United States Patent

Douglas et al.

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[45] **Apr. 11, 1972**

[54] UNSCRAMBLER FOR LIGHT BULB TRAYING MACHINE

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[73] Assignee: **Corning Glass Works,** Corning, N.Y.

[22] Filed: **Apr. 15, 1970**

[21] Appl. No.: **28,831**

[52] **U.S. Cl.** ..... **198/33 AA,** 221/10, 198/82

[51] **Int. Cl.** **B65g 29/00**

[58] **Field of Search** ..... 198/33 AA, 33 R, 40, 167, 165, 198/33 AD; 53/142; 221/10

[56] **References Cited**

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2,439,883	4/1948	Brown	53/142
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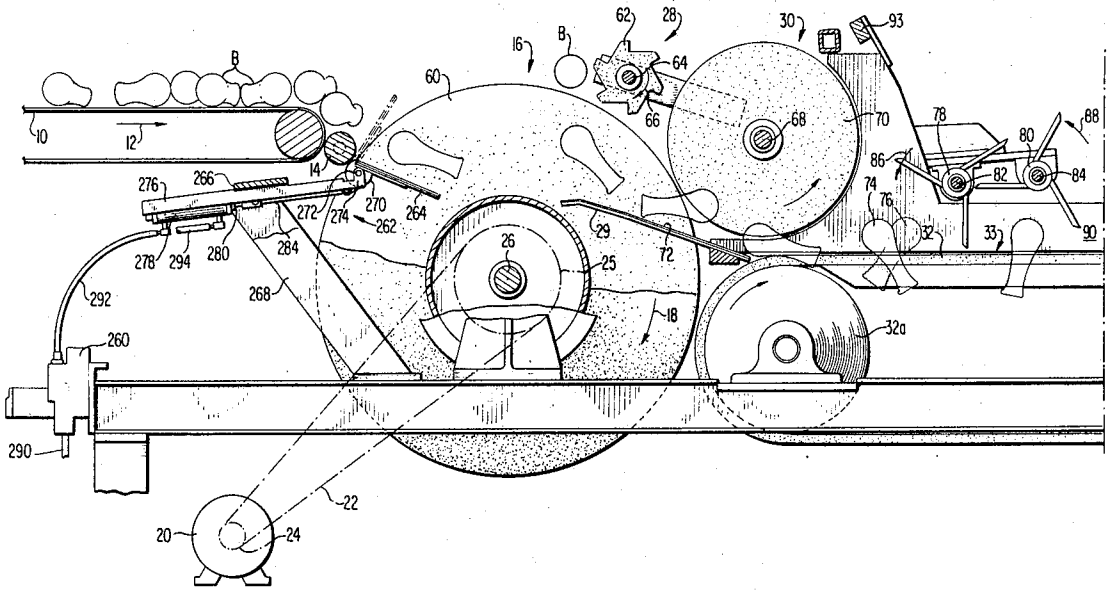
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[57] **ABSTRACT**

A photoelectric bridge containing a plurality of photoelectric elements is placed across a plurality of channels formed between adjacent conveyor belts and carrying light bulbs which are to be loaded into apertures in a tray. There must be a light bulb in each channel at the loading end so that each aperture in the tray is filled. The photoelectric bridge detects the speed of the light bulbs in each channel and produces an electric signal whenever the light bulbs are moving at less than a predetermined speed, thereby indicating that that channel is relatively full of bulbs. Upstream of the conveyor, the signal operates a diverter or blocking means to temporarily block bulbs from being fed to that channel, thereby diverting incoming lamp bulbs to the other relatively empty channels in which the bulbs are moving relatively quickly. Improved means are also provided for properly orienting the bulbs in the channels and for removing broken bulbs.

