

[54] **ELECTROSTATIC PAINTING SYSTEM**
[75] Inventor: **Carl E. Fitzgerald, Morton Grove, Ill.**
[73] Assignee: **Indesco Corporation, Morton Grove, Ill.**
[22] Filed: **Oct. 12, 1970**
[21] Appl. No.: **79,985**

3,356,061 12/1967 Wiggins 118/2
3,255,037 6/1966 Knight et al. 118/2
2,961,990 11/1960 Wruck 118/2
3,027,273 3/1962 Sacks 118/2
3,086,495 4/1963 Knight 118/2

Primary Examiner—Mervin Stein
Assistant Examiner—Leo Millstein
Attorney—Anderson, Luedeka, Fitch, Even & Tabin

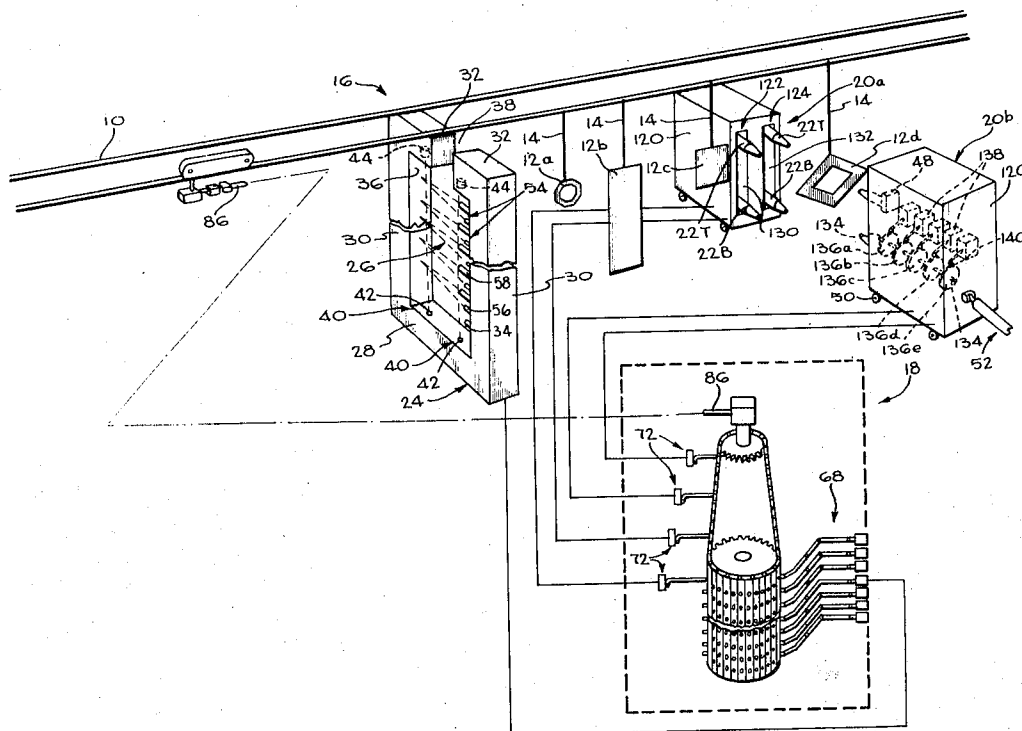
[52] U.S. Cl. 118/2, 118/7, 118/8
[51] Int. Cl. B05c 11/00
[58] Field of Search 118/2, 7, 8, 323;
239/63, 67; 117/17.5

