

[54] **INSPECTION AND TRANSFER MECHANISM**

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[51] Int. Cl. B07c 5/00

[58] Field of Search. 209/111.7, 73, 75, 121; 250/200

[56] **References Cited**
UNITED STATES PATENTS

3,100,571	8/1963	Reck et al.	209/121
3,355,980	12/1967	Mathias	209/111.7 X
3,289,832	12/1966	Ramsay	209/111.7 X
3,386,575	6/1968	Quinn	209/75
3,313,409	4/1967	Johnson	209/73

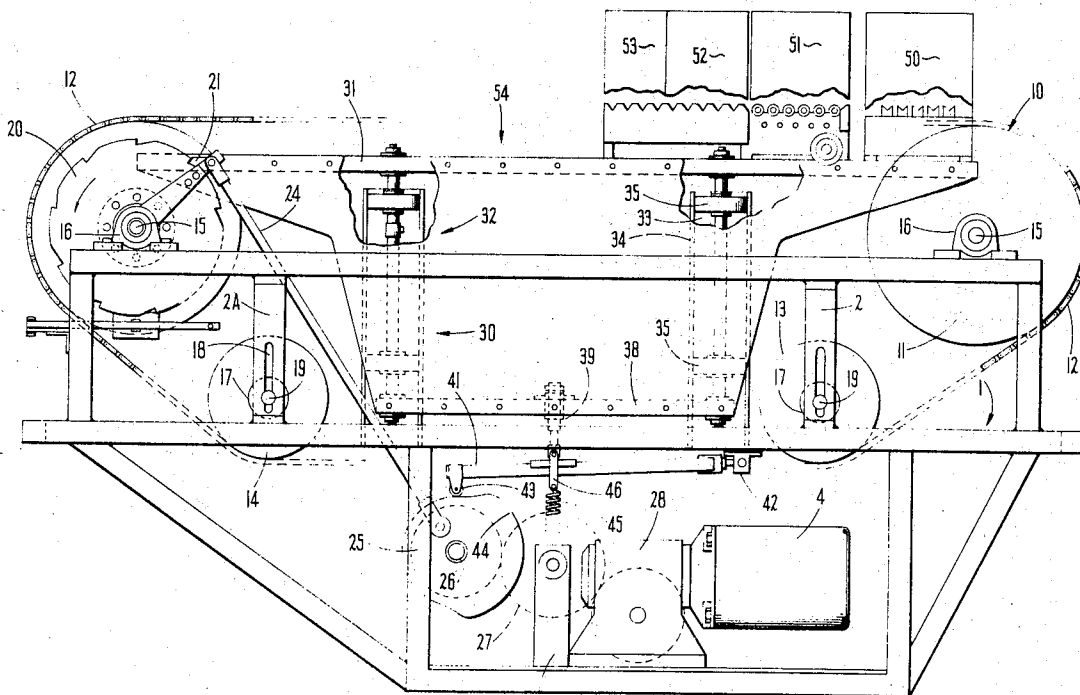
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[57] **ABSTRACT**

An inspection and transfer mechanism designed primarily for optically inspecting the surface of shell casings. The mechanism provides a continuous conveyor for conveying shell casings successively over a predetermined path. A mechanism is provided for raising a multiplicity of shells from the conveyor periodically and lifting them into preselected positions. A light and lens system projects a narrow, elongated light strip onto the shell casings at the preselected positions while the shells are being rotated about their longitudinal axis. A photocell system is positioned to detect light reflected from the shell and is designed with an electronic system to detect flaws in the sidewall of the casing, as determined by non-uniformity in the level of reflected light that is detected. Also provided in series with the sidewall, flaw-detecting means is a means for detecting an aperture or hole at the end of the shell and an ejection system responsive to detections of flaws.