9 Claims, 16 Drawing Figures



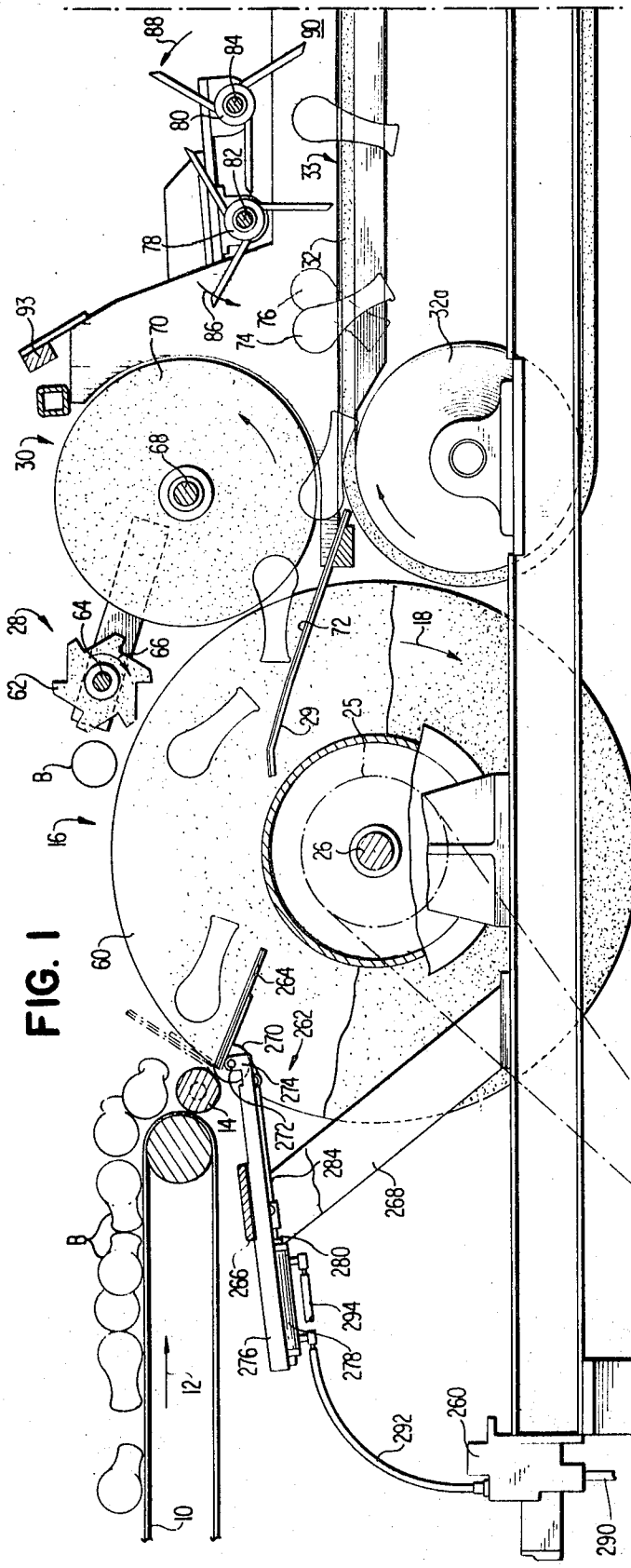


FIG. 1

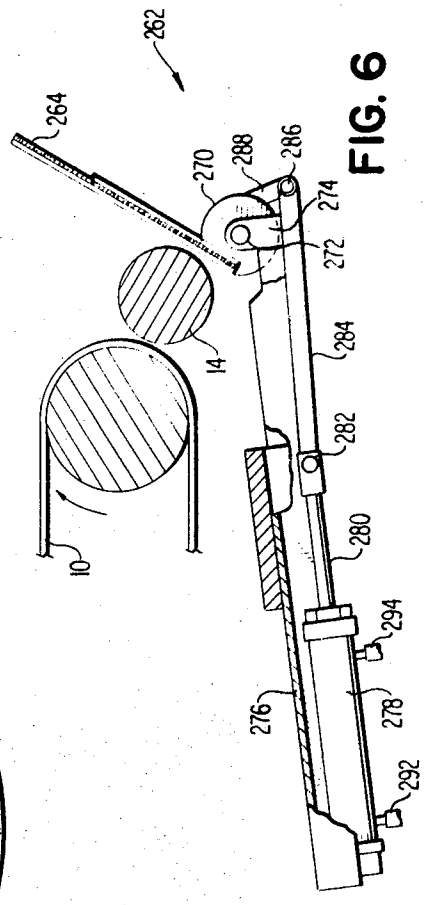


FIG. 6

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ATTORNEYS

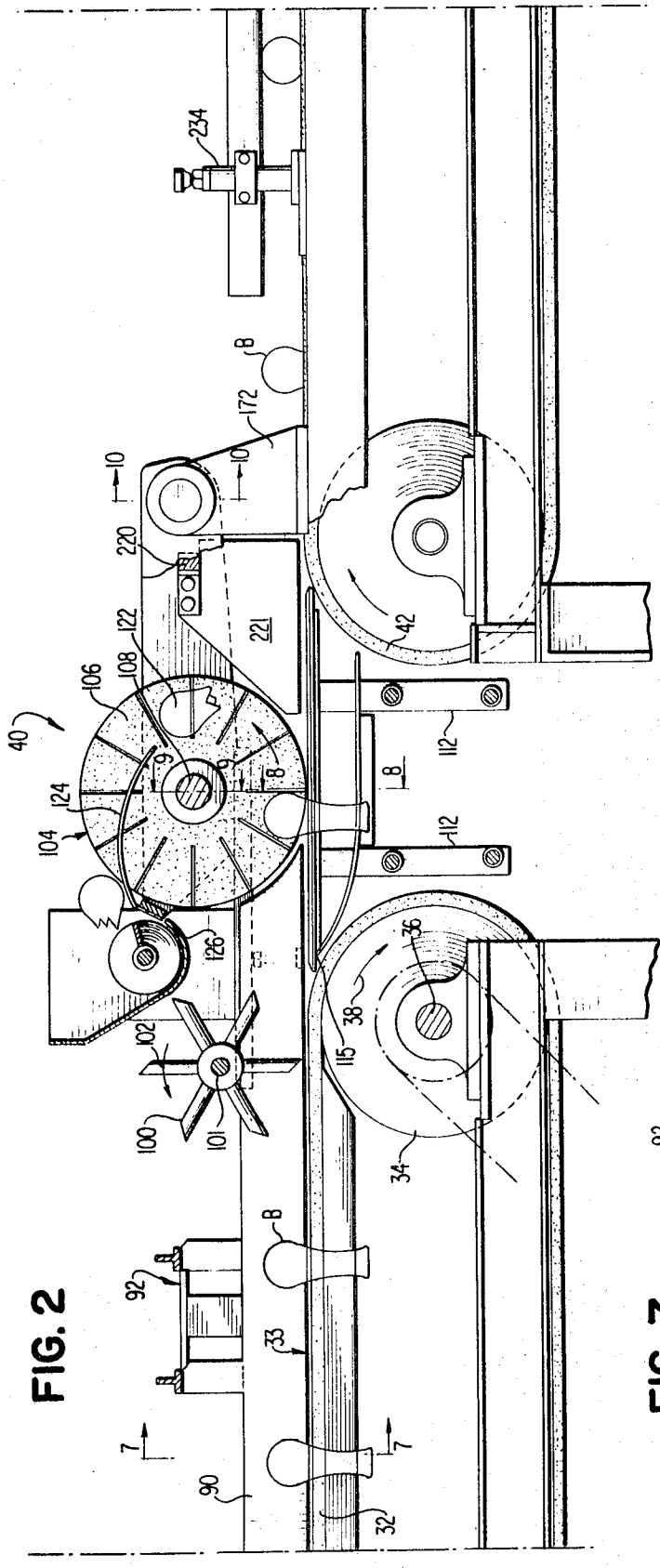


FIG. 2

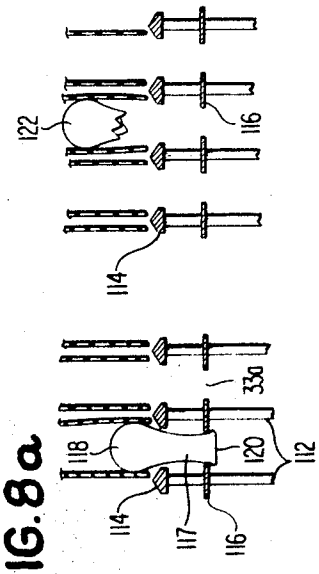


FIG. 8b

FIG. 8a

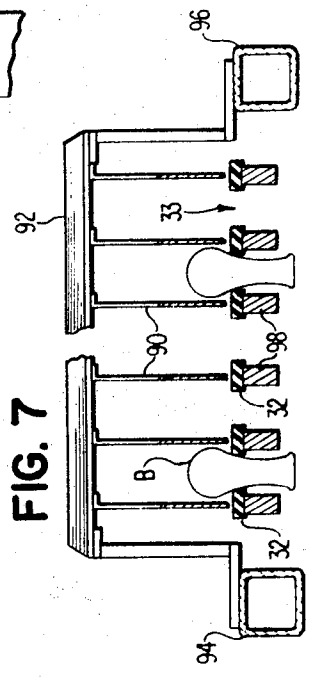
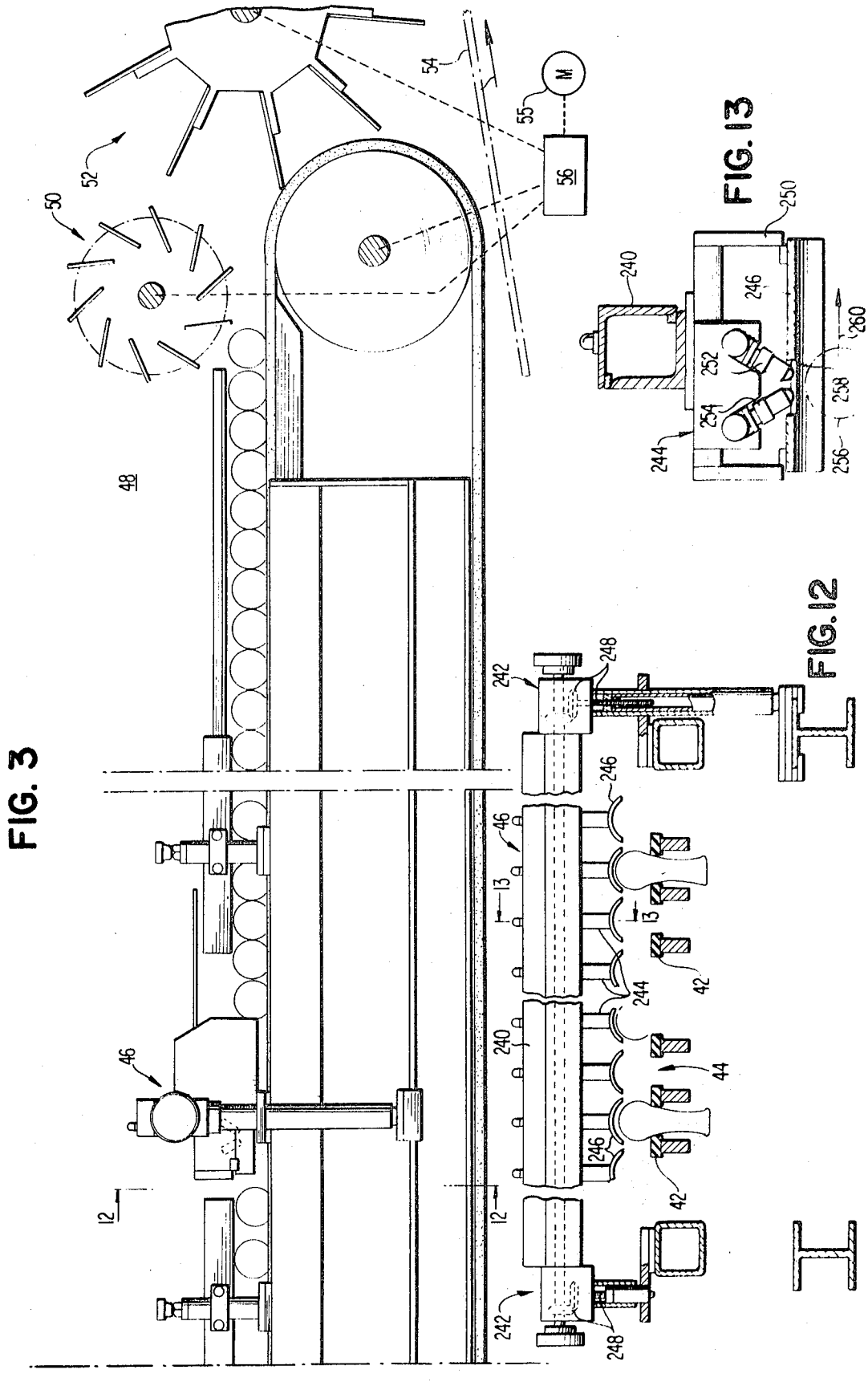