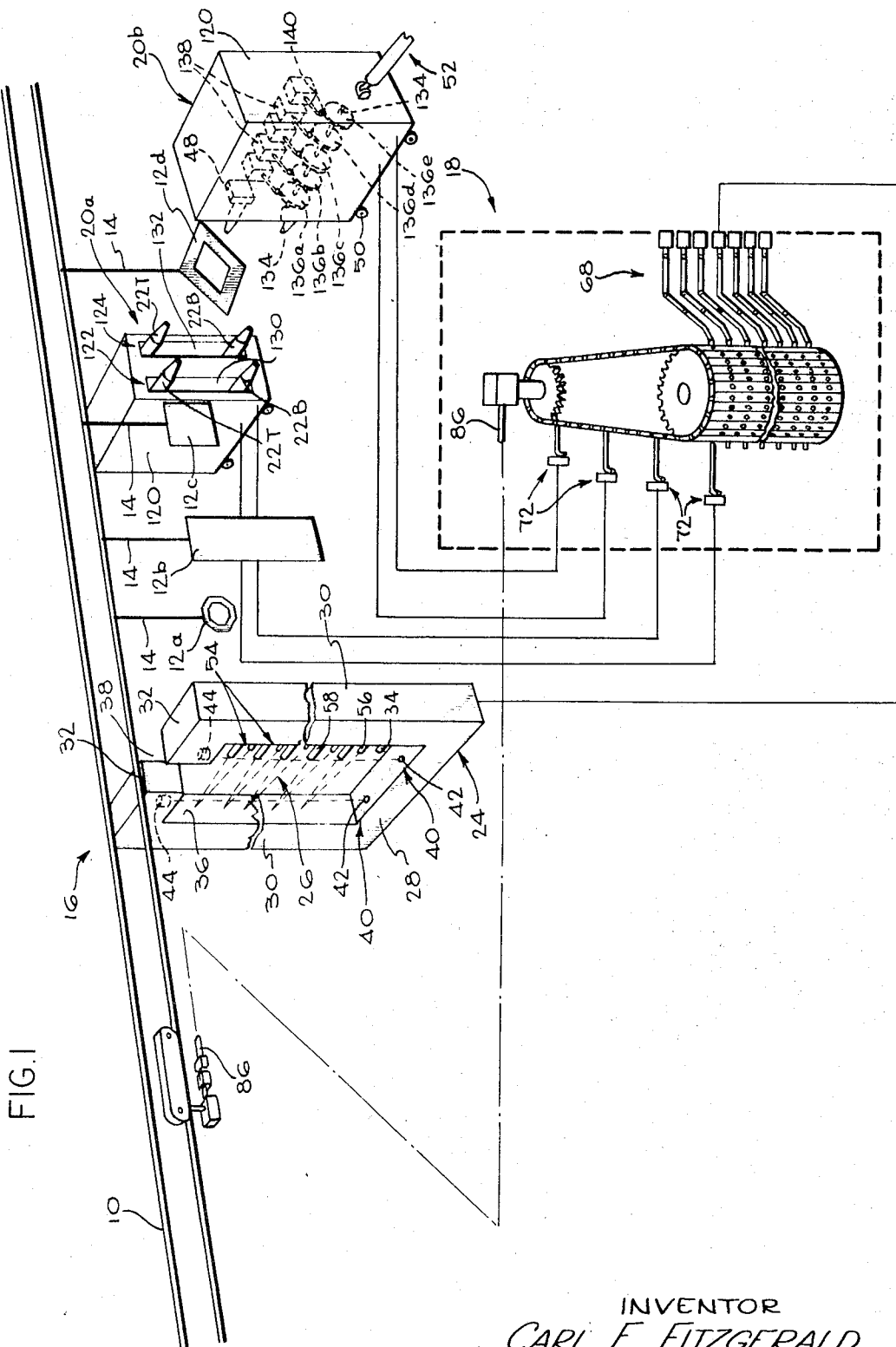
[56] **References Cited**
UNITED STATES PATENTS
3,593,308 7/1971 Fagan 340/172.5
3,646,521 2/1972 Porter 340/172.5
3,561,398 2/1971 Rose 118/7
3,594,211 7/1971 Drum 117/43

[57] **ABSTRACT**

An apparatus is provided for spray coating individual articles. The apparatus shown includes a conveyor for advancing the articles, a scanner for producing signals corresponding to the size and shape of the articles, a memory device for receiving signals from the scanner, and spray coating devices controlled by the memory device to provide a spray pattern for each article in accordance with its size and shape.

24 Claims, 9 Drawing Figures





INVENTOR
CARL E. FITZGERALD

Anderson, Suddick, Fitch, Egan, & Tablin
ATTYS.