24 Claims, 16 Drawing Figures


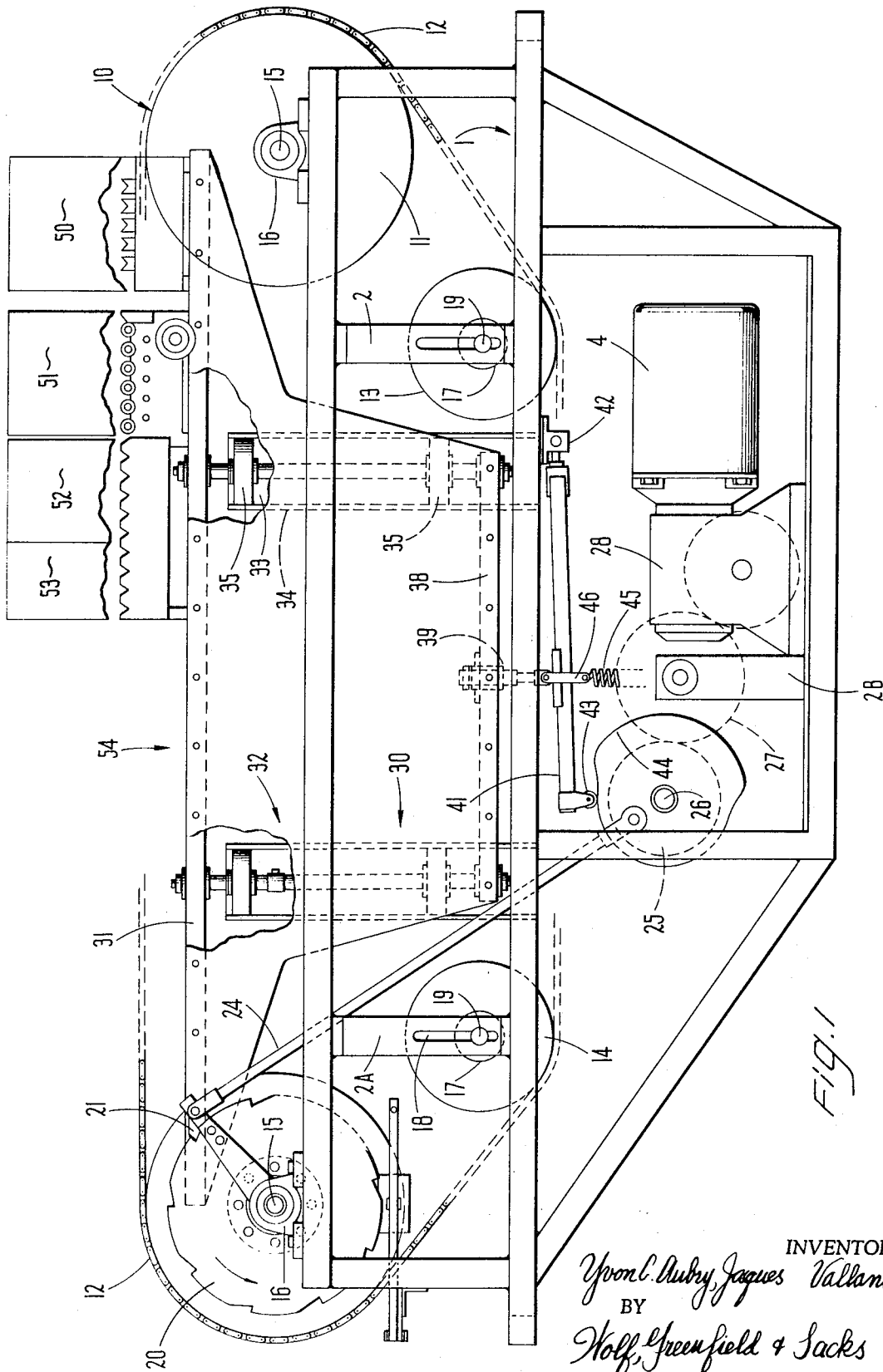


FIG. 1

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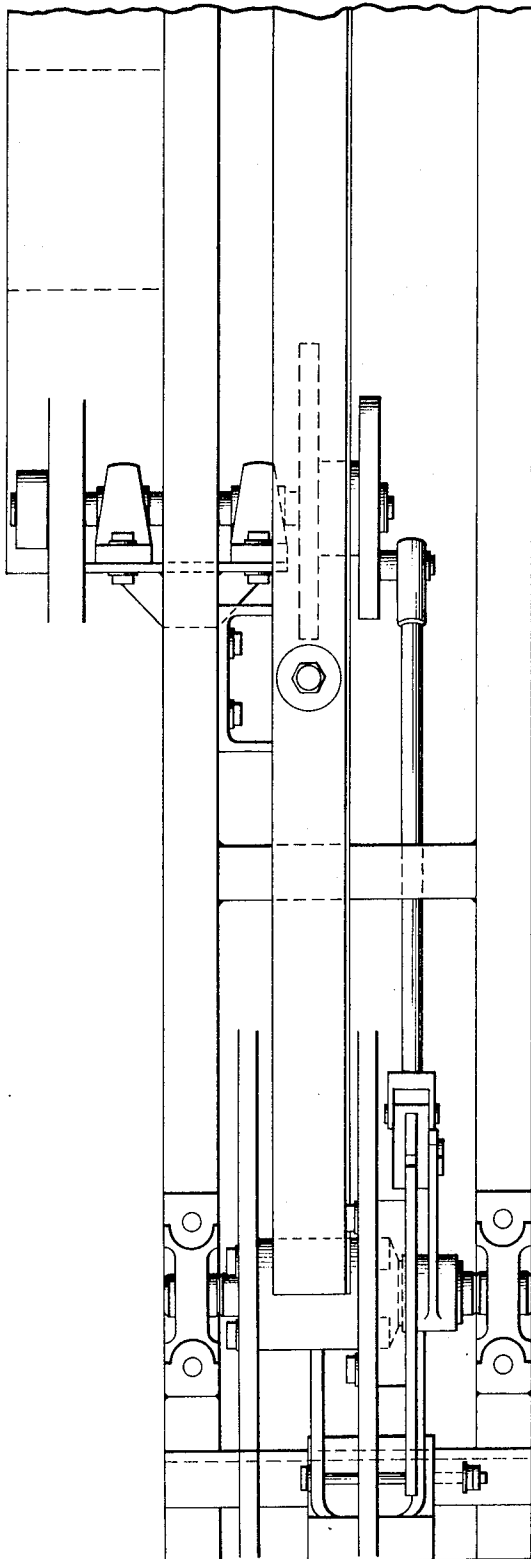
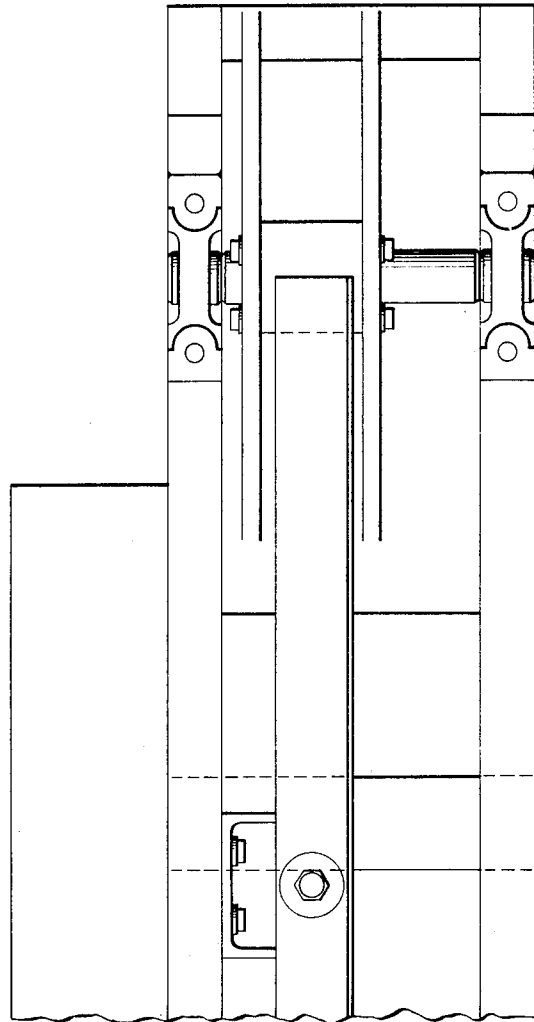
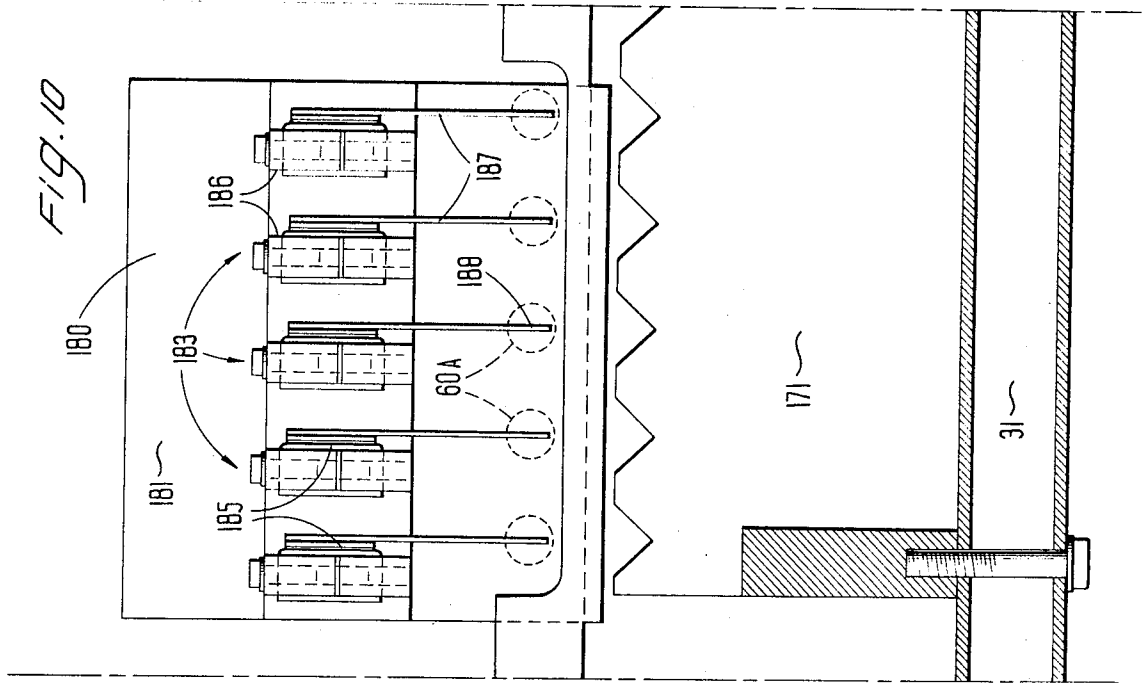
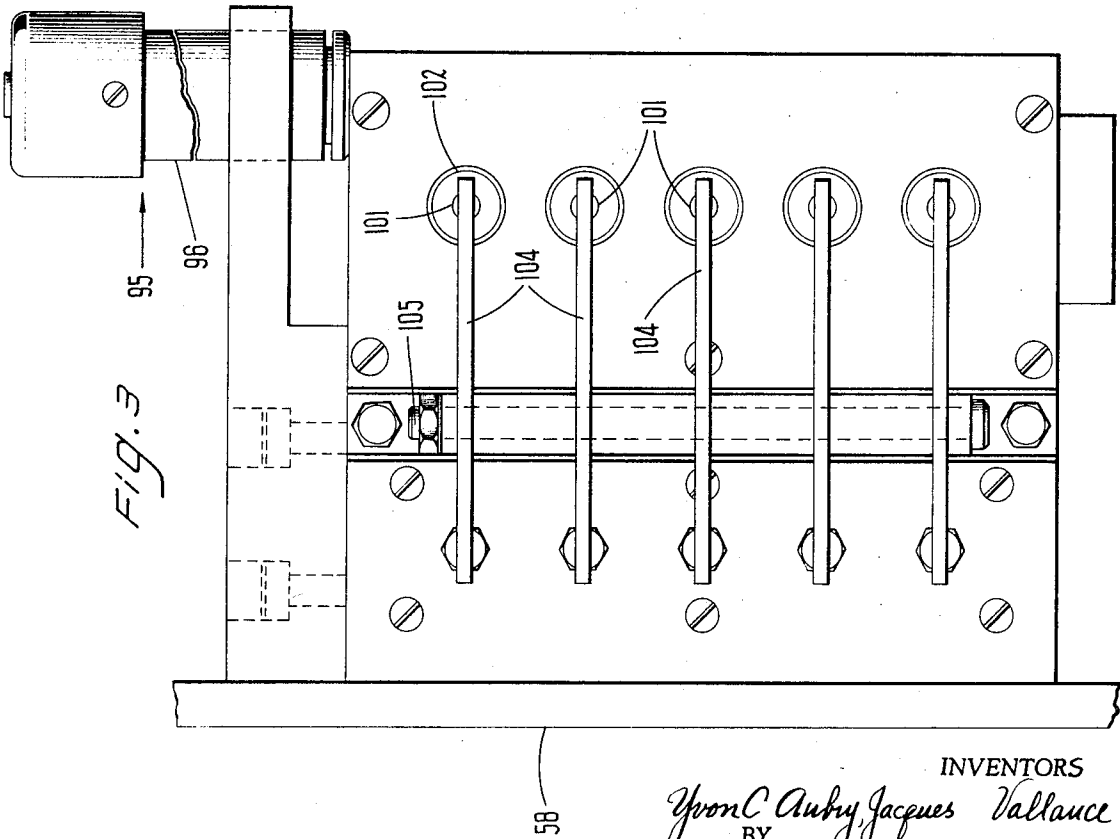


FIG. 2

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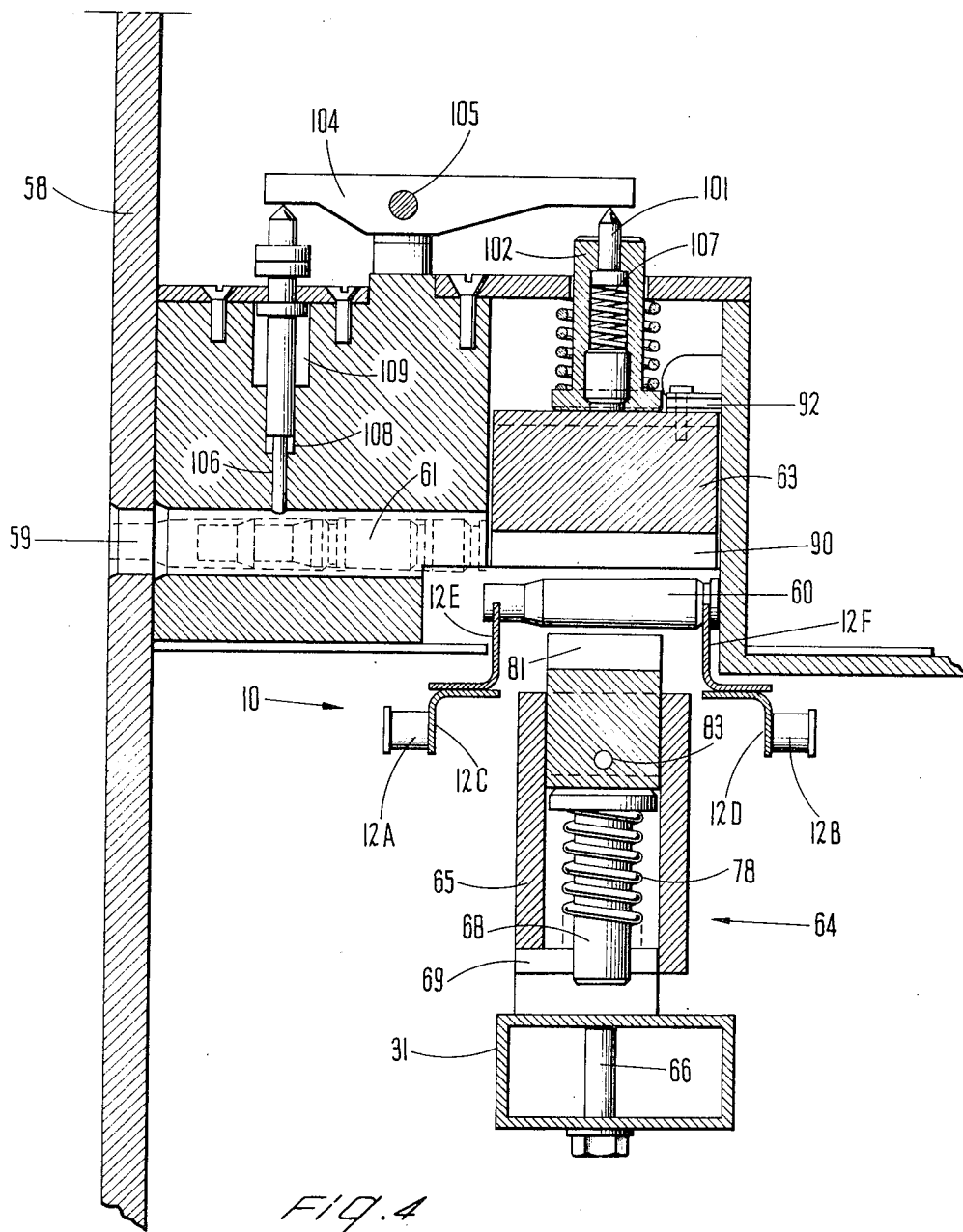
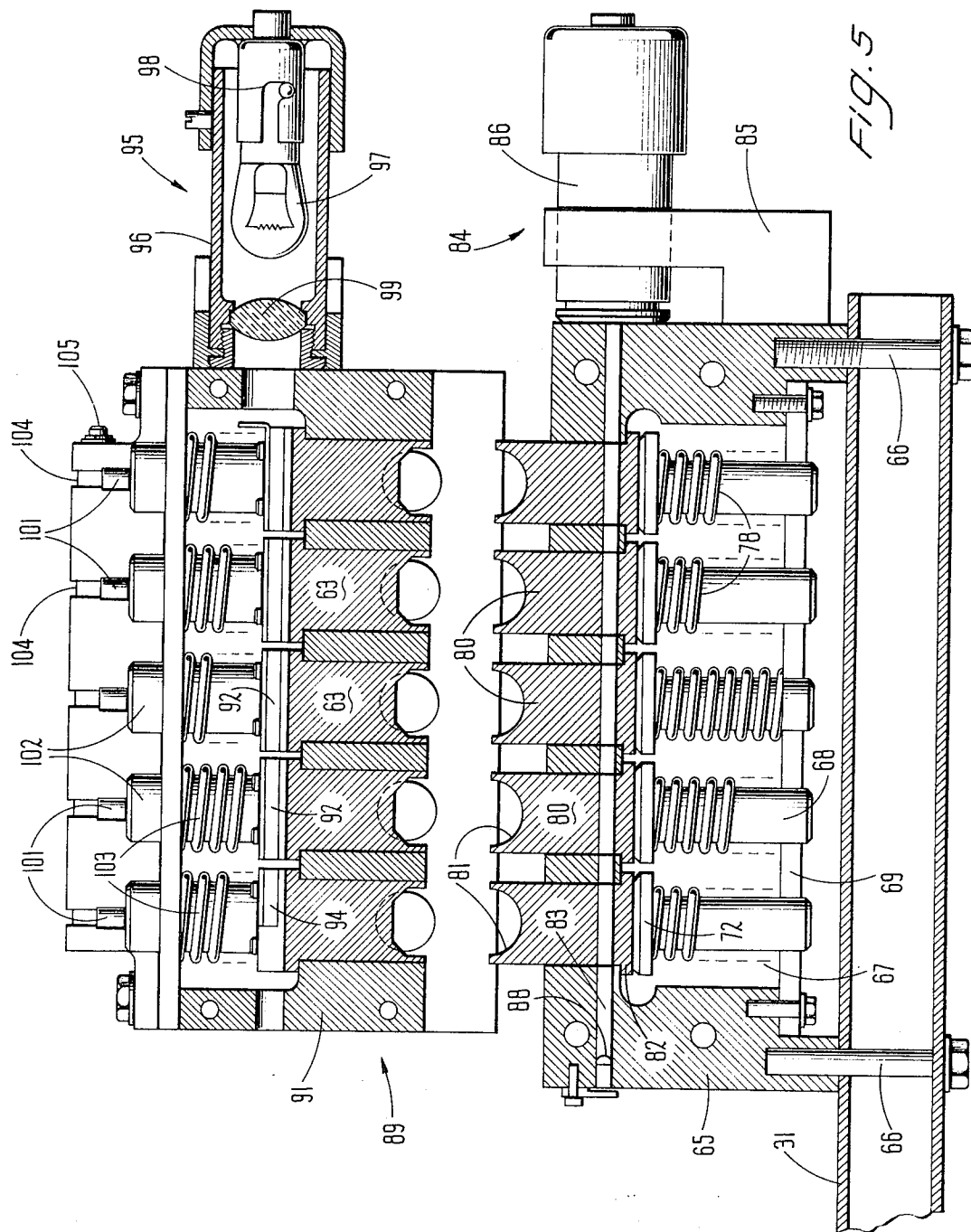