FIG. 7


FIG. 3
FIG. 12
FIG. 13
48
50
52
54
55
56
M
12
13
42
44
46
240
242
244
246
248
250
252
254
256
258
260

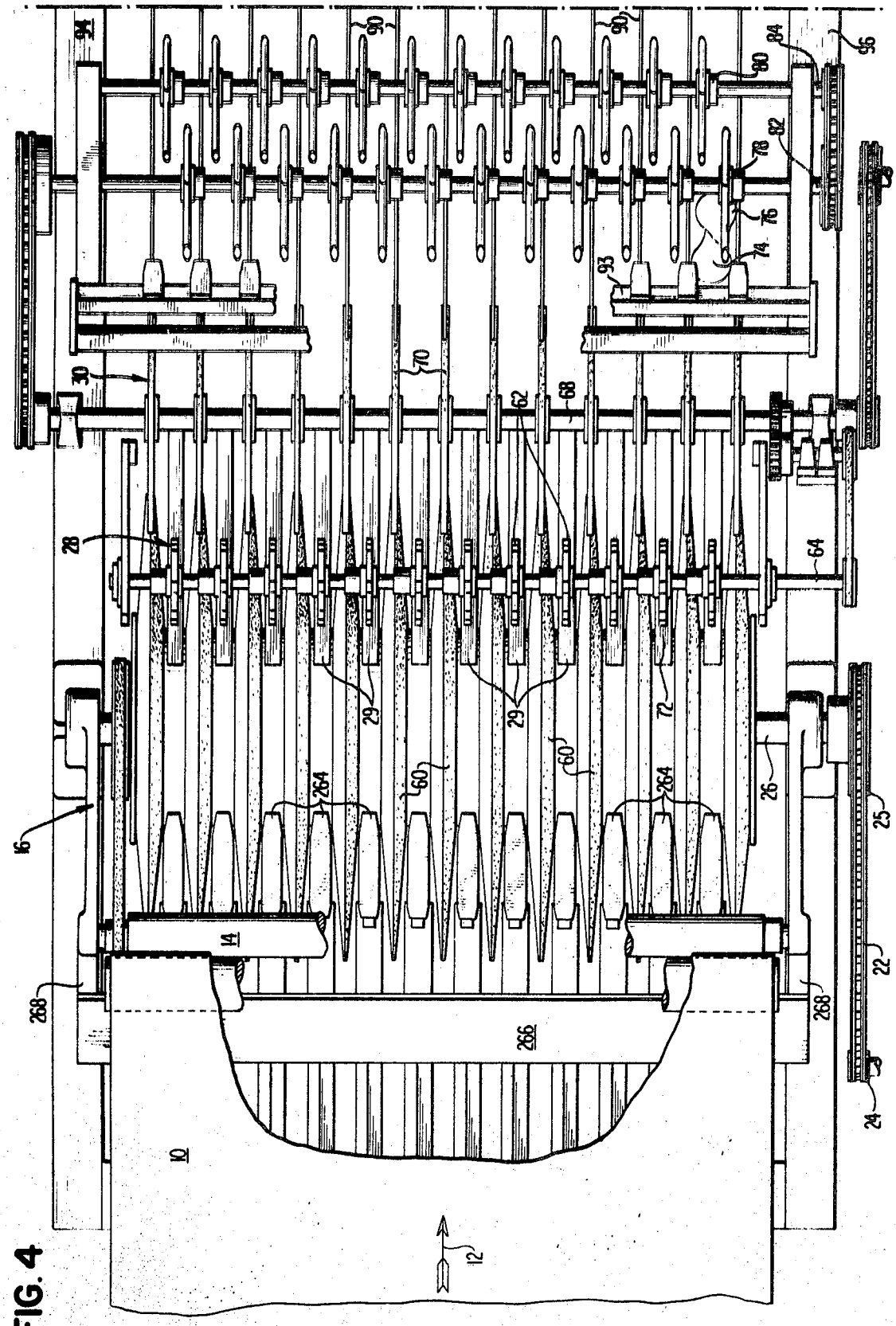

94
90
90
84
96
80
82
78
76
74
93
70
30
68
62
28
64
29
29
72
60
60
264
264
26
25
16
14
22
268
268
266
10
12
24

FIG. 4

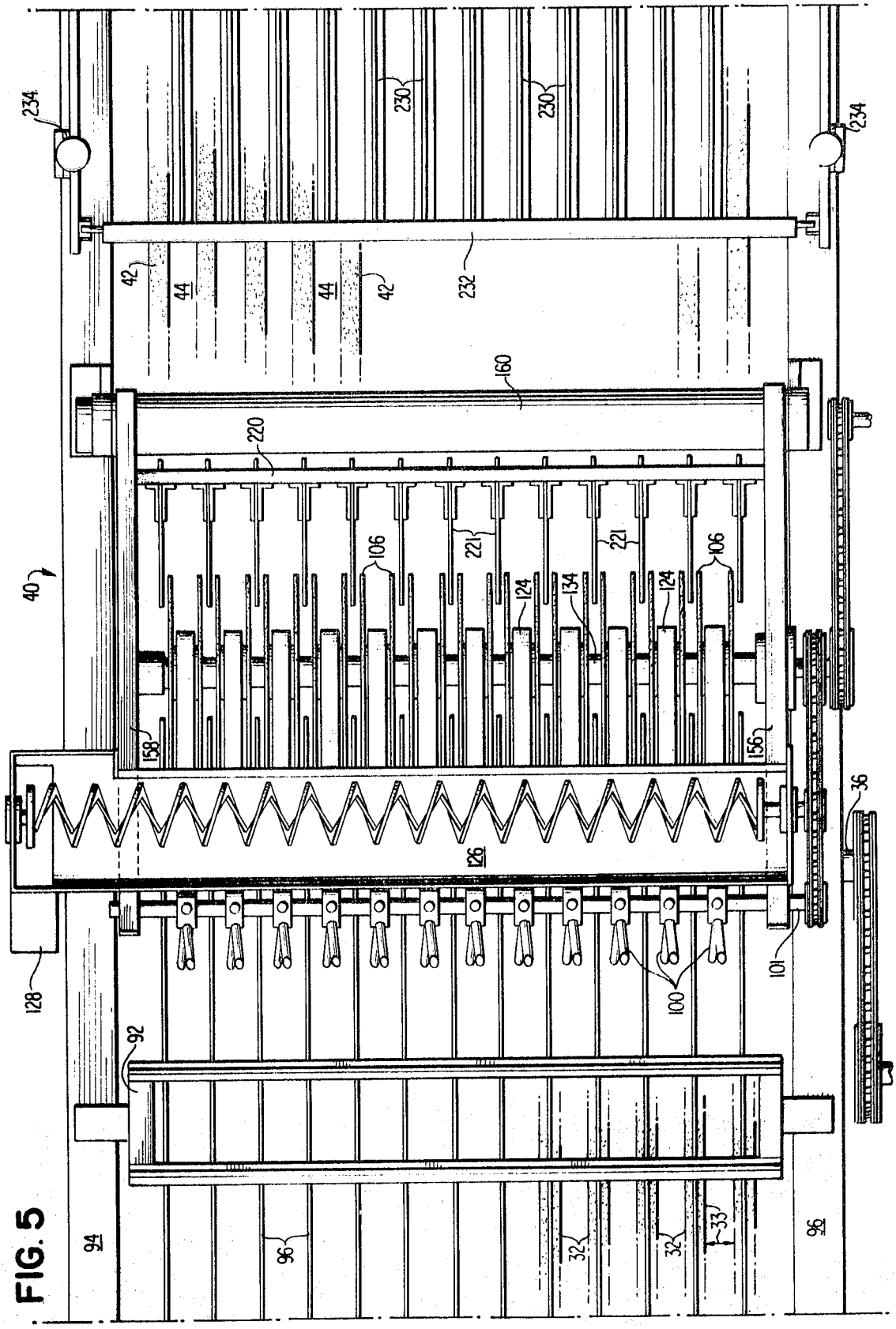

234
230
230
234
42
44
44
42
232
160
220
106
221
221
106
40
124
134
124
158
156
36
126
128
101
100
92
94
96
32
32
33
96

FIG. 5

FIG. 9

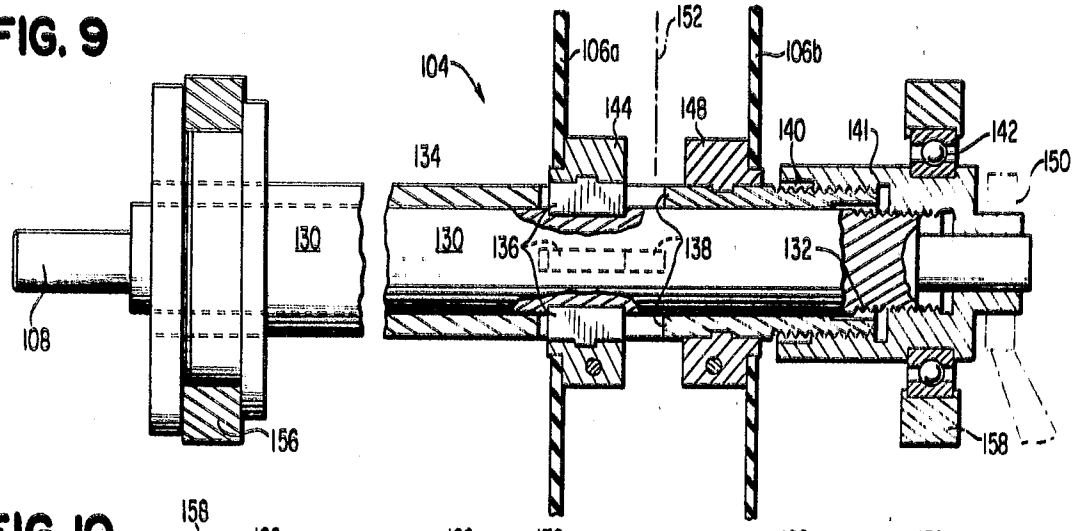
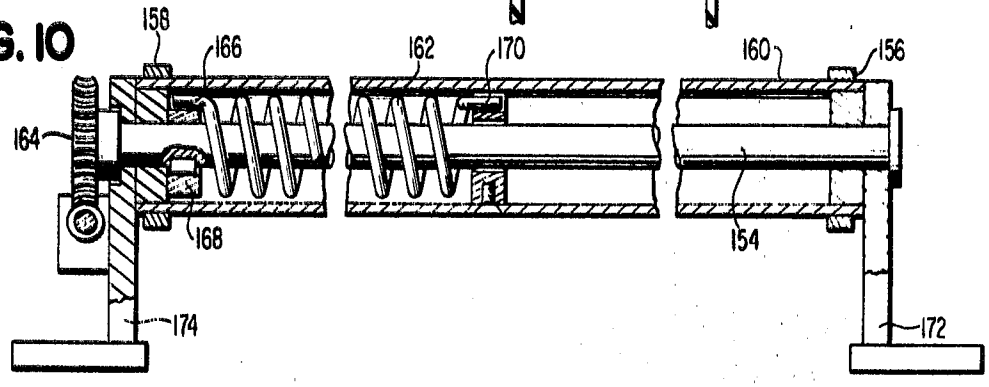