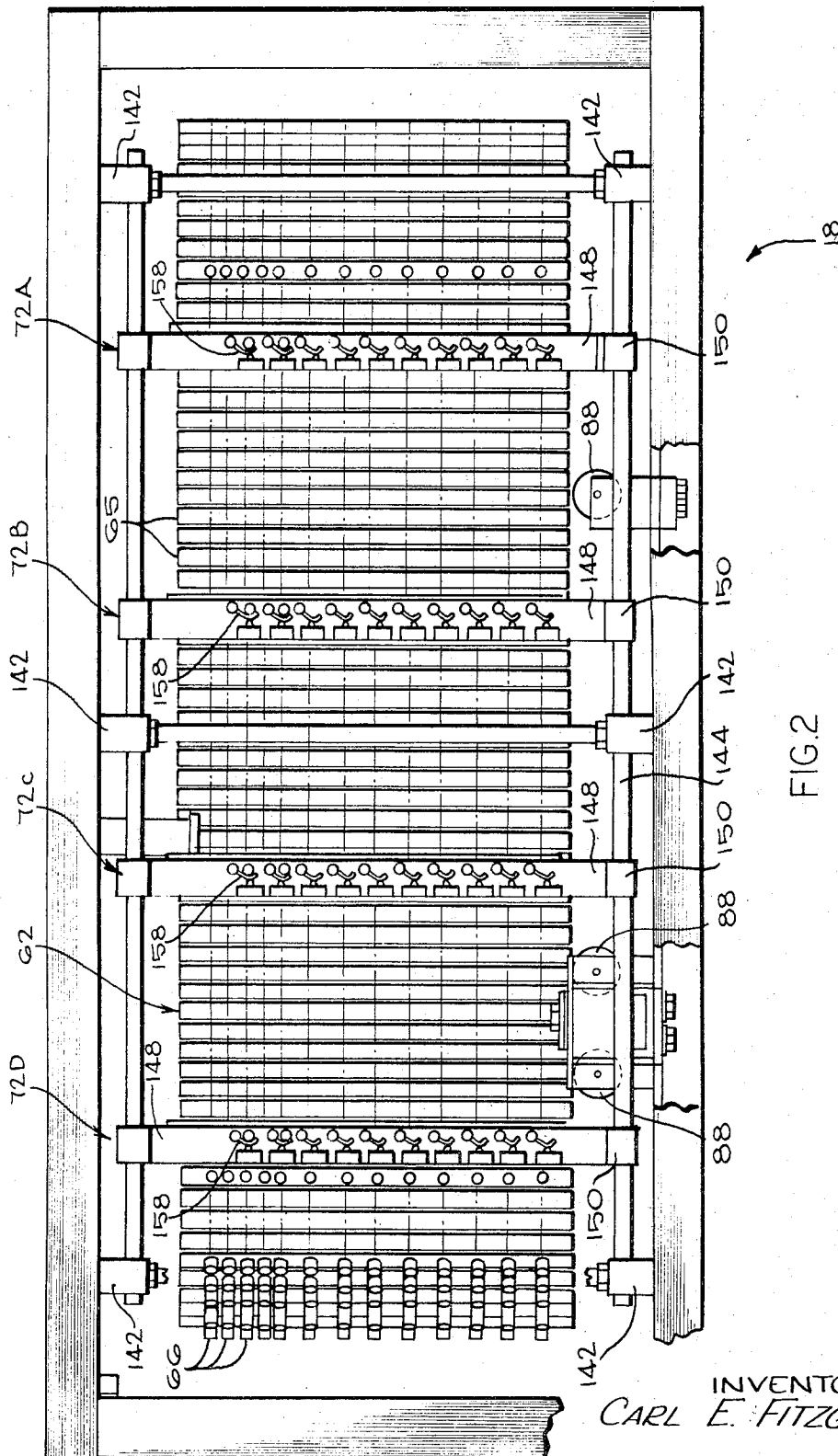


FIG. 2

INVENTOR
CARL E. FITZGERALD

Anderson, Luedeka, Fitch, Egan & Tabor
ATTYS.