FIG. 4

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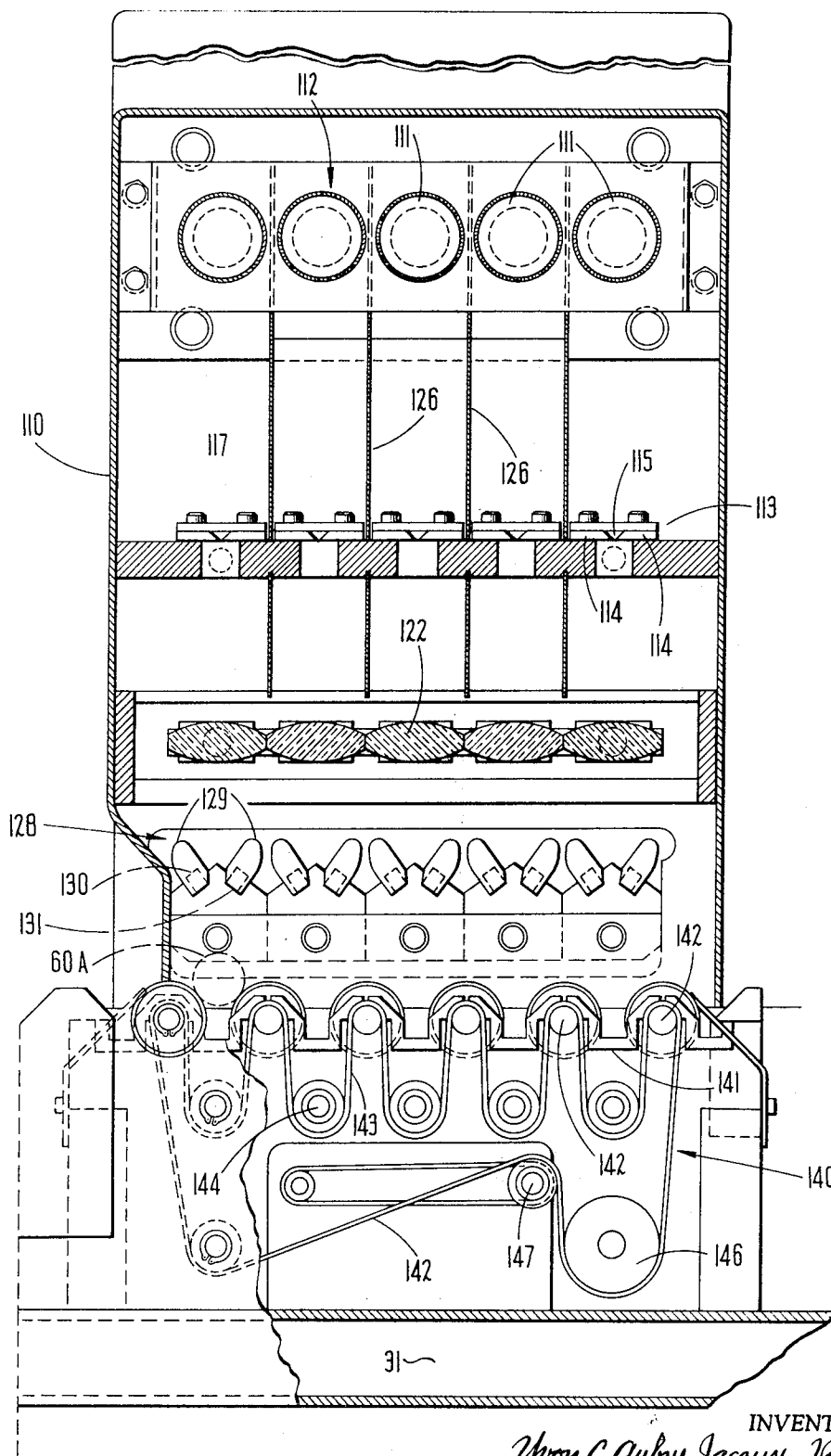


FIG. 6

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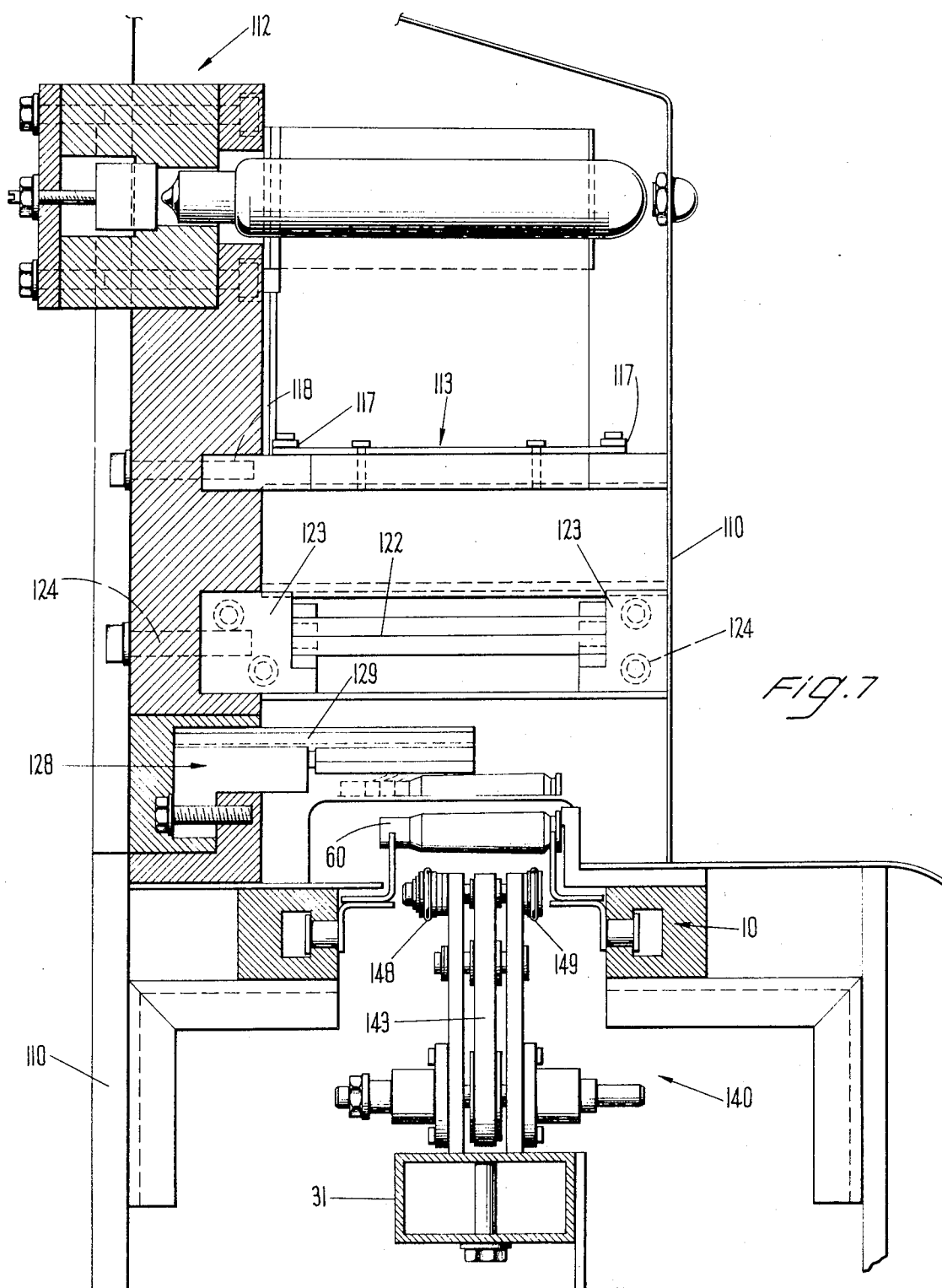