FIG. 10



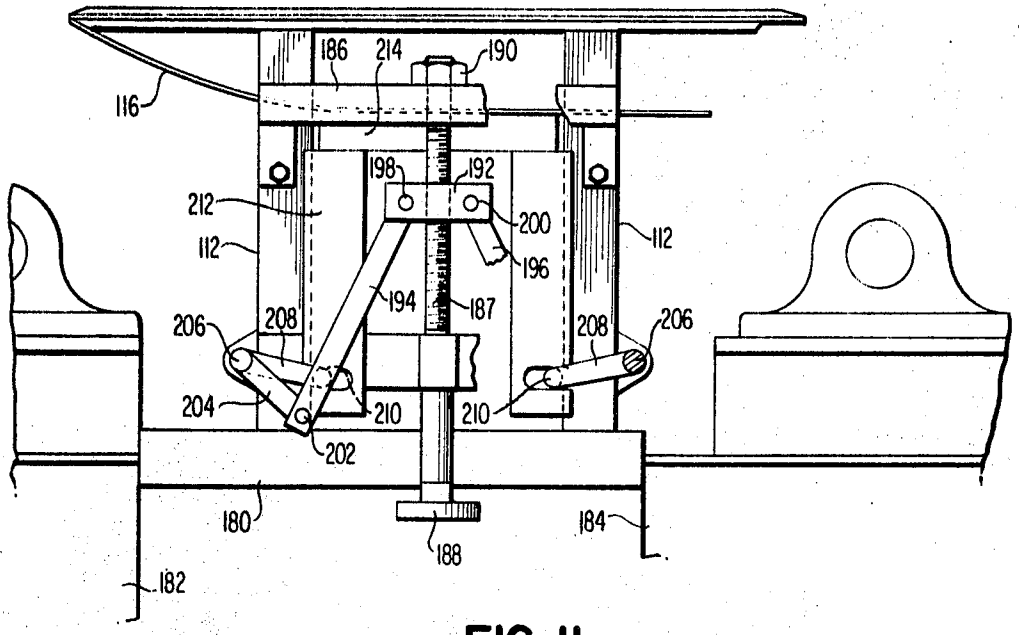


FIG. 11

FIG. 14

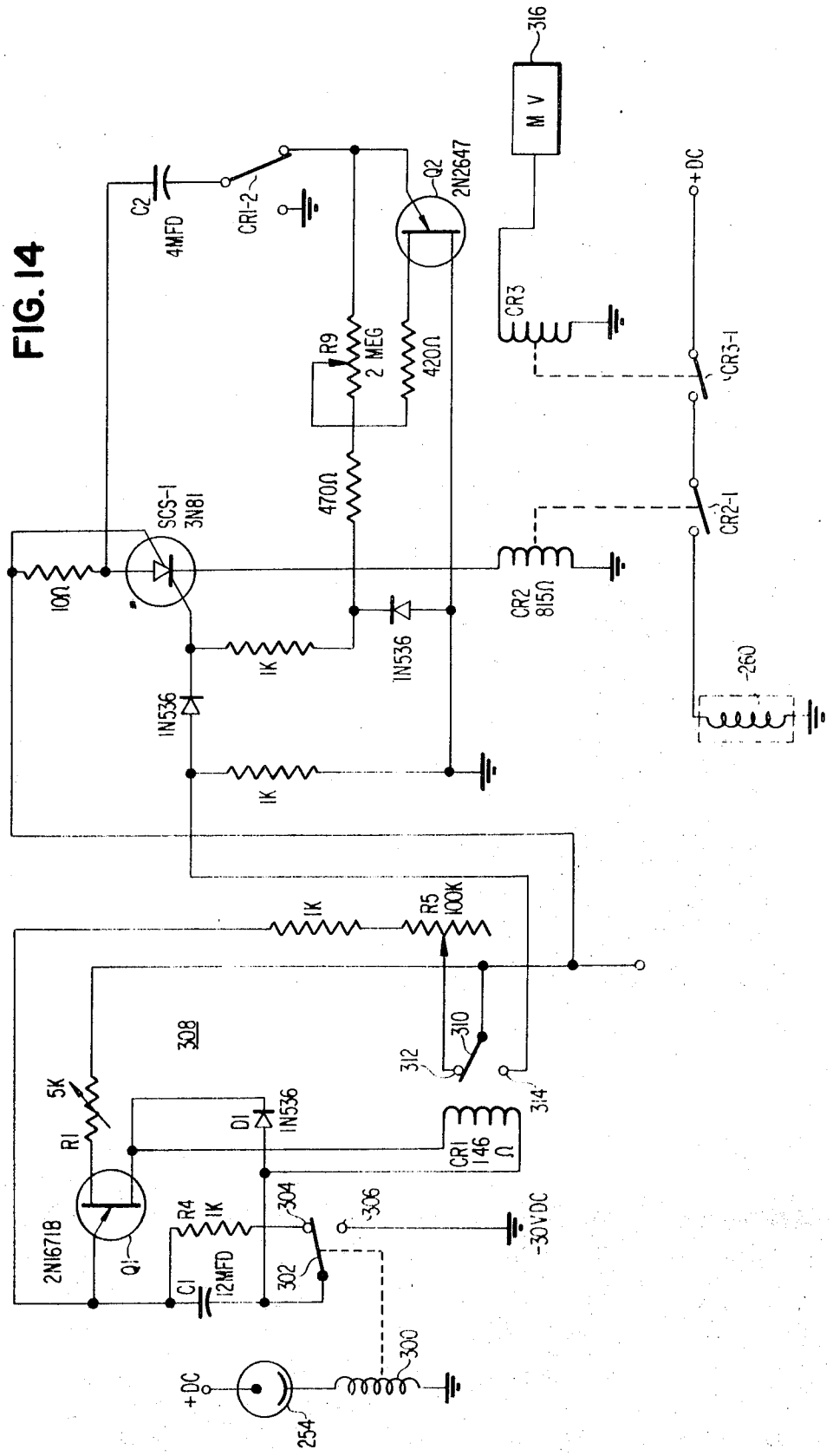
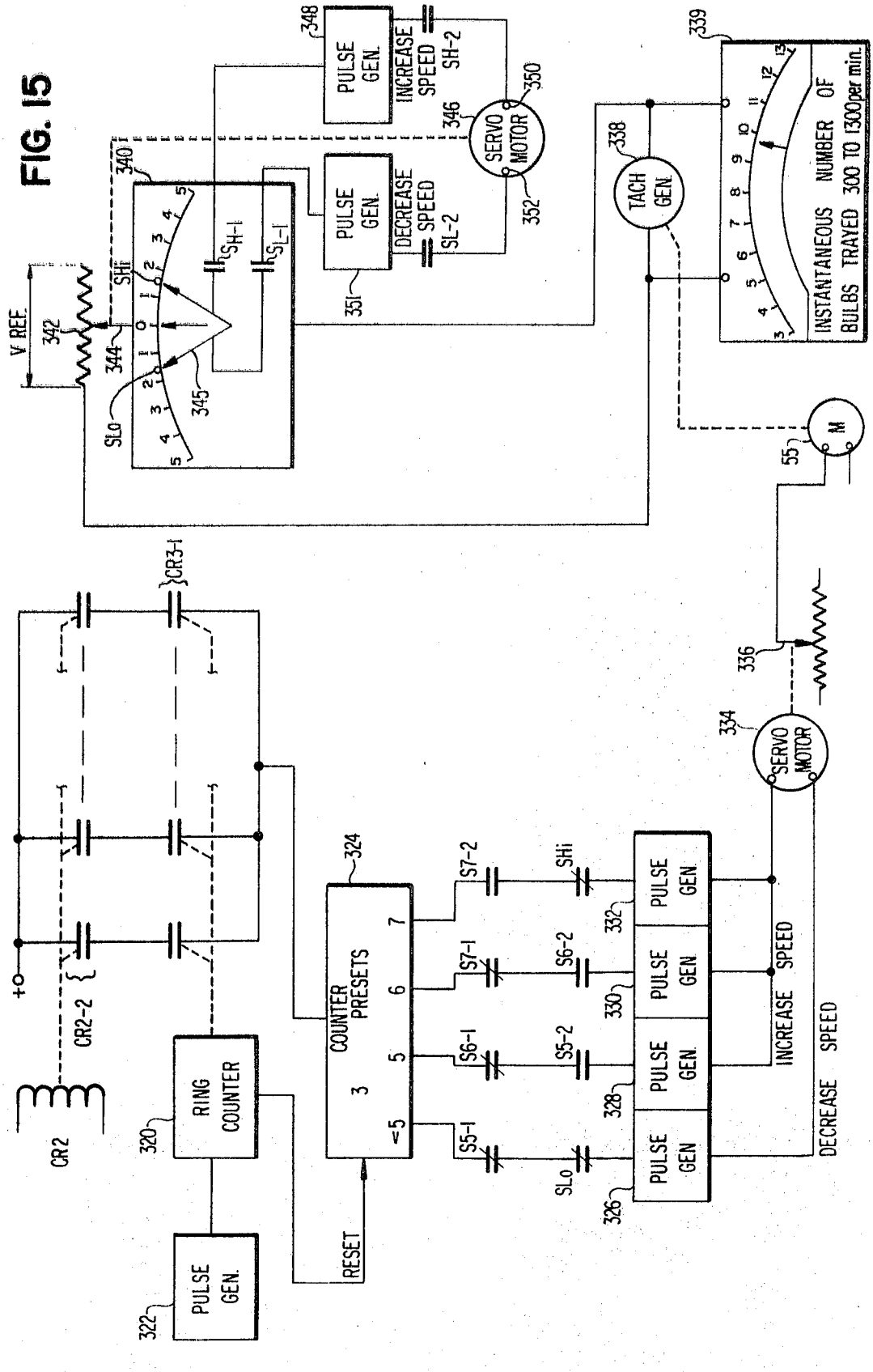

