for establishing the color criteria, and the means mounted in spaced relationship with the ballistic path is optical means for comparing the color of each article while adjacent said background plate to the color criteria established thereby.
3. Apparatus according to claim 1, wherein the means for sorting the articles includes: means for directing a blast of compressed air to the articles in response to the comparison made by the optical means.
4. Apparatus for arranging a random flow of articles into at least one stream, which comprises: a first conveyor for transporting articles, a second conveyor spaced from the first conveyor and adapted to receive articles from the first conveyor, means positioned between said first and second conveyors for diverting a portion of the flow from the first conveyor away from the second conveyor, and means positioned in the path of the articles diverted from the second conveyor for dividing the diverted flow into a plurality of streams.
5. Apparatus according to claim 4, further comprising: means positioned in the path of at least one of said plurality of streams for projecting each of said articles in a ballistic path.
6. Apparatus according to claim 4, wherein: the first and second conveyors are mounted over spaced rollers, and the means positioned between the first and second conveyors includes a roller mounted parallel to the conveyor rollers, a plurality of paddles mounted on the roller and means for rotating the roller, wherein the paddles engage and divert articles away from the second conveyor.
7. Apparatus according to claim 6, further comprising: means mounting the roller for translatory movement with respect to the flow of articles between the first and second conveyors to adjust the proportion of that flow that impinges on the paddles.
8. Apparatus according to claim 6, further comprising a baffle in the path of articles diverted by the paddles to guide them to the means for dividing the flow into a plurality of streams.
9. Apparatus for arranging a random flow of articles into single file streams, which comprises: a shaft mounted in the path of the random flow of articles, first and second rollers mounted on the shaft, and means for rotating the rollers in opposite directions to divide the flow of articles into two portions.
10. Apparatus according to claim 9, further comprising: baffle means mounted in the path of each of the respective flow portions, said baffles being operable to further divide the flow into streams.

11. Apparatus according to claim 9, further comprising: a high speed conveyor belt mounted in the path of at least one of the streams for spacing out the articles and propelling them in a ballistic path.
12. Apparatus according to claim 9, further comprising: a high speed conveyor belt mounted in the path of at least one of the portions for spacing out the articles in the portions, and means mounted in spaced relationship with the high speed conveyor for dividing the flow portions into streams of single articles.
13. Apparatus according to claim 12, wherein: the dividing means are vertically extending baffles spaced laterally the width of less than two articles side by side and roller means are mounted in spaced relationship with the top of the baffles into the space therebetween.
14. A method of inspecting articles comprising the steps of: arranging a group of articles into a stream, establishing a color criteria for the articles, propelling the articles in a substantially horizontal ballistic path, comparing each article to the color criteria while it is in said ballistic path, and sorting the articles in accordance with the results of the comparison to the color criteria.
15. A method of arranging articles for inspection, comprising the steps of: intercepting a flow of articles, arresting the horizontal component of the velocity of the articles, dividing the flow of articles into portions, propelling the articles of the portions of flow in ballistic paths, inspecting each of the articles, and sorting the articles in accordance with the results of the inspection.
16. Apparatus for arranging a group of articles into a stream and for inspecting the articles, which comprises: a first conveyor for transporting articles, a second conveyor spaced from the first conveyor and adapted to receive articles from the first conveyor, means positioned between said first and second conveyors for diverting a portion of the flow from the first conveyor away from the second conveyor, means positioned in the path of the articles diverted from the second conveyor for dividing the diverted flow into a plurality of streams, means for propelling each article of said stream in a ballistic path, a background plate adjacent said ballistic path for establishing a predetermined color criteria, optical means mounted in spaced relationship with said ballistic path and said background plate for comparing each article while it is above the background plate and in said ballistic path to the color criteria established by said background plate, and means for sorting the articles in accordance with the results of the comparison thereof with said color criteria.

17. Apparatus according to claim 16, wherein the means positioned in the path of the articles diverted from the second conveyor includes:

A pair of axially aligned rollers,
means for driving the rollers in opposite directions, 5
and
a baffle mounted opposite a portion of each roller.

18. Apparatus for inspecting articles, which comprises:

means for arranging a group of articles in a stream, 10
means for propelling each article of said stream in a ballistic path comprising a conveyor positioned to receive the stream of articles and means for driving

said conveyor at a speed sufficient to space out the articles falling thereon,
means disposed adjacent said ballistic path for establishing a predetermined color criteria,
means mounted in spaced relationship with said ballistic path and said means disposed adjacent thereto for comparing each article while it is in said ballistic path to the established color criteria, and
means for sorting the articles in accordance with the results of the comparison thereof with said color criteria.

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