FIG. 7

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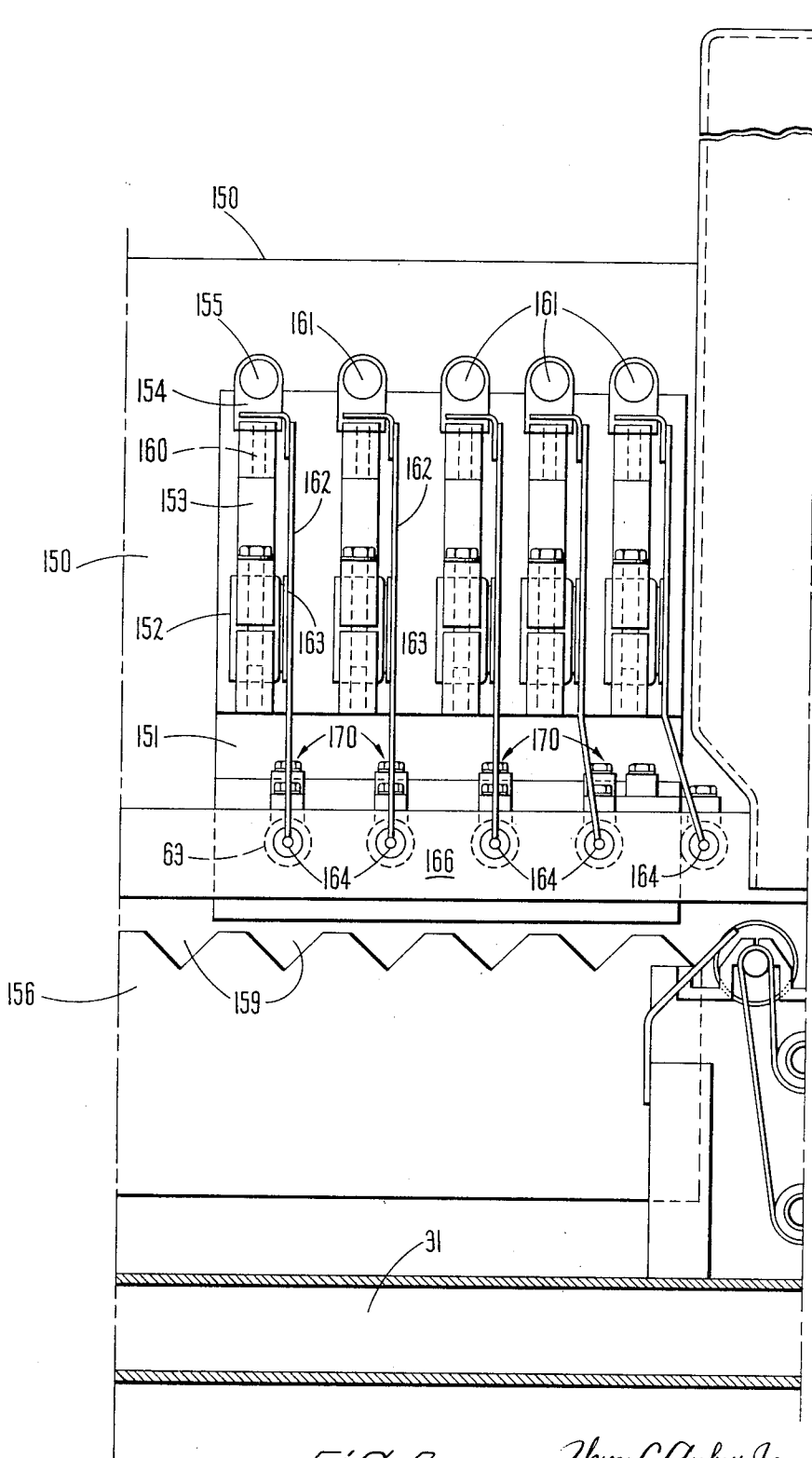


FIG. 8

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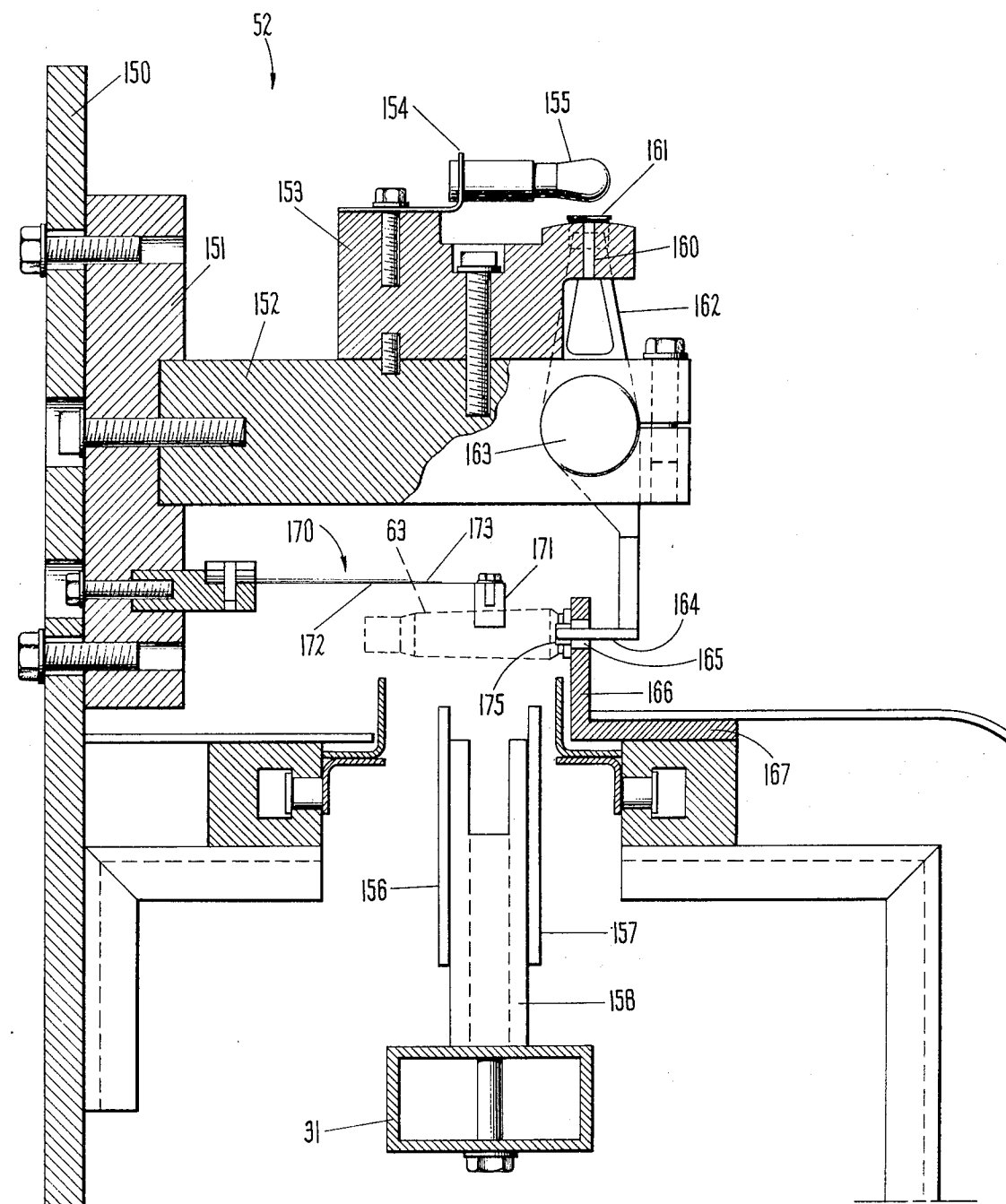
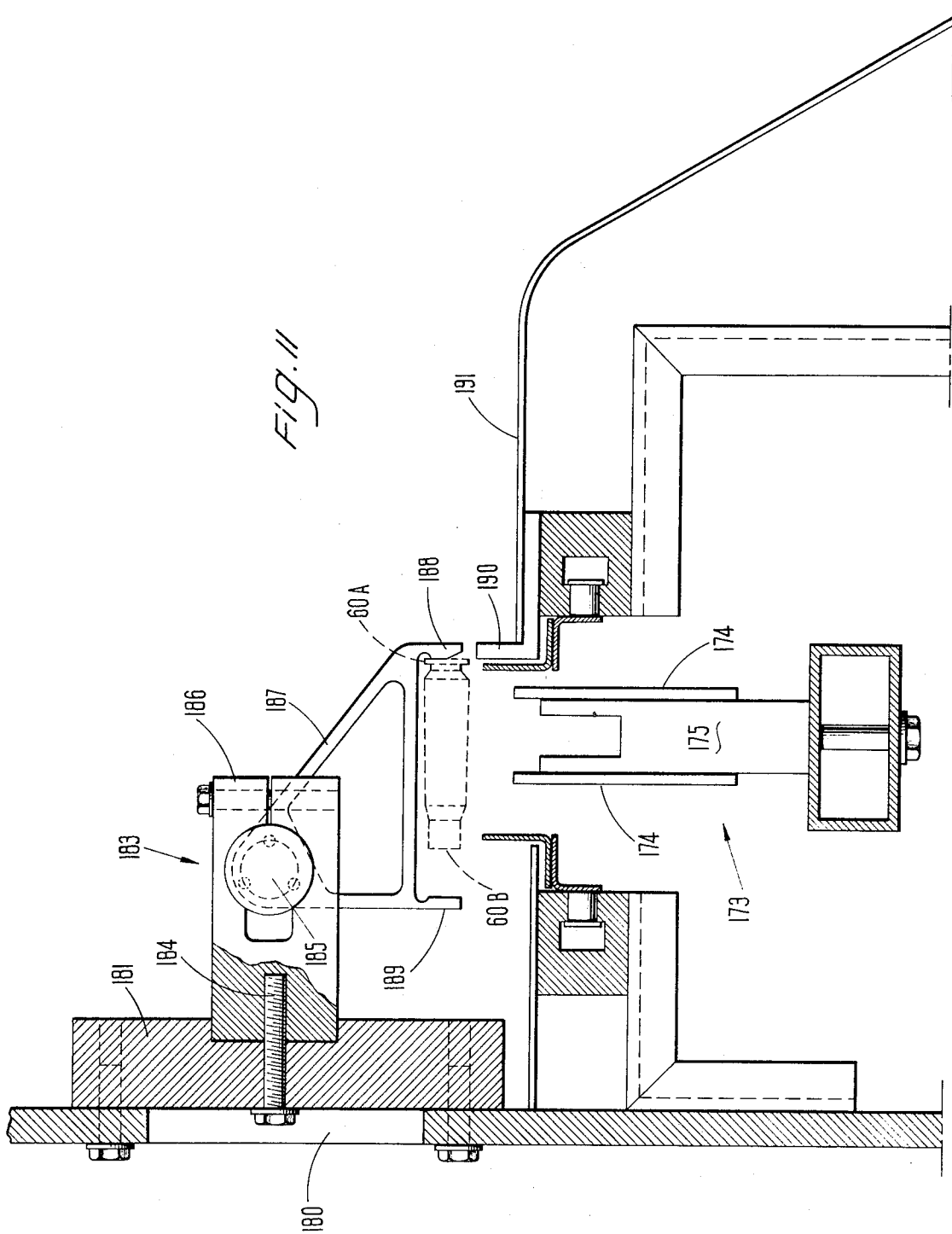
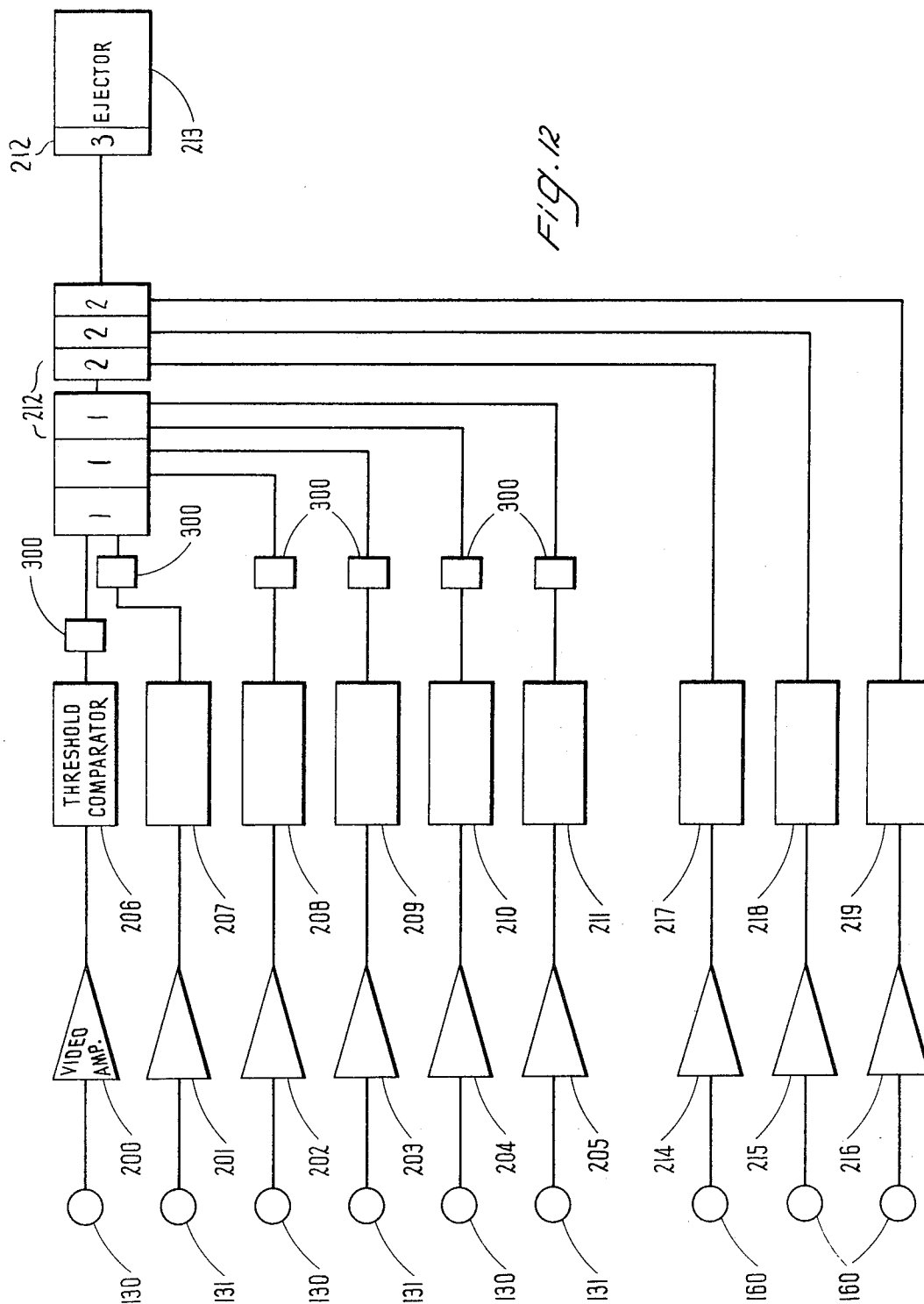