316
M V
+DC
Q2
2N2647
C2
4MFD
CR1-2
R9
2 MEG
420Ω
CR3
CR3-1
470Ω
SCS-1
3N81
10Ω
CR2
815Ω
CR2-1
IK
IN536
260
IN536
IK
IK
R5
100K
308
312
310
314
5K
R1
D1
IN536
CR1
146
Ω
2N1671B
Q1
R4
IK
304
306
-30VDC
C1
12MFD
302
300
+DC
254

FIG. 15


V REF.
342
344
345
SLo
SHi
SH-1
SL-1
340
PULSE GEN.
348
INCREASE SPEED
SH-2
SERVO MOTOR
346
350
352
PULSE GEN.
351
DECREASE SPEED
SL-2
TACH GEN.
338
339
INSTANTANEOUS NUMBER OF BULBS TRAYED 300 TO 1300 per min.
55
M
336
334
SERVO MOTOR
CR3-1
CR2-2
CR2
+o
RING COUNTER
320
PULSE GEN.
322
RESET
COUNTER PRESETS
324
3
5
6
7
<5
S7-2
S7-1
S6-1
S5-1
SHi
S6-2
S5-2
SLo
PULSE GEN
332
330
328
326
INCREASE SPEED
DECREASE SPEED

UNSCRAMBLER FOR LIGHT BULB TRAYING MACHINE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to the field of automatic article handling machines and more particularly to automatic lamp bulb traying machines in which bulbs received in a disarranged order from a lamp bulb making machine are unscrambled and arranged in rows on a conveyor so that the bulbs can be uniformly loaded into a tray a row at a time.

Description of the Prior Art

This invention is an improvement in an automatic lamp bulb traying machine of the type disclosed in U.S. Pat. No. 2,439,883. In such a prior art machine, rows of lamp bulbs are automatically fed to the tray loading mechanism. It is important that a bulb be present in each row at the tray loading mechanism so that every opening in the lamp bulb tray is filled. Each opening must contain a lamp bulb since, in the following frosting operation, the acid used for frosting is applied by nozzles located under the tray and, if there is no bulb in an opening, the acid will shoot up through the opening and fall upon the outer surfaces of the other bulbs in the tray. As recognized in the above-cited patent, since there was no means provided for keeping the number of bulbs in the rows substantially equal, two persons had to be stationed on either side of the conveyor belts in order to remove bulbs from full rows and place them in the relatively empty rows, thereby attempting to keep a full supply of bulbs in all rows at the tray loading end of the conveyor. These persons also removed broken bulbs and manually corrected the orientation of any bulbs so that each bulb was positioned neck-down between the parallel conveyor belts.

SUMMARY OF THE INVENTION

The primary object of the invention is to provide an improved unscrambler for a light bulb traying machine wherein the number of bulbs in each row is maintained substantially equal and also wherein the rows of bulbs being fed to the traying machine are automatically maintained relatively full of bulbs, thereby eliminating the need for persons to stand along side the machine to transfer bulbs from relatively full rows to relatively empty rows.

A more specific object of the invention is to provide photoelectric sensing means for detecting the relative speed of the bulbs in the rows in order to produce a control signal which operates blocking or diverting means for diverting bulbs at the input end from the rows which are relatively full to the rows which are relatively empty, thereby assuring that bulbs will continuously appear in all rows at the tray loading end of the machine.

Still another object of the invention is to provide an automatic traying machine with improved mechanical means for properly orienting the bulbs before they are fed to the tray loading mechanism.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side view of the input end of the unscrambler showing the blocking or diverting means;

FIG. **2** is a side view of the mechanism for rejecting broken bulbs;

FIG. **3** is a side view of the machine showing the photoelectric sensing means and the means for transferring the bulbs to trays;

FIG. **4** is a top view of FIG. **1**;

FIG. **5** is a top view of FIG. **2**;

FIG. **6** is a detailed side view of the diverter means shown in FIG. **1**;

FIG. **7** is a cross sectional view taken along line **7—7** in FIG. **2**;

FIGS. **8***a* and **8***b* are cross sectional views taken along line **8—8** in FIG. **2**;

FIG. **9** is a cross sectional view taken along line **9—9** in FIG. **2**;

FIG. **10** is a cross sectional view taken along line **10—10** in FIG. **2**;

FIG. **11** is a detailed view of a portion of the bulb rejecting mechanism illustrated in FIG. **2**;

FIG. **12** is a cross sectional view taken along line **12—12** of FIG. **3** showing the photoelectric bridge;

FIG. **13** is a detailed view of a single photoelectric unit taken along line **13—13** of FIG. **12**;

FIG. **14** is a schematic electrical diagram of a portion of the electronic control system; and

FIG. **15** is a block diagram of a portion of the electronic control system.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIGS. **1–3** illustrate the preferred embodiment of the improved traying machine in three portions with the lamp bulbs entering the machine at FIG. **1** and continuing successively through the portions of the machine illustrated in FIGS. **2** and **3**. FIGS. **4** and **5** are top views of FIGS. **1** and **2**, respectively. The traying machine of which the present invention is an improvement is of the type disclosed in U.S. Pat. No. 2,439,883, which is expressly incorporated by reference herein.

Before describing the details of the invention, there will be presented a brief description of the flow path of the lamp bulbs and the operations performed thereon with reference to FIGS. **1–5**.

A lamp bulb making machine (not shown) discharges lamp bulbs B onto a conveyor belt **10** moving in the direction indicated by arrow **12**. The bulbs generally extend across the width of the belt **10** and are completely disarranged. As the bulbs leave conveyor belt **10**, they are thrown, by action of rotating roller **14**, into a disc assembly **16** rotated in the direction indicated by the arrow **18** by means of a suitable drive mechanism such as an electric motor **20**, a chain **22**, sprockets **24** and **25**, and an axle **26**. A spider wheel assembly **28** and another disc assembly **30** cooperate with the disc assembly **16** and guide plates **29** to place individual lamp bulbs neck down in the channels **33** formed between a plurality of relatively narrow conveyor belts **32**, which are supported by a set of rolls **322** in the vicinity of disc assembly **30** and are driven at the same speed by a set of drive rolls **34** which are keyed to a common shaft **36** and driven by a suitable means, such as an electric motor, in the direction indicated by the arrow **38**. The surfaces of the drive belts are very smooth and preferably waxed so that, if a bulb is not blocked, there is sufficient friction between the belt and the bulb so that the bulb moves with the belt at the same speed thereof. However, if something blocks the path of the bulb, the bulb will remain stationary as the belts move beneath it. The bulbs are then moved to a checking station **40** where bulbs having broken neck portions are ejected. The unbroken bulbs are then transferred to another set of conveyor belts **42** which are similar to belts **32** and define channels **44** therebetween. The bulbs are carried beneath a photoelectric bridge **46** and then carried to the output end **48** of the unscrambler where they are removed by the operation of an escapement wheel **50** and a traying wheel **52** to be inserted into the openings of a tray **54** carried by a conveyor (not shown) operating in synchronism with belts **42**, escapement wheel **50**, and the traying wheel **52**, all as described in U.S. Pat. No. 2,439,883. The elements are all driven by the same electric motor **55** via a gear box **56**.

A detailed description of the structure and operation of the improved unscrambler portion of the traying machine will now be presented.

The disc assembly **16** is conventional and consists of a plurality of tapered spaced flexible discs **60** which frictionally engage the lamp bulbs being transferred from conveyor belt **10** and carries the bulbs in a clockwise direction towards conveyor belts **32**. A feature of the present invention is the spider wheel assembly **28**, consisting of a plurality of relatively soft notched wheels **62**, one of which is spaced between each pair of the discs **60**. The notched wheels are driven by means of a

common shaft **64** in the direction indicated by the arrow **66**. In the event that a lamp bulb, approaching the spider wheel assembly **28**, is being carried sideways on the surface of two of the discs **60**, then one of the spider wheels kicks such a bulb back in a counterclockwise direction to give the bulb another opportunity to fall in between two of the discs. Lamp bulbs properly positioned between the discs will pass beneath the spider wheel assembly **28** without being affected thereby, and then will be frictionally engaged by the disc assembly **30**. This assembly consists of a plurality of flexible spaced untapered discs **70** driven by a common shaft **68**. As shown in FIG. **4**, discs **70** are spaced the same distance apart as discs **60** and are in alignment therewith. Each pair of discs **70** frictionally engages a bulb from the corresponding pair of discs **62** and transfers the bulb to a corresponding channel between a pair of the moving conveyor belts **32**. Guide plates **72** are positioned between each pair of discs **60** and beneath the space between each corresponding pair of discs **70** to assist in the guiding of the light bulbs into the channels between the belts **32**. Guide plates **72** also prevent any bulbs from being retained by the disc assembly **16** beyond the transfer point with the disc assembly **30**. The disc assembly **30** also greatly enhances the proper orientation of the bulbs neck down and the channels formed between the belts **32**, and is another important feature of the invention.