FIG. 4

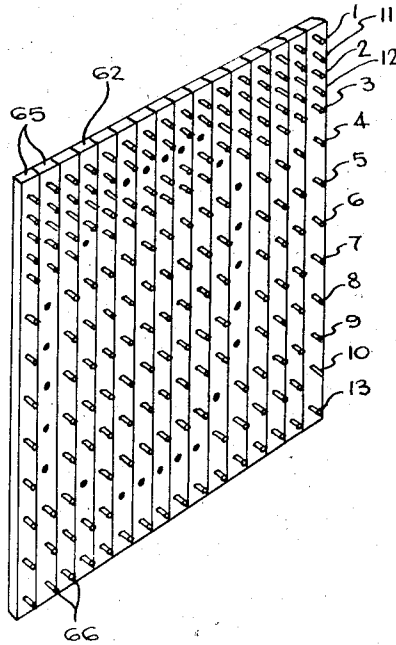


FIG. 5

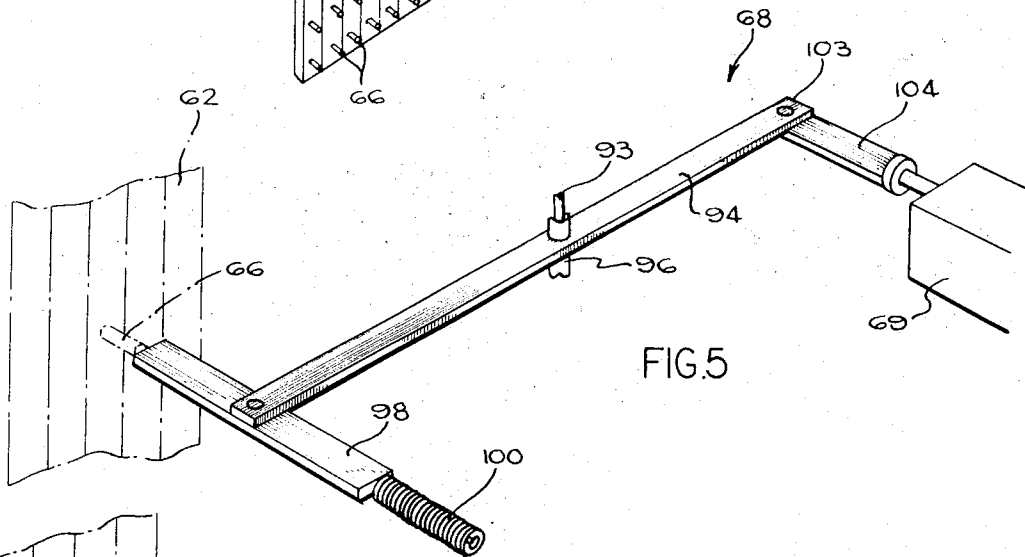
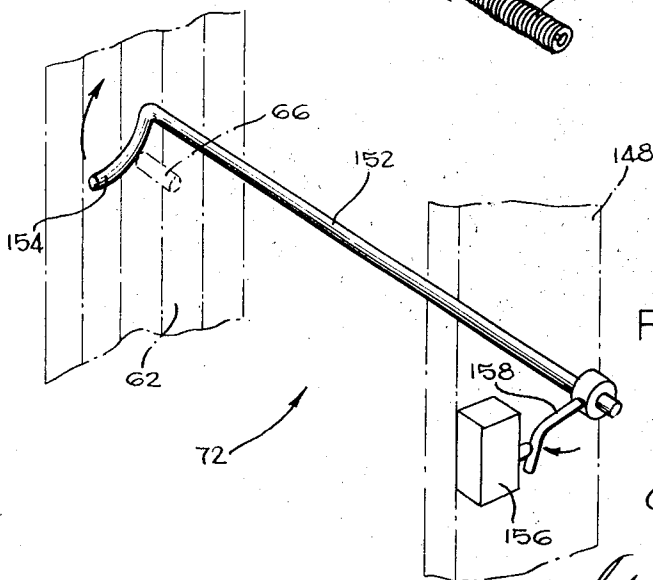


FIG. 6



INVENTOR
CARL E. FITZGERALD

Hjortson, Lueders, Fitch, Evans & Tablin
ATTYS.

FIG. 7

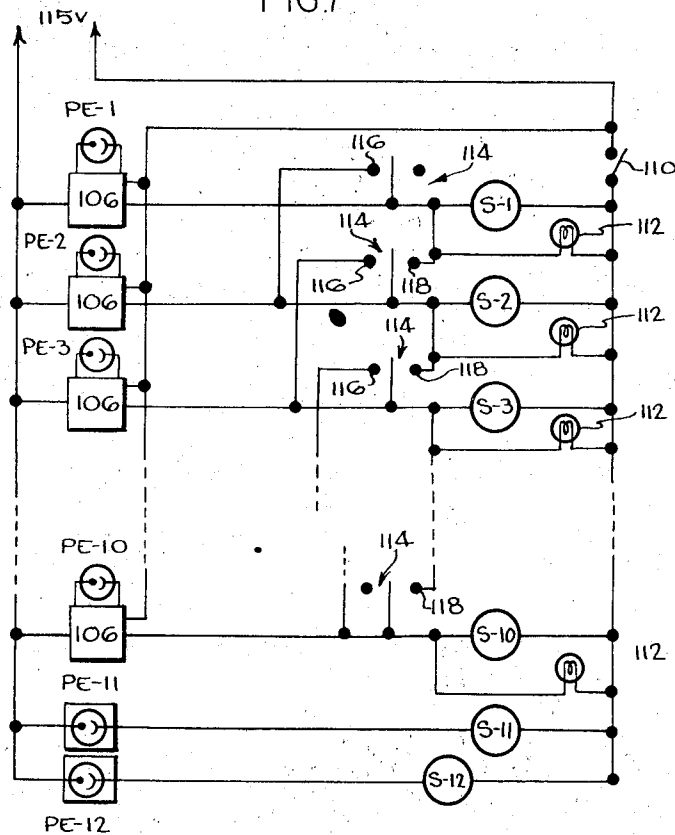
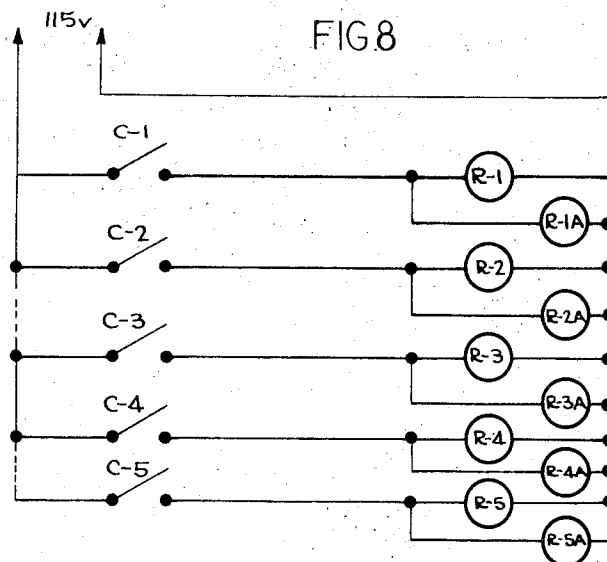