FIG. 9

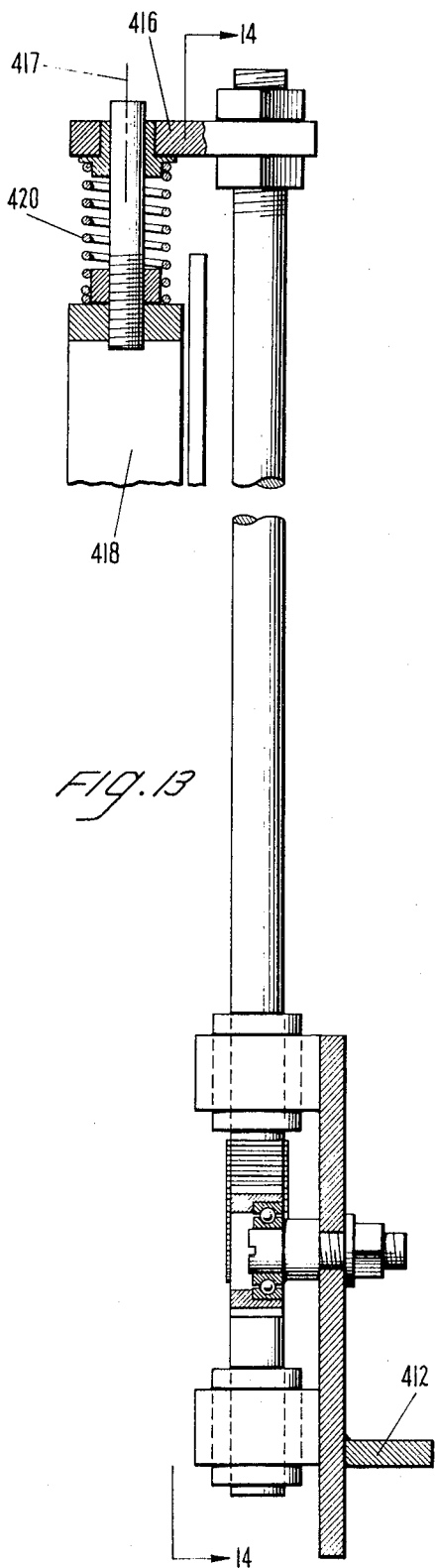
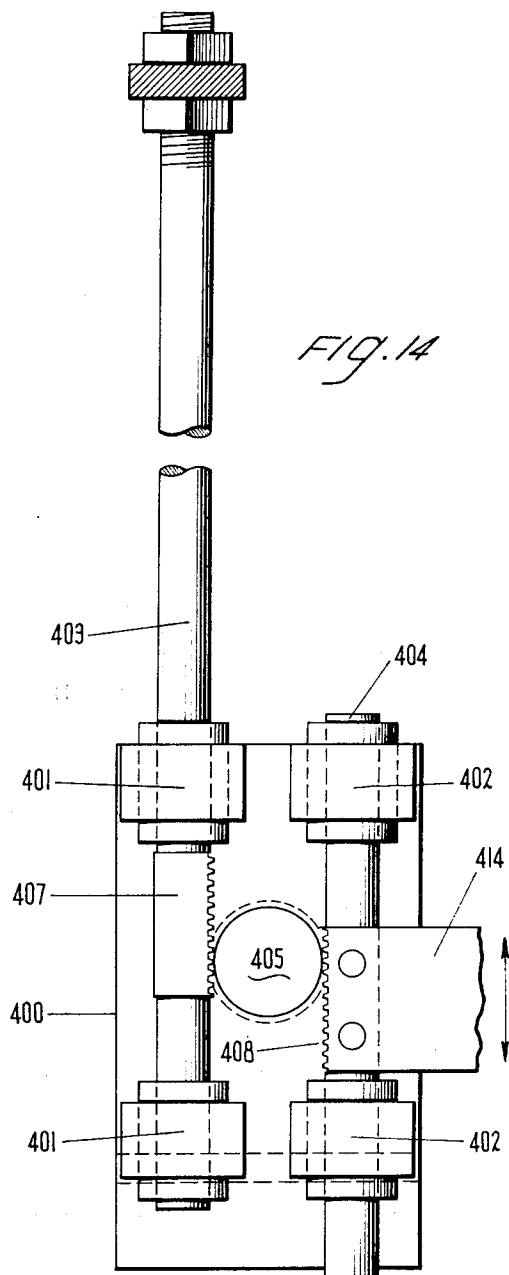
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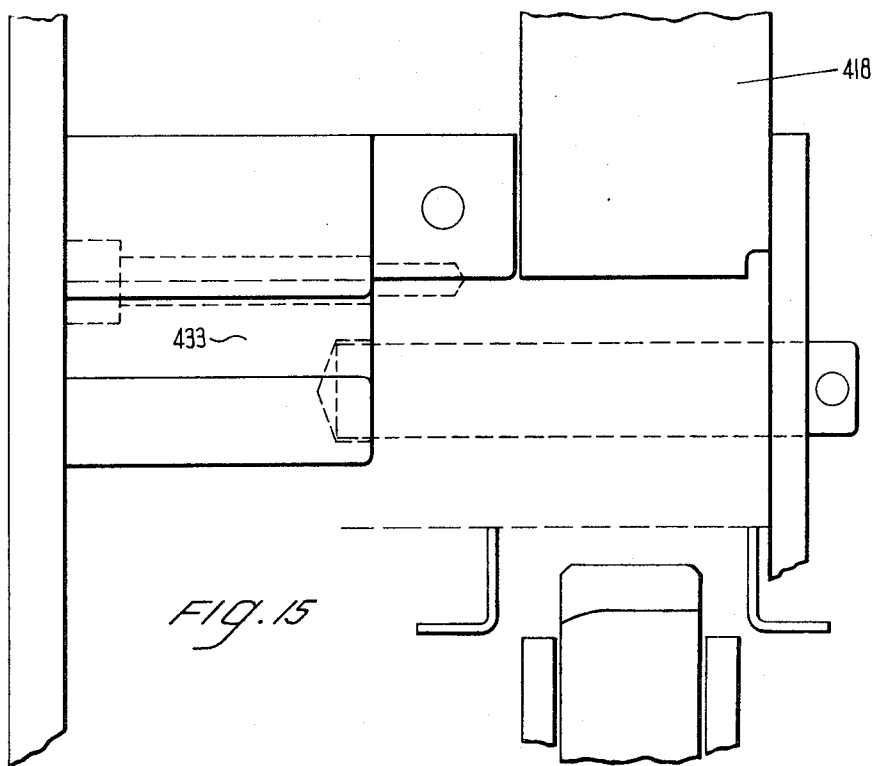
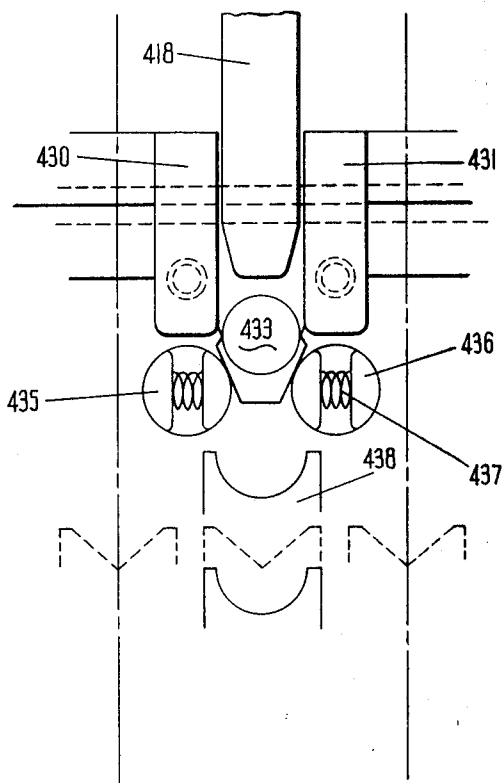
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INSPECTION AND TRANSFER MECHANISM

SUBJECT MATTER OF THE INVENTION

The present invention relates to an improved inspection and transfer mechanism intended primarily to optically inspect the surface of regularly shaped objects, such as shell casings, and other items capable of reflecting light in a relatively uniform fashion.

BACKGROUND OF THE INVENTION

Surface inspection of many objects heretofore has been a non-automated operation which is often tedious, inaccurate and expensive. As a consequence, the effectiveness and efficiency of such means for inspection that exist are not altogether satisfactory. For example, in the manufacture of shell casings for small arms, it is necessary to carefully inspect the surface of each shell casing for scratches, nicks or other flaws since these defects render the casing unacceptable for use. Heretofore it has been customary to successively feed these casings on a moving conveyor belt for visual inspection by individuals. Since many thousands of shell casings must be continuously inspected, defective shell casings are frequently passed by the inspectors because it is impossible to pay continuous attention to the shell casings as they move over the conveyor system. Furthermore, many defects in shell casings are not easily detected by the naked eye since the defects that render a shell casing unacceptable often may comprise nothing more than a hard-to-detect, longitudinal scratch on the surface of the shell casing. The consequence of missing such a flaw can be quite serious since it is not uncommon for such defective shells to explode in the gun and injure or, in some instances, kill the operator.