Sometimes two bulbs in the same channel, such as the bulbs **74** and **76**, become interlocked or jammed together as illustrated in FIG. **4**. In order to separate them, an important feature of this invention provides a pair of kicker wheels **78** and **80** which are driven by individual shafts **82** and **84** in a counterclockwise direction as indicated by the arrows **86** and **88**. As shown in FIG. **4**, there is one pair of kicker wheels **78** and **80** for each conveying channel. Each wheel contains three moderately flexible spokes which extend downwardly towards the channel so as to engage the enlarged portions of the bulbs **74** and **76**. The wheels are so disposed so that the spokes of one wheel are near one side of the channel while the spokes of the other wheel are near the other side of the channel. Furthermore, the wheels are driven at different speeds, for example, one may be driven twice as fast as the other. In such an arrangement, when two bulbs are jammed together, such as bulbs **74** and **76**, the action of the spokes on the two sets of wheels is to separate the bulbs, the slower moving wheel tending to retard the bulb which it engages and the faster wheel tending to accelerate the movement of the other bulb in the direction of the moving belts.

Another improvement of this invention is the provision of a pair of upstanding partitions **90** disposed on either side of each conveying channel. These partitions are, in practice, positioned along the centers of the belts and function to keep the bulbs in the desired neck-down position by preventing them from falling or turning sideways in the channels. These partitions are supported over the belts by means of supporting frames **92** and **93** which extend transversely across all the conveyor belts **32**.

FIG. **7** is a cross sectional view taken along lines **7—7** in FIG. **2** and shows, in more detail, the manner in which partition support frame **92** supports the partitions **90** over the centers of the belts **32**. The support frame **92** is itself supported on the main machine frame side rails **94** and **96**. Belt support members **98** are positioned beneath belts **32** in order to prevent the belts from sagging.

The bulbs spaced at varying distances are then carried by the conveyor belts **32** in a neck-down position in the channels to the bulb checking station **40** which functions to remove from the channels bulbs with broken neck portions. As a practical matter, if a bulb is broken, it will break at the narrowed neck portion of the lamp bulb envelope. This function in the prior art was provided by two persons, one standing on either side of the mmachine, who manually remove the broken bulbs. As the bulbs approach the right hand end of the conveyor belts **32**, a plurality of kicker wheels **100**, mounted on a common shaft **101** and rotating in the direction indicated by arrow **102**, kick or accelerate the bulbs toward another disc assembly **104** comprising a plurality of pairs of slitted flexible discs **106** driven by a common shaft **108** in the direction indicated by arrow **110**.

Disposed below each pair of discs **106** is a pair of vertical frame members **112** having supporting rail segments **114**, the top surface of each of which presents a double taper as shown in FIGS. **8***a* and **8***b*. Secured at **115** to the underside of each rail segment **114** are thin flexible strip-shaped members **116** which define channels **33***a* characterized in that they are slightly wider than the narrow portion of the neck of the bulbs but smaller than the outside diameter of the neck at the opening of the bulbs. Slots are provided in members **116** to allow for the passage of vertically extending supports **112**. Each bulb is frictionally engaged between two of the discs **106** which tend to rotate the bulb counterclockwise out of the channel **112**. As illustrated in FIG. **8***a*, if the neck **117** of the bulb **118** is intact, then the enlarged end portion **120** is forced upwardly against the lower surface of the members **116** to prevent the bulb from being removed from the channel, in which case the bulb is merely moved to the right to be inserted into one of the channels **44** between the conveyor belts **42**. However, as shown in FIG. **8***b*, if a bulb **122** has a broken-off neck portion, then the discs **106** will remove the bulb from the channel **33***a* and carry it upwardly counterclockwise and against a guide plate **124** from where it is discharged into a trough **126** containing a continuously rotating screw conveyor. The broken bulbs are conveyed by the screw conveyor to an outlet **128** from which they are ejected.

The assembly carrying the discs **106** is shown in more detail in FIG. **9**. For the sake of clarity, only one pair of discs **106** is shown in this Figure. Since different sized bulbs may be handled by this machine, it is necessary to provide some means for adjusting the spacing between each pair of discs **106***a* and **106***b* in order to accommodate different diameter bulbs. The common drive shaft **108** is integral with or fixed to an inner shaft **130** having a threaded end portion **132**. Shaft **130** is keyed to an outer hollow shaft **134** by means of keys **136** fixed to shaft **130** and riding in the slot **138** formed in the outer shaft **134**. Shaft **134** also has a threaded end portion **140**, but the end portions **132** and **140** have threads running in opposite directions. An appropriate threaded coupling **141** is threaded onto the end portions **132** and **140** and is mounted for rotation in a suitable bearing **142**. The disc **106***a* is fixed to a collar **144** which receives the portion of keys **136** extending through slots **138** beyond the periphery of shaft **134**. In like manner, the disc **106***b* is fixed to a collar **148** which is keyed to the outer shaft **134**. Consequently, when shaft **108** is rotating, shafts **130**, **134**, and the discs **106** rotate with it. Also, when a wrench **150** is applied to the end of the coupling **141** to rotate the coupling, the shafts **130** and **134** will be driven axially in opposite directions to either increase the separation between the discs or decrease the separation, depending upon the direction of rotation of the coupling **142**. Of course, since all the discs **106** are mounted in the same manner as discs **106***a* and **106***b*, all the discs are simultaneously adjusted. Furthermore, because of the construction, discs **106***a* and **106***b* are maintained equidistant from the center line **152** between the discs. The disc assembly **104** is pivotably mounted on a shaft **154** to enable the disc assembly to be rotated clockwise to give access to the channels **33**a below the assembly, if so desired. Shaft **101** of kicker wheel assembly **100**, trough **126** and shaft **108** of the disc assembly are supported between vertical plates **156** and **158** whose opposite ends are fixed to a hollow shaft **160** connected to shaft **154** via a relatively heavy torsion spring **162**. When the disc assembly **104** is in the position illustrated in FIG. **2**, the torsion spring is wound in such a direction as to counterbalance the weight of the disc assembly. This is accomplished by means of a worm gear **164** fixed to shaft **154**. One end **166** of the spring is fixed in a slot in a collar **168** which is fixed to the shaft **154**. The other end **170** of the torsion spring is fixed to the hollow shaft **160**. Shaft **154** is supported at its ends by extensions **172** and **174** which are fixed to

the machine frame. When the spring is properly wound to counterbalance the weight of the disc assembly, the disc assembly may be manually rotated clockwise without any great effort.

Since the bulbs may also vary in length, it is necessary to provide some means for adjusting the vertical position of the flexible metal slats **116**.

The mechanism illustrated in FIG. **11** is a means for accomplishing this result.

A mounting plate **180** is fixed at either end to the machine frames **182** and **184**, and a cross member **186** is fixed to the vertical support members **112** which support the V-shaped bulb holding rails **114**. These rails are V-shaped for two reasons: 1) to better conform to the curve of the bulb envelope and also 2) to permit any broken glass to fall off the rails. A threaded shaft **187** having a knob **188** on its lower end passes through the mounting plate **180** and the cross member **186** where it is clamped by a nut **190**. A yoke **192** is threaded on the threaded portion of the shaft **186**. A pair of lever arms **194** and **196** are pivoted at **198** and **200**, respectively, on the yoke **192**. Since this adjusting device is symmetrical, we will look at only one side thereof. The arm **194** is pivoted at point **202** to another arm **204** which is fixed to a shaft **206** which extends across the width of the machine. Fixed to the shaft **206** is a plurality of lever arms, such as **208**, having a roller **210** mounted on the end thereof. Cooperating with each of the rollers **210**, is a U-shaped member **212** whose upper portion **214** engages the lower end of the flexible metal slat **116**. There is a U-shaped member **212** and a pair of arms **208** for each of the metal slats. When it is desired to lower or raise the slats **116** to accommodate longer or shorter bulbs, respectively, knob **188** is turned in the appropriate direction to cause the arms **208** to rotate either up or down, to either raise or lower the U-shaped member **212** and thereby raise or lower the slats **116**.

A bar **220** extends across the width of the machine in the checking station and is fixed at either end thereof to the side frame members **156** and **158**. This bar supports a plurality of partitions **221** which further assist in keeping the bulbs in proper alignment so that they are accurately fed from the disc assembly **104** into the channels **44** between the conveyor belts **42** as illustrated in FIG. **5**. As the bulbs are carried by conveyor belts **42** toward the output end **48** of the machine, the bulbs begin to stack up in the channels, because their motion is temporarily blocked by the action of the escapement wheel **50**. Because of this stacking, some bulbs may be pushed or squeezed upwardly out of the channel. In order to prevent this, hold down rails **230** are mounted above the channels **44** formed between the belts **42**. These rails are fixed to cross members **232** which in turn are supported by standards **234** mounted on either side of the machine. These standards have adjusting means for adjusting the vertical height of the rails over the bulbs to accommodate different length bulbs. By placing the rails just above the height of the bulbs being processed, bulbs are prevented from jumping out of the channels.

As was mentioned before, the bulbs traveling along the channels in the various conveyor belts are spaced at varying distances because of the random manner in which the bulbs are transferred from the conveyor belt **10** to the additional disc assembly **16**. However, it is important that all the channels be filled with bulbs at the output end **48** of the machine so that each hole in each row of the trays contains a bulb before the bulbs are subjected to an acid spraying operation for frosting the interior of the bulbs. Ideally, there should be several bulbs stacked up in each channel at the output end **48** of the machine. Practically, it is desirable to have each row of bulbs stacked up back to the photoelectric bridge **46**.