FIG. 8



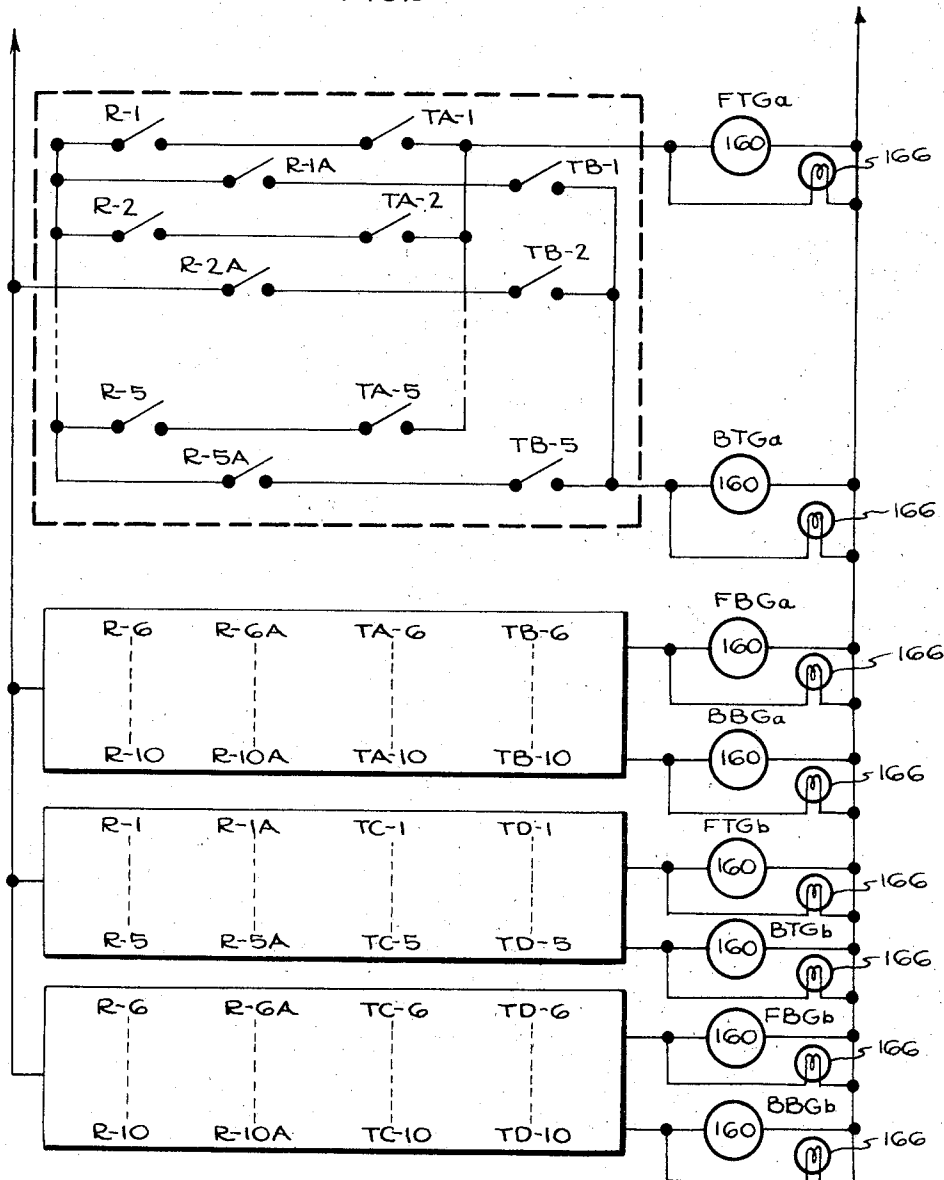
INVENTOR

CARL E. FITZGERALD

Anderson, Lyndella, Fitch, Evans, & Tabin

ATTYS.

FIG. 9



INVENTOR

CARL E. FITZGERALD

Anderson, Lundberg, Titch, Evers, & Tabin
ATTYS.

ELECTROSTATIC PAINTING SYSTEM

The present invention relates to an electrostatic spray painting system and also to a memory device which finds particular application in that system.