The difficulties and limitations of visual inspection of objects such as described are not limited to shell casings for munitions. For example, occasionally it is necessary to visually inspect wooden sticks. Splintered or decayed wood render particular sticks unacceptable for various reasons, and these too must be removed from the assembly line.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a fully automated means for transporting regular objects such as shell casings, sticks or the like to an inspection station; inspecting them for surface defects; and thereafter removing the defective units from the conveyor system. A further object of the present invention is to provide an improved means and method of inspecting shell casings for surface flaws. A still further object of the present invention is to provide improved means and method of loading shell casings and like objects onto a conveyor system. A further object of the present invention is to provide means for selectively removing cartridges, shells or the like from a conveyor system for inspection purposes. Another object and advantage of the present invention is to provide an improved method of inspecting shell casings. A still further object of the present invention is to provide an improved means and method of inspecting the ends of cartridge shells or casings. A still further object and advantage of the present invention is to provide an improved means and method of rejecting defective cas-

ings or objects from a conveyor line. A still further object of the present invention is to provide an improved conveyor system for conveying shells and like objects through an inspecting and testing station.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing objects and advantages of the present invention will be more clearly understood when considered in conjunction with the accompanying drawings in which:

FIG. 1 is a side elevational view of a machine embodying the present invention with portions shown broken away and removed for ease in understanding the drawing;

FIG. 2 is a top plan view of the machine shown in FIG. 1;

FIG. 3 is a top plan view of a detail of the invention showing a loading station;

FIG. 4 is a cross-sectional view of the loading station taken substantially along the line 4—4 of FIG. 3;

FIG. 5 is a cross-sectional detail of the loading station taken substantially along the line 5—5 of FIG. 4;

FIG. 6 is a longitudinal cross-section of a fault-detecting station for detecting faults in the major surface of objects being examined with a cross-section taken substantially along the line 6—6 of FIG. 7;

FIG. 7 is a transverse, cross-sectional elevation of the fault-detecting station of FIG. 6 taken substantially along the line 7—7 of FIG. 6;

FIG. 8 is a side elevational detail illustrating a fault-detecting station for detecting major faults at the end of the objects being examined, taken substantially along the line 8—8 of FIG. 9;

FIG. 9 is a cross-sectional view of the fault-detecting station of FIG. 8 taken substantially along the line 9—9 of FIG. 8;

FIG. 10 is a fragmentary, side elevation of a detail showing an ejecting station and taken substantially along the line 10—10 of FIG. 11;

FIG. 11 is a cross-sectional detail of the ejecting station of FIG. 10, and taken substantially along the line 11—11 of FIG. 10;

FIG. 12 is a schematic diagram of a suitable electric circuit for operating the device;

FIG. 13 is a cross-sectional detail of a modified actuating mechanism for a modified form of the loader;

FIG. 14 is a cross-sectional elevation taken along line 14—14 of FIG. 13;

FIG. 15 is a fragmentary elevational view of a modified loader shown partially in cross section and used in conjunction with the actuator of FIG. 13; and

FIG. 16 is a fragmentary cross-sectional view taken from the right of FIG. 15.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The embodiment described in connection with the accompanying drawings is designed for use in inspecting rifle shells. However, the invention is equally applicable to embodiments in machines for inspection of a wide variety of other products including for example, vials, sticks, and other relatively elongated, smooth-surfaced products.

Referring first to FIGS. 1 and 2, there is illustrated an overall illustration of a rifle shell inspecting machine

embodying the present invention. In this arrangement there is a frame comprising a plurality of members including longitudinal, vertical and horizontal struts or beams suitably arranged to support the various components hereafter described. If desired, the sides of the machine may be provided with covering elements which partially support the various components described. The power for driving the various components may be suitably supplied by a motor means 4 connected by suitable gearing or chain drives to the various driven components. Supported between the sides of the frame is endless conveyor belt means 10. This conveyor belt means extends around drive rolls 11 and 12 at the feed end and rear end respectively, and idler rolls 13 and 14 below the drive wheels or rolls 11 and 12. These rolls are suitably journaled for rotation. Rolls 11 and 12 are supported on shafts 15 in turn journaled for rotation at opposite ends in bearings 16, with the bearings 16 supported at the side frames of the machine. Rolls 13 and 14 are supported for rotation on shafts 17 which in turn may be adjustably supported in slots 18 extending vertically in the vertical beams 2A, with the rolls secured by suitable means such as bolts 19. The conveyor belt means 10 is intermittently driven though a ratchet wheel 20 which is keyed to the shaft 15 to which wheel 12 is also keyed. This wheel 20 is adapted to be rotated intermittently in incremental steps by the intermittent engagement and drive of the pawl 21 which is supported on shaft 22 in turn journaled on shaft 15. Intermittent movement of the pawl for engagement with the shoulders of the ratchet wheel 20 is provided through an elongated link 24 which is pivotally connected at its upper end to the pawl 21, and at its lower end is pivotally linked to a cam 25 in turn mounted on the shaft 26. The shaft 26 is geared through a suitable gear 27 and, if desired, through a gear reduction 28 to the motor drive 4.

An elevator means 30 is also supported on the frame. This elevator means is designed to intermittently raise a plurality of shells from the conveyor belt 10 and move them into operating engagement with the various stations hereafter described. This elevator means includes an elongated platform 31 at the upper of the machine. The platform 31 extends longitudinally of the machine between the side frames from the forward to the rear end of the frame. The platform is suitably supported for vertical reciprocal movement on the elevators, generally illustrated at 32 and 33. These elevators are similar in construction to each other and support respectively the rear and forward ends of the platform for uniform vertical movement. The elevators of each have a frame 34 adapted to support the bearings 35 for sliding vertical movement. Supported by the bearings 35 for longitudinal axial movement is a shaft 36. The upper end of the shaft 36 is suitably secured to the platform 31. The lower end of the shaft 36 is suitably bolted to a transverse bridge member 38. The bridge member 38 has each end secured to one of the shafts 36. Symmetrically connected to the bridge member 38 is an adjustable bearing 39 having a roller 40 at its lower end. The roller 40 bears against the pivoting beam 41. The pivoting beam 41 has one end movably supported by a universal joint 42, and at the other end is provided with a bearing wheel 43. The bearing wheel 43 is maintained in pressured contact with a can 44 by

a helical spring 45 which has one end connected to a yoke 46 in turn secured to the bearing 39 and the other end suitably secured to the frame member 2B.

Supported on the frame above the vertically movable platform 31 are a series of stations designed for handling and inspecting shells being fed onto the conveyor. These stations include a loading station 50, a fault-detecting station 51, an end wall or bottom-inspecting station 52, and a reject or ejecting station 53. These stations occupy a substantial length of the conveyors but length, as illustrated at 54, is provided above the platform 31 for attachment of other stations that may be desirable.

Referring now to FIGS. 3, 4 and 5, there is illustrated in greater detail the loading station 50. This loading station 50 is supported above the conveyor 12 and is designed to place cartridge shells in successive groups of five on the conveyor belt means 10. The conveyor belt means 10 consists essentially of an endless, parallel pair of chain links 12A and 12B suitably supported for parallel, endless movement over the drive rolls. Supported on and secured to these chains 12A and 12B by brackets 12C and 12D are successive pairs of support elements 12E and 12F. These support elements have upper edges scalloped to receive the opposite ends of the five shells which are fed successively into the machine for inspection. The five scallops in bracket 12E are of smaller diameter than the scallops of bracket 12F since the bracket 12E supports the neck of the shell and bracket 12F supports the base of it. These brackets are designed to support five shells 60 perpendicular to the longitudinal axis of the conveyor 12.

The loading station 50 is suitably supported on the frame of the machine by a supporting wall 58. This supporting wall is provided with a hole 59 through which shells 60 may be fed successively from a suitable hopper arrangement, not shown. The shells are fed successively into the five adjacent holes 59 with their bottom first. Five elongated holes 61 in loading station 50 are coaxially aligned, each with a hole 59 to form five passages through which successive shells pass toward the conveyor belt means 10. When the machine is in a non-loading position, however, these passages 61 are blocked by members 63 which are positioned directly over the conveyor belt means 10 and are adapted to be moved vertically with respect to it. Members 63, to be described in greater detail hereafter, are each selectively moved from a blocking relation with respect to their respective passages 61, as illustrated in FIG. 4, to non-blocking positions by virtue of the cyclical movement by the elevator means 30. The cyclical movement of the elevator means 30 causes the elongated, preferably rectangular cross-sectioned platform 31 (FIG. 4) to move upwardly. This in turn causes vertical movement of the shell-loading mechanism, generally illustrated at 64.

The shell-loading mechanism 64 comprises a body 65 which is rigidly secured longitudinally of and above platform 31. The body 65 may be secured above the platform 31 by any suitable means as, for example, by the bolts 66. The body 65 has an enclosed interior 67 (FIGS. 4, 5) in which there is provided five pins 68. One pin 68 is provided for each of the five shells that are simultaneously handled in the loading station. The pins 68 are journaled for vertical movement in holes in

the bottom 69 of the body 65, and are tensioned toward their uppermost position by helical springs 78 which are coaxial with the pins. The lower end of these springs 78 bear against the bottom 69 of the body 65, and at their upper end they bear against the under surface of the head 72 of the pin 68. The head 72 of the pin 68 each support a cradle 80. Each cradle 80 in turn is journaled for limited vertical movement in an aperture in the body 65; and has a series of scallops at its upper surface 81, each adapted to receive and support a cartridge shell 60. Each cradle 80 is normally maintained in an upper position relative to body 65 by interengagement of the annular shoulder 82 of the cradle base with the upper wall of the body 65. Holes 83 extend through the body 65 and through each cradle 80 at their respective bases. When the cradles are all maintained in their normal upper position, each of the holes 83 in the cradles and body 65 are longitudinally aligned. A light source 84 (FIGS. 3 and 5) is secured to one end of the loading station in alignment with these holes 83 when they are aligned. The light source 84 is supported on the body 65 by suitable means, such as bracket 85. The light source comprises the housing 86 within which is positioned a suitable light bulb and focusing lens that directs rays of light from the bulb within the housing 86 longitudinally through holes 83. When the cradles 80 are all properly aligned, light from the bulb in the light source 84 actuates the photocell 88 at the opposite end of the holes 83. Activation of photocell 88 functions as a fail-safe system. Thus, photocell 88 may be used to trigger a circuit to stop the operation of the machine when one of the pins 68 is held down against the tension of the spring 78 by an obstruction when the loading mechanism 64 is being raised. This might, for example, happen when a shell accidentally falls across two cradles 80.

When the loading mechanism 64 is moved upwardly by platform 31, cradle 80 engages member 63 and raises it to unblock holes 61 and permit five shells to be moved onto conveyor belt means 10. At the same time, this upward movement causes the holes 59 to close upon actuation of the upper section 89 of the loading station.