In order to eliminate the necessity for two persons standing on opposite sides of the machine to make sure all channels are filled, an important feature of this invention provides an automatic means for keeping all channels filled with bulbs. As mentioned before, when the paths of the bulbs are not blocked, they travel at the same speed as the conveyor belts **42**. However, when they become stacked up because of the blocking action of the escapement wheel **50**, the bulbs begin to block the movement of each other and to travel more slowly than the conveyor belts which are carrying them. Consequently, bulbs which are traveling at a relatively high speed, i.e., at the speed of the conveyor belts when they pass under the photoelectric cell bridge **46**, indicate that that channel is relatively empty or starved of bulbs. Conversely, when the bulbs traveling underneath the bridge are moving relatively slow, it is an indication that that channel is relatively full of bulbs. As will be described in more detail below, the function of the photoelectric bridge, in conjunction with electronic control circuits illustrated in FIGS. **14** and **15**, is to produce a control signal indicative of each slow moving bulb which control signal is then used to divert bulbs away from the disc pairs in disc assembly **16** corresponding to the slow moving channels.

As illustrated in FIG. **12**, the photoelectric bridge **46** comprises a support member **240** which is supported by a pair of adjustable mechanisms **242** which in turn are mounted on the side frame members of the machine. Mounted in the member **240**, above each channel **44**, is a photoelectric unit **244** having a cylindrical shade **246** fixed to the lower end thereof. The bridge may be raised and lowered according to the height of the bulbs in order to assure a strong signal output from the photoelectric units. This adjustment may be accomplished by means, for example, of the screw and bevel gear systems **248** within each of the adjustable mechanisms **242**.

As shown in FIG. **13**, each photoelectric unit **244** comprises a housing **250** including a lamp **252** and a photocell **254**. The bulb **256** is shown passing beneath the aperture **258** in the housing and in the direction indicated by the arrow **260**. Light from the lamp **252** impinges upon the top surface of the bulb **256** and is reflected back to the photocell **254** which in turn produces an electrical signal indicating the presence of a bulb. The angles of the photocell and lamp are adjusted to give the strongest signal output.

As will be described in more detail below, the electronic control circuits discriminate between a short photocell signal corresponding to a fast moving bulb and a long photocell signal corresponding to a slow moving bulb. A long signal produces a control signal which in turn operates a solenoid valve **260** in the blocking or diverter assembly shown in FIGS. **1** and **6**. The blocking or diverter assembly **262** comprises a plurality of blocking or diverter paddles **264**, one for each of the lamp bulb carrying channels in the machine. FIGS. **1** and **6** show the details of a single blocking member or diverter, and FIG. **4** shows all the blocking or diverter mechanisms supported by a plate **266** which is connected to the machine main frame by means of a pair of brackets **268**. Looking at a single blocking member or diverter, we see that the paddle **264** is fixed, as by riveting, to a metal disc **270**. The disc **270** is rotatably mounted on a pin **272** which is mounted in a pair of brackets **274** fixed to the diverter support frame **276** which in turn is supported by the cross member **266**. Support frame **276** also carries an air cylinder **278** which reciprocates a piston rod **280** pivotably connected at **282** to a connector rod **284** which in turn is pivoted at **286** to a lever arm **288** fixed to disc **270**.

The full line position of the diverter panddle **264** in FIG. **1** is the normal position of the paddle, i.e., the position for the condition when its corresponding row of bulbs passing under the photoelectric bridge **46** is relatively empty and therefore moving quickly beneath the photoelectric bridge so that no control signal is produced to operate the solenoid valve **260**.

When the control signal is produced by the electronic control circuit, indicating that the bulbs are stacked up in the corresponding row beneath the photoelectric bridge and therefore moving relatively slowly, the diverter is moved to its dotted line position where it blocks bulbs from entering between the two discs corresponding to the stacked up channel. Consequently, the bulb is diverted to spaces between other pairs of discs corresponding to rows which are relatively

empty and therefore moving relatively quickly beneath the photoelectric bridge. Air under pressure is supplied to the solenoid valve **260** via the inlet **290**. Depending upon the position of the solenoid valve, the air is supplied to the cylinder **278** by either a conduit **292** or **294**. When the diverter paddle **264** is in its normal full line position, as illustrated in FIG. **1**, the air pressure is applied via the conduit **294** so that the piston rod is forced to the left thereby pivoting the diverter paddle **264** clockwise to the full line position shown. When the control signal is received by the solenoid valve **260**, the air is diverted from conduit **294** to conduit **292** to force the piston rod to the right, thereby pivoting the diverter paddle **264** counterclockwise to the dotted line position.

The operation of the diverters by the photoelectric bridge maintains equal the number of bulbs in all the channels approaching the output end **48** of the machine. However, in addition to this transverse loading problem, there is also a longitudinal loading problem, i.e., the distribution of the bulbs along the lengths of the belts **42**. If too many of the diverters are energized, this means that the traying machine is running too slowly. If too few of the diverters are energized, this indicates that the traying machine is running too fast. It is obvious that if all of the channels or rows of bulbs are stacked up to a point upstream of the photoelectric bridge **46**, then all of the diverters will be out and the rows of bulbs cannot be equalized. Furthermore, if none of the rows of bulbs is stacked back to the photoelectric bridge, then none of the diverters is out and again the rows cannot be equalized. Therefore, it is desirable to have a certain percentage of the rows stacked up to a point upstream of the bridge and the remaining stacked up to a point downstream of the photoelectric bridge. For a 12 row or channel machine, it has been found desirable to have five, six, or seven diverters operating for optimum equalization of the rows. The electronic circuitry, as will be described below, assures this type of diverter operation by controlling the speed of the traying machine, i.e., the conveyor belts **42**, the escapement wheel **50**, the traying wheel **52**, and the tray conveyor **54** by controlling the speed of the drive motor **56** which drives these components of the traying machine.

FIG. **14** is a schematic diagram of a circuit for generating from the output of each photocell **254** the control signal which operates solenoid valve **260** which in turn operates the diverter paddle **264**. There is such a circuit for each of the diverter paddles, but since they are all identical, the circuit for only one diverter paddle is shown in FIG. **14**.

Each time a bulb passes under the photoelectric bridge **46**, the light reflected from the dome of the bulb impinges upon the photocell **254** which becomes conductive to energize a relay coil **300**. In the normal or unenergized condition of relay coil **300**, its movable contact **302** is closed to the fixed contact **304**. When the relay coil is energized, the movable contact closes to the other fixed contact **306**. The contacts of the relay **300** are part of a slow-make, fast-break time delay circuit **308**. The length of time that the relay coil is energized is dependent upon the speed of the bulbs passing under the photocell **254**. If the bulbs are stacked up to the photoelectric bridge, they pass under the bridge at a slower rate than when they are stacked back to a point downstream of the photoelectric bridge. Since it is desired to operate the diverter paddle only when the bulbs in the corresponding channel are moving slowly, the purpose of circuit **308** is to distinguish between slow moving and fast moving bulbs. It has been found in the typical operation of the machine that a bulb in a full row or channel requires about 100 milliseconds to pass under the photocell, whereas a bulb in a relatively empty channel requires only about 50 milliseconds. Therefore, it is desired to generate a diverter control signal only when the photocell is energized by the reflected light for a period of time in between these two values, say, for example, 75 milliseconds. Therefore, in essence, circuit **308** is designed to provide a delay of 75 milliseconds from the time of energization of the relay coil **300** and the closure of the contact arm **302** to the fixed contact **306**. This delay is provided by the adjustable **100K** resistor **R5**.

The circuit also includes a relay coil **CR1** whose movable contact is shown in its normal or de-energized position closed to fixed contact **312**. When the relay coil **300** is energized, contact **302** closes to contact **306** thereby permitting a capacitor **C1** to charge at a rate determined by the value of resistor **R5**. If the relay coil remains energized sufficiently long for the voltage of capacitor **C1** to reach the firing voltage of the unijunction transistor **Q1**, **Q1** then fires and becomes conducting to permit the capacitor **C1** to discharge through the emitter and lower base of the unijunction transistor and through the relay coil **CR1** to move the contact **310** to the fixed contact **314**. Firing of the unijunction transistor **Q1** indicates that a slow moving bulb has passed under the photocell **254**, in this case, a slow moving bulb being one that requires **75** milliseconds or longer to pass under the photocell. Closing of the contact **310** to contact **314** connects the gate of a silicon controlled switch **SCS1** to the capacitor **C1** which applies a positive pulse to the gate, thereby turning the switch **SCS1** on. A diode **D1** across relay coil **CR1** shorts out any counter EMF which could result in spurious operation of **Q1**. The **1K** resistor **R4** shorts out any residual charge on capacitor **C1** through the normally closed contacts **302, 304** when relay coil **300** is de-energized, thereby eliminating the possibility of timing errors due to an accumulative residual EMF on the capacitor **C1**. The variable **5K** resistor **R1** is used to bias the upper base of the unijunction transistor **Q1** relative to the lower base and the emitter.

The conduction of the silicon controlled switch **SCS1** causes a relay coil **CR2** to be energized to close its normally open contacts **CR2–1** which are connected in series with the solenoid valve **260** controlling the operation of the diverter paddle. Connected in series with these contacts are a pair of contacts **CR3-1** which are opened and closed periodically in accordance with the pulse rate of a multivibrator **316** which periodically energizes and de-energizes the relay coil **CR3**. Energization of solenoid **260** raises the diverter paddle to its dotted line position to block bulbs from entering the channel corresponding to the photocells **254**. Multivibrator **316** functions to modulate the operation of the diverter, i.e., the diverter is moved back and forth between its full line and dotted line positions as long as contacts **CR2–1** are closed. This modulation prevents hunting of the system so that a full row does not suddenly become starved of bulbs as might happen if the diverter were left in its dotted line position for the duration of a control signal.