In the electrostatic spray painting of individual articles, it is conventional to advance the articles along a given path by means of a conveyor, the articles generally being suspended from the conveyor by means of hangers. Spray guns are positioned adjacent the path of the articles and reciprocate continuously in a vertical plane. In order to conserve paint, however, the guns do not spray constantly but are rather triggered so as to spray only when an article has entered their spray area, i.e., the area which can be covered by the spray of a given gun. The triggering of the guns may be accomplished by means of a photoelectric system which senses the entry of the article itself into the spray area, or may be accomplished simply by means of a micro-switch which is actuated by the hanger as it passes a given point on the conveyor path.

A principle disadvantage with the above-described system is that although it is sensitive to the presence of an article within the spray area of a given spray gun, it is not sensitive to the size or configuration of the article. For example, once they have been set, the spray guns will provide the same spray pattern whether the articles which pass it are long or short. Obviously, therefore, when a short article passes the guns only a portion of the spray pattern is utilized and a significant amount of paint may be wasted. The guns cannot accommodate themselves to different sizes of articles automatically. In one attempt to alleviate this problem, the spray guns are set for a spray pattern suitable for one specific size of article, and a number of such articles and no others are sprayed. When it is desired to spray articles of a different size, the guns are reset. If the different articles are components of the same unit, however, such as cabinet frames, doors and drawers, the articles sprayed first must be placed in storage until all of the components have been successively sprayed and dried. This requires a considerable amount of inventory space.

Moreover, in a conventional system, the guns begin to spray when the article as a whole enters the spray area and cease to spray when the article as a whole leaves the spray area. An article having an opening such as, for example, a picture frame, will be sprayed as though it were solid. That is, the area defining the opening is sprayed in the same manner as is the area defining the frame. Again, much paint is wasted.

It is therefore a principal object of the present invention to provide an improved electrostatic spray painting system adapted to automatically provide a spray pattern which corresponds to the particular size and shape of the article being sprayed without independent adjustment by an operator.

An additional object of the invention is to provide an improved memory device particularly adapted for use in a system such as the electrostatic spray painting system described.

A further object of the invention is to provide a memory system which is essentially mechanical in nature and which does not require highly skilled personnel to maintain it in working order.

These and other objects and advantages of the invention will become apparent with reference to the following description and accompanying drawings.

In the drawings:

FIG. 1 is a schematic representation of an electrostatic paint spraying system showing various of the features of the invention;

FIG. 2 is an enlarged elevational view of one component of the system of FIG. 1;

FIG. 3 is a plan view of the component illustrated in FIG. 2;

FIG. 4 is a fragmentary perspective view of a portion of the component illustrated in FIGS. 2 and 3;

FIG. 5 is a fragmentary perspective view of one portion of the component illustrated in FIGS. 2 and 3;

FIG. 6 is a fragmentary perspective view of a second portion of the component illustrated in FIGS. 2 and 3; and

FIGS. 7 through 9 are wiring diagrams for the circuit of the system shown in FIG. 1.

The system of the present invention is intended for the electrostatic spray painting of individual articles. In the following description, to avoid any misunderstanding, the vertical dimension of the articles as they face the spray guns will be referred to as their height. The lateral dimension of the articles as they face the spray guns will be referred to as their width. This latter dimension will generally be a horizontal dimension and be measured in the direction in which the articles are moving. One surface of each article facing one of the spray guns will be referred to as its front face, and the opposite surface of the article, which faces another spray gun, will be referred to as the back face of the article. The dimension of the articles measured transversely of the direction of movement of the conveyor, i.e., the distance between the front and rear faces of the articles, will be referred to as their depth.

Very generally, the embodiment of the present invention illustrated in the drawing (FIG. 1) includes an overhead conveyor 10 from which articles 12 are suspended by means of hangers 14. The conveyor 10 advances the articles along a defined path past a scanner 16 which generates signals corresponding to the disposition, size and shape of the articles, i.e., their height, width and depth. The signals are transmitted to a memory device 18 which converts them into stored data. A pair of electrostatic paint spraying devices 20 having constantly reciprocating spray guns 22 are provided along the path of the articles in the line of advance, i.e., downstream from the scanner 16. The spray painting devices 20, (designated 20a and 20b, respectively, in the drawing) hereinafter referred to as reciprocators because of the manner in which the guns 22 move, receive signals from the memory device 18 and these signals, as well as the position of the guns, determines whether a particular gun will spray at any given point in time. If the spray pattern of each gun be considered to be the outline it would trace on a flat planar surface extending longitudinally of the conveyor and traveling therewith past the gun, it will be appreciated that the spray pattern which each gun directs at any particular article corresponds to the size and shape of that article.

More specifically, the conveyor 10 can be of the type conventionally used in paint spraying applications. It is an overhead conveyor in the sense that the articles 12 are disposed beneath rather than on top of the portion of the conveyor which supports them. Provision is made on the conveyor for the attachment of the hangers 14 by means of which the articles 12 are connected to the conveyor. The hangers 14 can also be of the type

conventionally utilized in paint spraying systems, and the specific construction of neither the conveyor 10 nor the hangers 14 form a part of the present invention.