In this arrangement five members 63 each have a lower surface 90 that is arcuately shaped to receive the upper surface of a shell. The members 63 are suitably supported in a frame or housing 91 with this housing 91 supporting the members 63 for vertical movement. Above and secured to each of the members 63 is a flat plexiglass light guide 92, with each of these guides 92 suitably secured to a member 63 and adapted to be longitudinally aligned with the photocell 94 which may be substituted for the endmost plexiglass guide 92. The photocell 94 is normally excited or energized by light from the light source 95. This light source 95 comprises a housing 96 within which there is positioned a light bulb 97 supported by a socket 98. The bulb 97 is aligned with lens 99 which focuses light rays through the aligned plexiglass guide 92 to energize the photocell 94 when the unit is in a normal operative position. The light source 95 may, thus, be similar to light source 84 in structure and purpose. Also supported on the member 63 are linkage systems 100 which function to close holes 59 when shells are in the lifting mechanism. These linkage systems each include

an upwardly extending pin 101 which is contained at its lower end in housing 102 for limited vertical movement. Pin 101 is a segmented pin in which adjacent ends of the intermediate portion are normally maintained in a fixed, spaced relation by a helical spring 107. Lower end of housing 102 is outwardly flared and rests on top of member 63. Housing 102 and member 63 are downwardly tensioned by helical spring 103 which bears against housing 91 at its upper end and the flared lip of housing 102 at its lower end. The upper end of pin 101 bears against one end of lever 104. Lever 104 is pivotally supported by a journal 105 on the housing. The end of the lever 104 remote from pin 101, engages a stop mechanism 106. This stop mechanism consists of a pin that engages the arm 104 at its upper end and projects downwardly into the aperture 61 at its lower end. The pin may be provided with a shoulder section 108 to limit its downward movement. A spring 109 may be provided at its upper end to normally maintain pin 106 in pressure tension with the arm 104. As illustrated, the journal 105 may commonly support each of the five lever arms 104.

In the operation of this loading station, successive shells 60 are fed into the five (holes or passages) 61 with their narrow ends trailing. The shells are normally maintained in the passages or holes 61 until the platform 31 and lowering mechanism moves the cradles 80 upwardly. When the cradles 80 move upwardly, they each engage a member 63 thus, in turn, causing the members 63 to move upwardly and unblock holes 61 so that the shells may be moved onto the cradles 81 which are then aligned with the holes 61. At the same time the pins 101 are moved upwardly and rotate the levers 104 about their journal 105. This in turn causes the pin 106 to be moved downwardly against the tension of spring 109. When the lowermost end of pin 106 moves downwardly into passage 61, the next successive shell is engaged, thereby precluding it from moving further into the hole or passage 61 to prevent inadvertent malfunction of the loading station. Springs 103 return the members 63 to their normal positions when the platform or lifting mechanism moves downwardly under the action of the previously described cam mechanism drive system. The spring 109 will normally maintain the pin 106 in engagement with one end of the arm 104 which readies the loading station for the next successive loadings from the five passages 61.

When the platform 31 moves downwardly, the five shells which have been fed onto the cradles 81 are lowered until they engage the serrated surface of brackets 12E and 12F. As soon as they are engaged by these brackets, the five shells are moved to the next successive station where they are then raised from the conveyor by the cyclical vertical movement of the lifting mechanism. The shells 60 are moved to the next successive station by the intermittent movement of the conveyor belt means 10.

The next station to which shells are fed after being delivered to the conveyor belt means from the loading 50 is the fault-detection station 51, illustrated in FIGS. 6 and 7. The fault-detecting station 51 is suitably supported in a housing 110 that is mounted on the frame of the machine in longitudinal alignment with the loading station 50 and directly above a lifting mechanism and the conveyor belt means 10. In this embodiment, five

substantially identical units are provided for simultaneous fault inspection of the five shells simultaneously delivered by the loading station 50. At the upper end of the fault-detecting station 51 is a series of light sources which may comprise the light bulbs 111 which, preferably, should be incandescent. These bulbs 111 are suitably mounted in a socket assembly 112. Suitable electrical connections are provided for normally maintaining these bulbs on. The bulbs are positioned directly above light gates 113 (FIG. 6). These light gates each comprise a pair of parallel, elongated, opaque members 114 defining an elongated, beveled slot 115 that extends preferably the length of the light source. If desired, suitable bracket means 117 may be provided at each end which permit minor adjustments in the dimensions of the gate. These gates are supported on a bracket 118 that extends across the housing 110. The slots 115 are narrow and extend at least the length of the shells 60 which are moved to positions below. Positioned directly below each slot 115 is a lens 122 that is coextensive with the slot and is designed to focus light rays from the bulb 111 passing through the slots 115 onto shells directly below that been carried to the fault-detecting station by the conveyor means 10. The lenses 122 may be suitably supported in brackets 123, in turn secured at their ends to the housing 110 by end bolts 124 or by other suitable means. Preferably, each bulb 111, its gate 113, and its lenses 122 are separated from the adjacent bulbs, gates and lenses by vertical partitions 126 which limit light reflections and diffusion that might otherwise affect readings on adjacent cells.

Positioned immediately below the lenses are the five photocell subassemblies 128. Each of these five photocell subassemblies comprise a bracket 129 that is designed to support two sets or series of cells. These sets of cells are aligned angularly to one another, as illustrated in FIG. 6, with the two sets of photocells aligned to detect a thin line of reflected light on the surface of a shell. Light through the slots 115 and lenses 122 is focused in a thin line on the shells when the shells are moved upwardly by the lifting mechanism into a position directly below the sets of cells 130 and 131. The set of individual cells 130 extend the length of the shell being inspected with each of the photocells being focused downwardly so as to detect flaws or pick up light reflection from the major length of shell. The length of the set of cells 131, however, is much shorter. The individual cells of set 131 are focused angularly with respect to the set of cells 130, as is best illustrated in FIG. 7. This shorter set of photocells 131 are aligned to receive light reflections from the shoulder of the shells that are being inspected. In this connection, all shell cases taper to a shoulder section which is angular with respect to the major axis of shells in an angular band near the neck of the shell.

The platform 31 and conveyor belt means 10, previously described, extend below fault-detecting station 51. Supported on the platform 31 is a drive system, generally illustrated at 140. This drive system is used to rotate shells in the same groups of five in which the shells are delivered when they are raised by the lifting mechanism into an inspecting position immediately beneath the sets of photocells 130 and 131. In this arrangement, a bracket 141 supports six rotatable shafts

142. These shafts 142 are commonly driven by an endless belt 143. The belt 143 extends about five idler rolls 144 and the drive roll 146. Suitable take-up or idler rolls 147, external of the belt 142, may be provided if desired. Drive roll 146 is connected by suitable means (not shown) which may, for example, comprise a chain drive and idler sprockets, to a small motor which may be suitably supported on the elevator 30 to provide constant rotation of the shafts 142. The shafts 142 are arranged so that they all rotate in the same direction. Each shaft has an O-ring 148 secured at one end. These O-rings are sized to engage and rotate shells 60 when the lifting mechanism raises the drive mechanism 140 and an adjacent pair of O-rings 148 are moved into engagement with the shell immediately above it. A second O-ring 149 is freely mounted on each shaft 142 at the end of the shaft opposite the O-ring 148. Each O-ring 149, however, is free to rotate at speeds differing from the speeds of rotation of O-ring 148. This differential is necessary since the shells are not of uniform diameter over their length.

In the operation of the fault-detecting station, shells are carried in sets of five by the conveyor belt means 10 to a position below the fault-detecting station. The cam-actuated mechanism then causes the platform 31 to rise and the conveyor belt means 10 to stop substantially simultaneously. The conveyor belt means 10 stops with five shells located directly below each of the light bulb means previously described. The lifting mechanism moves the platform 31 upwardly until each of five shells is lifted from the support elements 12E and 12F, and is engaged by the four O-rings, 148, 149, with two at each end. The O-ring 148 are rotated causing the shells they support to rotate directly below the photocell sets 130 and 131 in the positions indicated by dotted outlines 60A. These photocell sets as indicated, are focused along the length of the shell to detect a thin line of light that is reflected from the shells as it rotates. If the uniformity of light reflection is disturbed, as for example, by a thin scratch or other flaw either in the areas upon which the photocell set 130 or photocell set 131 is focused, the information is fed into a suitable memory circuit, hereafter described, for subsequent ejection of that shell when it subsequently reaches an ejection station. After a suitable time interval during which the shells have been rotated at least 360 degrees and thereby inspected, the platform 131 is moved downwardly carrying the shells 60 to back onto the support elements 12E and 12F of the conveyor means 10. The conveyor belt means 10 is timed in its intermittent forward movement so that it now advances this set of five shells to the next station which is another fault-detecting station 52, for detecting faults at the end of the shell. At the same time, the subsequent set of five shells loaded onto the conveyor are moved to the fault-detecting station 51.

The end fault-detecting station 52 is positioned immediately after and in longitudinal alignment with fault-detecting station 51 and is directly above a lifting mechanism and platform 31. Station 52 is also above the conveyor means 10 which carry the shells in groups of five from the fault-detecting station 51 to the station 52. When the cyclical operation of the conveyor belt means 10 causes a set of five shells to reach station 52, the conveyor system stops and the platform 31 is cycli-

cally raised in a manner previously described. A lifting mechanism supported on platform 31 may comprise a pair of plates 156 and 157 that are suitably supported by a bracket 158 in turn mounted on the platform 31. The plates 156 and 157 have serrated upper edges providing a series of cradles 159 (FIG. 8). Upward movement of the platform 31 causes five shells on the conveyor means 10 to be engaged in and raised upwardly by the cradles 159 to the dotted position 63. In this position, the shells are aligned with a series of end fault-detecting means of the station 52. These means are each similar and may be commonly mounted on a sidewall 150 in turn mounted on a frame of the machine. A bracket 151 which is suitably secured to the sidewall 150 is provided with means for securing a plurality of subassembly members. These subassembly members each comprise a bracket 152 that extends over the conveyor belt means 10. The bracket 152 has a second bracket 153 supported above it. This bracket 153 has a lamp 155 which is secured to it by an L-shaped member 154. The lamp 155 is vertically aligned with a photocell 160 (FIG. 9) that is mounted in the bracket 153. A shutter 161 is adapted to move in between the lamp 155 and the photocell 160, so that the photocell may be actuated when the shutter 161 is moved from alignment with the lamp 155 and the photocell 160. The shutter 161 is carried by a lever 162 which in turn is mounted on an armature of a rotary solenoid 163 for rotation, as hereafter described. The lower end of the lever 162 projects below bracket 152 and is provided with an inwardly extending finger 164 that is adapted to be pivoted on rotation of the armature 163 through and out of an opening 165 in the bracket 166 (FIG. 9). The bracket 166 in turn comprises an L-shaped bracket having a lower arm 167 mounted on the frame of the machine by suitable means. The aperture 165 is designed to be axially aligned with the bottom of the shell 63 (when in position) which occurs when the shell is raised to an inspecting position on upward movement of platform 31.

Positioned directly above the conveyor belt means 10 and adapted to be engaged by the five shells when they are moved to position 63 by the platform 31 are five similar leaf spring means 170. Each leaf spring means includes a series of parallel springs 172, 173 adapted to engage and firmly hold the shell below when the shell moves to position 63.

Solenoid 163 is actuated by synchronized master electrical means hereafter described, and the armature of the solenoid is rotated and with it lever 162 moves causing the pin 164 to move inwardly through hole 165. If a normal shell having a bored hole 165 is positioned in the cradle 159, the pin 164 will move all the way into the hole 175, thus causing a slot (not shown) in the shutter 161 to be positioned between lamp 155 and the photocell 160. The lamp is suitably connected to a power supply so that it will excite photocell 160 when the slot in shutter 161 allows light to impinge on the photocell 160. At a time when the pins 164 would normally be well in holes 175, an electrical sampling is made simultaneously of each photocell 160. The timing of this sampling is controlled by the master electrical means hereafter described. When a photocell is not thus activated during the sampling period, a signal is generated indicating an unacceptable shell. This signal

is stored in a memory circuit of suitable design to eject the particular defective shell detected when it reaches the ejection station.

After sampling, the solenoid is returned to its original state thus causing the pin 164 to be withdrawn from engagement with the shells. The platform 31 is moved downwardly returning the shells to the conveyor belt means 10. The conveyor belt means is then advanced so that the five shells tested at station 52 move to the ejection station 53 which is illustrated in detail in FIGS. 10 and 11.