Since the relay coil **300** will be de-energized between each pair of bulbs even though the bulbs are closely stacked together, it is desirable not to have the relay **CR2** drop out between bulbs. The delay action to prevent this is provided by the capacitor **C2** and another unijunction transistor **Q2**. When relay coil **CR1** is energized, its switch contacts **CR1–2** connect capacitor **C2** to ground. However, when **CR1** is de-energized by the turning off of the unijunction transistor **Q1**, switch contacts **CR1–2** connect the capacitor **C2** to the emitter of **Q2**. At a predetermined time, controlled by the variable resistor **R9**, the capacitor **C2** will charge to a voltage sufficient to cause unijunction **Q2** to conduct, thereby discharging capacitor **C2**. This drives the anode of **SCS1** to a negative cutoff value, thereby rendering it non-conductive. At this time, relay **CR2** drops out to open its contacts **CR2–1** in the diverter control circuit.

FIG. **15** is a block diagram illustrating the manner in which the speed of the traying machine is controlled to compensate for variance in the longitudinal loading of the belts **42**. Each of the relay coils **CR2** also has another set of normally open contacts **CR2–2** which are closed by the energization of the relay coil **CR2**. These contacts are placed in series with another set of normally open contacts **CR3–1** which are closed sequentially during each cycle of a ring counter **320** driven by a suitable pulse generator **322**. For example, the ring counter may sequentially energize relay coils corresponding to each of the contacts **CR3–1**.

All the series combinations of contacts CR2—2 and CR3–1 are connected in parallel to the input of a preset counter **324** having three presets. For each cycle of the ring counter **320**, the preset counter **324** counts the number of diverter operations as represented by closures of contacts CR2—2. The preset counter **324** is reset on each thirteenth count of the ring counter.

The preset counter has four output lines corresponding to diverter counts of less than five, five, six and seven, respectively. When the counter counts up to counts of five, six and seven, corresponding pairs of contacts are operated, for example, by energization of corresponding relays. Switch contacts **S5–1** and **S5–2** are associated with a count of five, switch contacts **S6–1** and **S6–2** with a count of six, and switch contacts **S7–1** and **S7–2** with a count of seven. The switch contacts are illustrated in their normal position, i.e., the position when the counter is not at the count corresponding to the count associated with the particular set of contacts.

Each of the four preset counter output lines is connected to energize corresponding ones of four pulse generators **326**, **328**, **330**, and **332**.

These pulse generators are connected to a stepping servo motor **334** which drives a speed control potentiometer which controls the speed of the traying machine drive motor **56**. The pulse generator **326** is connected to the reverse winding of the servo motor which causes the potentiometer **336** to be adjusted to slow down drive motor **55**. Pulse generators **328**, **330**, and **332** are all connected to the forward winding of servo motor **334** and have pulse rates of increasing value. In other words, the pulse rate of pulse generator **332** is greater than that of pulse generator **328** and therefore would increase the speed of motor **55** much more quickly.

When the number of closed diverter contacts CR2—2 is less than five during one cycle of the ring counter **320**, thereby indicating that less than five diverters are in their blocking positions and also indicating therefore that the traying machine is running faster than desired, the pulse generator **326** is energized through the closed contacts **S5–1** and S_{lo} to reduce the speed of the machine. As a result, more rows or channels should have bulbs stacked up to the photoelectric bridge, and therefore eventually five diverters will be operated and the counter **324** will count up to five. In this case, contacts **S5–1** open and contacts **S5–2** close to permit energization of the pulse generator **328** whose output drives the servo motor in the direction to increase the speed of the drive motor **55**. If the number of diverters counted increases to six, then switch contacts **S6–1** open and switch contacts **S6–2** close to energize the higher pulse rate generator **330** to more quickly increase the speed of the drive motor **55**. In like manner, if the diverter count reaches seven, switch contacts **S7–1** open and switch contacts **S7–2** close to energize the highest pulse rate generator **322**.

Drive motor **55** also drives a tachometer generator **338** which is connected to a voltmeter **340** calibrated in hundreds of light bulbs being trayed per minute. The tachometer voltage is bucked in a meter relay **340** against a portion of a reference voltage V_{ref} appearing across a voltage divider **342**. The adjustable tap **344** is positioned so that the portion of the reference voltage bucked against the tachometer voltage results in a null or zero reading of the meter relay needle **345**. For example, the tap may be set such that the needle reads zero when 1,100 bulbs per minute are being trayed. The meter is calibrated in ± hundreds of bulbs relative to this figure of 1,100. The switch contacts S_{lo} represents a traying speed of 950 bulbs per minute and the switch contacts S_{hi} represent a traying speed of 1,250 bulbs. Consequently, if the traying speed should drop below 950 bulbs per minute, needle **345** opens the contact S_{lo} to disable the pulse generator **326**, thereby preventing further decrease in the traying speed. In like manner, if the traying speed should exceed 1,250 bulbs per minute, the switch contacts S_{hi} are open to disable the fast pulse generator **302**, thereby preventing any further increase in the traying speed.

This type of digital proportional control combined with the diverter action maintains equal distribution of the bulbs in all the rows and insures that the loading of the belt is controlled in such a manner that the equalization action of the diverters is effective.

It may happen that some unusual circumstance would require a change in the load set point represented by the position of the adjustable tap **344**. For example, the output of the bulb making machine feeding conveyor **10** may either increase or decrease for a period of time. To accommodate this possibility, a servo motor **346** is coupled to the adjustable tap **344**. A pulse generator **348** is coupled to the forward terminal **350** of the servo motor, and a pulse generator **351** is connected to the reverse terminal **352** of the servo motor. Each of the pulse generators **348** and **351** contains a time delay circuit (not shown) of approximately six seconds. When the needle **345** strikes the switch at the high speed point of +150 bulbs, it closes the switch contacts S_{H-1} and S_{H-2} to electrically connect pulse generator **348** to the servo motor **346**. However, because of the built-in delay, these switches must be closed for at least six seconds before the servo motor is energized to move the voltage divider tap **344** and thereby change the load set point of the traying machine. In like manner, when the needle **345** strikes the low speed switch at −150 bulbs, the switch contacts S_{L-1} and S_{L-2} are closed to couple the pulse generator **351** to the servo motor **346**; if these switches remain closed for 6 seconds or more, the servo motor **346** moves the adjustable tap **344** to a new load set point and a lower traying speed.

While the invention has been particularly shown and described with reference to a preferred embodiment thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined in the following claims:

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In a light bulb traying machine including unscrambler means for separating a plurality of disarranged light bulbs into individual rows and discharging the bulbs onto conveying means, said conveying means including a plurality of moving belts defining channels therebetween for carrying said bulbs in a neck-down position, the bulbs moving from the input end to the output end of said conveying means, the improvement comprising:

a. photoelectric sensing means between said input and output ends of said conveying means for sensing the speed of individual bulbs moving in each of said channels and for producing a bulb signal proportional to the time required for each bulb to pass said sensing means,

b. blocking means including a plurality of blocking members each associated with a different one of said channels and individually operable to block bulbs from relatively slow moving channels of bulbs so that the bulbs are diverted to relatively fast moving channels of bulbs whereby all channels carry substantially the same number of bulbs, and

c. first electronic control means responsive to bulb signals whose durations exceed a predetermined duration to produce a control signal to operate said blocking means.

2. The improved light bulb unscrambler means as defined in claim **1** further comprising means for continually modulating an operated blocking member between blocking and non-blocking positions.

3. An improved light bulb unscrambler means as defined in claim **1** wherein said photoelectric sensing means comprises a plurality of photoelectric sensing devices equal in number to the number of said channels, each photoelectric device being positioned to sense the speed of the bulbs in a different one of said channels.

4. The improved light bulb unscrambler means as defined in claim **1** further comprising:

a. motor means for driving said conveyor means, and

b. second electronic control means responsive to the number of operated blocking members to control the speed of said motor means.

5. The improved light bulb unscrambler means as defined in claim 4 wherein said electronic control means comprises:

a. preset counter means for counting the number of operated blocking members and containing a plurality of preset counts, and

b. pulse generator means coupled between said preset counter means and said motor means for incrementally changing the speed of said conveying means in accordance with the relationship between said preset counts and the actual count of the blocking members.

6. The improved light bulb unscrambler means as defined in claim 5 further comprising:

a. adjustable load set point means for determining a permissible range of bulb speeds which may be controlled by said preset counter means and said pulse generator means, and

b. means responsive to a bulb speed at either end of said permissible range for a predetermined time to adjust said load set point means to shift said permissible range.

7. An improved light bulb unscrambler means as defined in claim 4 further comprising bulb hold down means mounted over said channels to prevent bulbs from being ejected upwardly out of said channels.

8. An improved light bulb unscrambler means as defined in claim 4 wherein said separating means includes a plurality of rotating discs, said disarranged bulbs normally being inserted between pairs of said discs and rotated therewith to be discharged onto said conveying means, said separating means further comprising a plurality of spider wheels rotating in a direction opposite to said discs for dislodging bulbs carried on the peripheries of said discs.

9. An improved light bulb unscrambler means as defined in claim 4 further comprising a pair of spoked kicker wheels disposed over each of said channels and operating at different speeds for engaging a pair of interlocked bulbs and separating them.

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