The function of the scanner 16 is to determine the size and shape of each article 12. More specifically, the scanner determines the height, width, and depth of each article, as well as its outer configuration and any open areas of significant size which are not to be painted. To illustrate the types of articles that can be efficiently and economically painted in succession without any operator adjustment to the system, four representative articles are shown in FIG. 1. The first article 12a is in the form of an open hexagonal frame, i.e., it has an hexagonal outer configuration and an hexagonal central opening. The second article 12b is much longer and much narrower than the article 12a and has no openings. Likewise, the third article 12c has no openings. However, it is much wider and much shorter than the article 12b. The fourth and last article illustrated is also in the form of an open frame but has a diamond-shaped outer configuration and a diamond-shaped opening. It should be appreciated that the articles 12 which are shown in the drawings are merely illustrative and that the wide variety of articles which are commonly spray painted, such as metal cabinets and the like, can be handled with equal adaptability by the system to be described.

In electrostatic spray painting, the distance between the spray gun and that surface of the article being sprayed which is immediately adjacent the spray gun affects the efficiency and performance of the gun. The paint is, of course, ejected from the gun under pressure. When the article sprayed is simply a thin plate, the pressure must be sufficient to convey the paint to essentially the center of the path along which the article is traveling. On the other hand, when the article is relatively deep so that the surface to be sprayed is relatively close to the gun, not nearly as much pressure is needed and, in fact, too much pressure may be undesirable and result in splattering of the paint. Accordingly, the scanner 16 is adapted to detect the depth of the article being sprayed so that the pressure of the fluid as it leaves the gun, or the distance between the gun and the article, can be automatically adjusted.

The scanner 16 is also capable of detecting the outer configuration of each article, including its height and width, so that the overall spray pattern will be no greater in height than is necessary and be of minimum duration so that the minimum amount of paint is used. The scanner is also capable of detecting openings within the outer boundaries of the articles so that paint is not wasted by injecting it through open spaces in which there are no surfaces to receive it. This detection is independent of the configuration of the article preceding of following the one being scanned so that a series of articles of random configuration can be conveyed for spraying, and each will, if necessary, produce a spray pattern unique from that produced by the other articles of the series.

Referring now more specifically to the drawings, the scanner 16 includes a frame 24 outlining a relatively large pathway 26 lying in a vertical plane transverse to the direction of movement of the articles. The pathway 26 is of sufficient size to accommodate in height and depth any one of the articles being painted. The frame 24 comprises a horizontal base 28, an upright 30 extending vertically upwardly from each end, respec-

tively, of the base 28, and a pair of cross members 32, one of which is provided at the upper end of each of the uprights 30. The base 28 is disposed transversely of the direction of movement of the articles and is positioned so as to be beneath the articles as they are advanced by the conveyor 10. The uprights 30 include opposed inwardly facing surfaces 34 and 36 which are disposed so as to be on opposite sides of an article advancing through the pathway 26; thus, the surfaces 34 and 36 are spaced from each other a distance somewhat greater than the depth of the deepest article being conveyed. The cross members 32 overhang the base 28 and project inwardly toward each other at the upper end of the frame, but terminate short of each other so as to define a gap 38 through which a hanger 14 may pass while carrying an article through the pathway.

The upper surface of the base 28 and the lower surfaces of the cross members 32 are together provided with a pair of photoelectric sensing units 40, one unit being provided on each side of the center of the base, which center lies directly beneath the path of travel of the hangers 14 which carry the articles 12. The photoelectric sensing units 40 are spaced from the center of the base and, thus, from each other a predetermined distance, the magnitude of which is determined by the character of the spraying devices, as will become apparent shortly.

Each photoelectric sensing unit 40 comprises a light source 42 mounted on the upper surface of the base 28 and a photoelectric cell 44 mounted on the under surface of one of the cross members 32 in vertical alignment with the light source 42. The light source 42 is adapted to direct a beam of light essentially vertically upwardly toward the photoelectric cell 44 of that sensing unit 40. When this beam of light is interrupted, as by the passage through the pathway 26 of an article 12 having the required depth, a signal will be produced, as hereinafter described, which is indicative of the depth of the article advancing through the pathway 26.

A signal from the photoelectric sensing units 40 is generated by the movement through the pathway 26 of an article of sufficient depth to interrupt the light beam of at least one of the two units. The generated signals are fed to the memory device 18 which records the signals and ultimately sends a corresponding signal to each reciprocator 20 and, more specifically to a solenoid 48 in each reciprocator which is effective to control the pressure under which the paint is ejected. Thus, for example, a reciprocator 20 could be set to operate at either of two different pressures, as dictated by its solenoid 48. If the beams of the photoelectric sensing units 40 were not interrupted, indicating a thin article in terms of depth, the solenoid 48 would cause the paint to be discharged at a high pressure. If the beams of the photoelectric sensing units 40 are interrupted, however, indicating a deeper article, the solenoid would cause the paint to be discharged at a lower pressure.