The ejector station 53 is positioned directly above the conveyor belt means 10 and the platform 31 immediately adjacent and successive to the end fault-inspecting station 52. In the cyclical operation of the platform, a set of five shells is moved upwardly off the conveyor belt means 10 into the ejection system by a lifting mechanism 173. This mechanism comprises parallel plates 174 supported by a bracket 175 in turn mounted on platform 31. The plates 174 have aligned, serrated upper edges adapted to receive and cradle five shells. Although FIG. 11 illustrates the ejector station with the lifting mechanism 173 in a down position, the position of the shells on the lifting mechanism during ejection is illustrated in dotted outline.

A support wall 180 in the ejector station is suitably secured to and extends upwardly from the frame of the machine. A bracket 181 is secured to this wall by suitable means, such as bolts. A series of modular ejection mechanisms 183 are secured to the bracket 181 by suitable means, such as bolts 184. Five modular ejection stations 183 are provided, one for each of the five shells being simultaneously examined. This modular ejection means comprises a solenoid 185 supported in a frame 186. Solenoid 185 has a rotatable armature that carries an ejection lever 187. The solenoid is adapted upon actuation to cause the lever 187 to pivot rapidly in a counterclockwise direction, as illustrated in FIG. 11. The lever 187 comprises a bracket having a pair of spaced end elements 188 and 189 that depend from a connecting web. The inner surfaces of the leg 188 are vertically aligned with a guide 190 that generally engages the base of the shells 60 when they are raised from the conveyor belt means 10 by the lifting mechanism 173. Thus, the base 60A of each shell is normally engaged by a leg 188 for alignment purposes when the lifting mechanism raises the shells to the ejector mechanism. Each ejector mechanism is designed to cause the lever arm 187 to pivot over a sufficient arc as to cause the inner surface of the leg 189 to strike the end 60B of a shell. The ejector mechanisms are suitably connected to an electrical circuit having a memory, as described in connection with FIG. 12, of such design as to cause only those ejector modules 183 to be actuated when a shell is positioned underneath the ejector module with the shell having previously been detected in either stations 51 or 52 as being defective. Thus, upon actuation of the solenoid 185, the leg 189 strikes the end 60B of the defective shell and drives it to the right as viewed in FIG. 11, where it may be suitably caught in a hopper attached to the protective housing 191.

Control of the machine may be attained through a circuit schematically illustrated in FIG. 12. In this arrangement, each of the sets of photocells 130 and 131

that are designed to detect surface flaws are connected to a video amplifier 200, 201, etc.

On actuation of switches 300 by master electrical means, the threshold comparator output is connected to the memory circuit 212. Under these conditions, signals from the photocells 130, 131 that are continuously amplified by the video amplifiers 200 through 205, are compared by the threshold comparator with a preset level. If the signal exceeds the preset level, which occurs when a defective shell has been detected, a reject signal is applied to and stored in the memory circuit 212.

Photocells 160 are connected to the sampling circuit 217, 218, 219, through an amplifier 214, 215, 216, etc.

The photocells 160 that are not illuminated when the hole on the bottom of the shell is defective or was not properly drilled cause the sampling circuit to register a signal in the memory during the sampling period. Thus, a signal indicative of a defective shell is placed on the memory circuit 212 for each shell in which through some inadvertence the hole in the base was not drilled.

The memory circuit 212 consists of three stages arranged in series. Information about the surface of the shells is stored in stage one. Information about the ends of the shells is stored in stage two. The third stage holds information for ejection purposes. As each group of five shells moves to a successive station in the machine, the information regarding these shells moves to a corresponding stage in the memory circuit where it is appropriately modified. At the third stage, those shells which are defective are ejected by actuation of the ejection mechanism in response to information contained in the third stage of the memory circuit. The remaining shells are then returned to the conveyor belt means when the elevator moves downwardly to a normal position for further intermittent movement. The shells are thus carried by the conveyor belt means 10 forwardly to a suitable collection point.

The master electrical control means may comprise a cam on the master drive of the machine which carries a laterally extending flange arcuately positioned with respect to the axis of the cam. A light source and aligned photocell are arranged to be interrupted by the flange on rotation of the cam. By preselecting the duration of the interruption, suitable electrical signals may be generated for synchronized control of switch means that control the various electrical circuits and components described above.

We claim:

1. An inspection system comprising a conveyor for conveying a plurality of like, rotatable objects successively and in gangs in a first direction to a detecting station, means for rotating simultaneously each of said objects in a selected of said gangs about a fixed axis at said detecting station, means for projecting a beam of light onto each of said objects as they are rotated about said axes, photocell means positioned to optically sense portions of said light reflected by each of said objects as they are rotated, and means responsive to variations in said reflected light sensed by said photocell means including circuit means for identifying the particular gang and object therein causing said variations in said reflected light.

2. An inspection system as set forth in claim 1 including means responsive to said means for identifying, for moving said particular object from said conveyor.

3. An inspection system as set forth in claim 1 wherein said objects are of generally cylindrical configuration, each of said axes of rotation being coincident with the central axis of each said generally cylindrical objects and, wherein said photocell means comprises a plurality of photocells, each of said photocells extending lengthwise of its associated said fixed axis, said means for projecting a light beam comprising means for projecting said beam onto said object as a narrow, elongated beam extending lengthwise of said object.

4. An inspection device as set forth in claim 3 including a plurality of said sets of photocells associated with each of said fixed axes, each of said photocells in said sets thereof being arranged to detect light reflected from different portions of the same object.

5. An inspection device as set forth in claim 4 wherein said means for projecting a light beam comprises a light bulb, means forming a narrow slot aligned with said bulb, and a focusing lens aligned with said bulb and slot.

6. An inspection device as set forth in claim 5 wherein said sets of photocells are aligned with said bulb, narrow slot and lens and with one set positioned on one side of the path of said light beam and the other set positioned on the other side thereof.

7. An inspection device as set forth in claim 6 including means for stopping said conveyor at said detecting station, means for interengaging said selected gang of objects at said first station with said rotating means and means for thereafter disengaging said objects from said rotating means.

8. An inspection device as set forth in claim 7 wherein said conveyor means supports said objects in a manner which enables them to be lifted free from said conveyor and wherein said means for interengaging said objects comprises lifting means including a drive system adapted to raise said object rotating means from beneath said conveyor, said object rotating means being adapted to lift said objects from said conveyor and to thereafter support said objects for rotation.

9. An inspection device as set forth in claim 8 wherein said rotating means comprises a plurality of shafts, means supporting said shafts parallel to one another, rings mounted on said shafts for rotation and adapted to engage and support said objects, and means for rotating said rings whereby said objects are rotated.

10. An inspection device as set forth in claim 9 including a platform, said rotating means supported on said platform and means for reciprocally moving said platform with said driving system in a vertical direction.

11. An inspection device as set forth in claim 10 wherein said conveyor comprises a pair of spaced belts and said rotating means is interposed and is adapted to be moved in said vertical direction between said belts.

12. An inspection device as set forth in claim 1 having an end fault-detecting station for detecting faults in an end of said objects, means supporting said end fault-detecting station in longitudinal alignment with said detecting station along said conveyor.

13. An inspection system comprising a conveyor for conveying a plurality of like, rotatable objects successively in a first direction to a detecting station, means for rotating said objects about an axis at said detecting station, means for projecting a beam of light onto each of said objects as they are rotated, photocell means

positioned to optically sense portion of said light reflected by said objects as they are rotated, means responsive to variations in said reflected light sensed by said photocell means including circuit means for identifying the particular object causing said variations in said reflected light, a loading station positioned over said conveyor in longitudinal alignment with said detecting station, said loading station comprising means forming a hole through which said objects are successively fed to said conveyor at a position adjacent and above said conveyor, means for receiving and lowering said objects to said conveyor, and means for blocking the feeding of further objects to said conveyor while said objects are lowered.

14. An inspection device as set forth in claim 13 wherein said means for receiving and lowering comprises a platform, cradle means supported on said platform for movement upwardly to a position in alignment with said means for feeding objects, means movable to and from a position blocking said hole and adapted to and from said blocking position by movement of said cradle means.

15. An inspection device as set forth in claim 14 wherein said platform extends longitudinally of and below said detecting station and said means for rotating said objects are mounted on said platform for vertical movement into engagement and relation with an object on said conveyor whereby said object is raised from said conveyor into a position in which said beam of light is focused on said object.

16. An inspection device as set forth in claim 15 having means for intermittently advancing said conveyor and means for reciprocally vertically moving said platform in synchronized relation to said intermittent movement of said conveyor.

17. An inspection device as set forth in claim 12 including means for engaging said end of an object for detecting faults, means electrically responsive to detected faults in said end including means for identifying the particular object having said fault.

18. An inspection device as set forth in claim 17 including a lifting mechanism supported on said platform for engaging and raising an object from said conveyor into a position for said end fault detecting, and contact means engaged by said object when raised into said position for actuating said end fault-detecting means.

19. An inspection station as set forth in claim 18 wherein said end fault-detecting means comprises a solenoid having a rotatable armature, a lever secured to said armature for limited rotation, means at one end of said lever for engagement with the end of said object upon rotation of said lever, photocell means and a light source aligned with said photocell means, a shutter carried by the other end of said lever and adapted to be moved to and from a position intermediate said light source and photocell means, and circuit means operable when said photocell means is actuated by said light source and means for storing signals generated in said

circuit means to indicate said objects with defective ends.

20. An inspection device as set forth in claim 19 wherein said means for moving said particular object from said conveyor comprises an ejection station positioned in longitudinal alignment with said fault-detecting station, a lifting mechanism positioned below said conveyor and adapted to be moved upwardly to engage and lift said objects from said conveyor to said ejection station.

21. An inspection station as set forth in claim 20 comprising a solenoid having a rotatable armature, an arm carried by said armature adapted to engage one end of defective objects and upon actuation drive said objects from said lifting mechanism.

22. Means for loading a plurality of objects successively onto a conveyor comprising means forming a hole through which said objects are successively fed to said conveyor at a position above said conveyor, means for engaging upper and lower portions of said objects and thereafter moving said objects successively downwardly onto said conveyor, and spring loaded restraining means positioned above said conveyor and onto which said objects move from said hole, said restraining means adapted to be spread for passage therethrough of said objects when positioned on said conveyor.

23. An inspection system for inspecting the cylindrical surface of a rotatable object comprising means for rotating said cylindrical object about its cylindrical axis, means for projecting a beam of light onto said cylindrical surface of said object as it is rotated about said axis, said beam projecting means being arranged to direct said beam along a plane which includes said axis, and to illuminate a longitudinal strip of said cylindrical surface of said object, photocell means positioned to optically sense portions of said light reflected by said objects as they are rotated and means responsive to predetermined variations in the character of said reflected light as sensed by said photocell means including circuit means for identifying the particular object causing said variations in said reflected light.

24. A system as defined in claim 23 wherein said means are disposed at a detecting station and further comprising a conveyor for conveying a plurality of said objects successively to said detecting station, means mounting said photocell means so that it receives light from a direction which is disposed at an angle to said plane in which said light beam lies and which intersects said plane of said light beam at a predetermined region, said predetermined region being disposed remote from said conveyor and at a location which intersects the surface of said object to be inspected when said object is supported at said axis, means for moving said object from said conveyor to a position in which it is in alignment with said axis and means for rotating said object about said fixed axis.

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