Alternatively, the reciprocators 20 could be mounted for movement toward and away from the path of travel of the articles 12, as by means of wheels 50 (FIG. 1), and the memory device could be designed to send signals to a piston-cylinder arrangement 52, either electrical or mechanical, or some equivalent device, which would physically move the reciprocator 20 toward and away from the path of the article to compensate for changes in the depth of successive articles.

In order that the scanner 16 may detect the height and width of each article as it is advanced through the pathway 26, the inwardly facing surface 34 of one of the uprights 30 is provided with a vertically arranged series of photoelectric units 54. In a preferred embodiment, ten of the units 54 are provided at 6 inch intervals, covering a total of 5 feet; however, a greater or lesser number may be provided if desired. In the drawing, the scanner 16 is broken away for convenience of illustration. Like the photoelectric units 40, each unit 54 includes a light source 56 and a photoelectric cell 58. However, unlike the units 40, both the light source 56 and the photoelectric cell 58 of the units 54 are mounted on the same surface 34 spaced vertically from each other a short distance such as, for example, three inches. The inwardly facing surface 36 of the remaining opposed upright 30 is rendered reflective by the attachment thereto of a mirror or by any other method which is convenient. Thus, the light source 56 of each unit 54 projects a ray of light against the surface 36, which ray is reflected back and detected by the corresponding photoelectric cell 58. Thus, insofar as the units 54 are concerned, each beam consists of a direct ray and a reflected ray, the interruption of either of which will cause the photoelectric cell to generate a signal which is transmitted to the memory device 18 which registers the information, as hereinafter described.

Of course, it should be appreciated that the light source 56 could be located on the surface 34 and the photoelectric cell could be located on the surface 36 so that, as in the case of the units 40, only a direct ray of light would be provided. However, the use of both a direct and a reflected ray provides each unit 54 with a greater scope and is thus believed to be preferable. It should also be appreciated that the frame 24 is merely a convenient means of supporting the photoelectric units 44 and 54 and the reflective surface 36 and that these photoelectric units and surface need not be supported by a common structure but could, for example, be supported by independent structures or even portions of the building in which the system is located.

By way of example, consider the passage of the hexagonal article 12a with an hexagonal opening through the pathway 26. The leading or most advanced surface of this article is a point from which the leading edges of the article diverge. When this point enters the pathway 26, it will interrupt a beam of one of the photoelectric units 54, the particular beam interrupted depending upon the vertical location of the point within the pathway. The interruption of this beam will cause an appropriate signal to be sent to the memory device 18. This signal indicates not only the presence of a paintable surface within the pathway, but also the vertical location of that surface relative to the overall height of the pathway. As the article progresses, the diverging leading edges interrupt additional beams if the article has sufficient height and appropriate signals are likewise sent to the memory device. However, since these latter signals come from different photoelectric units than the first, and since there is a time delay between the interruption of the first beam and the interruption of the additional beams, the information received by the memory device reflects the fact that the leading edge of the article diverges from a common point. As the article progresses further, the beam of the first photoelectric unit will come into registration with the hexagonal opening of the article and the light beam from

that unit will no longer be interrupted. Thus, no signal will be sent to the memory device, thereby indicating that no surface to be sprayed is present. The uppermost and lowermost beams interrupted by the leading edge of the article will remain interrupted by the upper and lower portions of the article, which portions extend laterally for some distance so that these units continue to send signals, thereby reflecting the fact that the surfaces interrupting these beams are continuous. Since the article 12a is symmetrical about its vertical center line, the reverse of the above will occur as the second half of the article passes through the pathway 26. The system is designed so that continuous interruption of the beam of any one photoelectric unit for an extended period of time, such as when a particularly wide unit passes through the pathway, will result in the transmission of a continuous signal to the memory device, as subsequently described.

The memory device 18 of the illustrated embodiment is electromechanical in nature so that its working components can be readily observed and repaired by normal plant maintenance personnel in the event of a malfunction, and so that its operation can be easily observed to determine if, in fact, it is operating properly. The memory device 18 is therefore preferred in many respects to magnetic memory devices which are generally more sophisticated in nature and require greater skill and expertise in repair and maintenance. However, any of the various forms of memory devices can be utilized in the system, if desired.

Very generally, the device 18 includes an endless belt 62 (FIGS. 2-4) which is continuously advanced at a predetermined speed which is synchronized with the speed of the conveyor 10. The belt 62 is formed of a plurality of bars 65, each of which is provided with a row of holes with each hole having disposed therein a pin 66. In a preferred embodiment, the bars are metal but, of course, other materials could be employed. The pins normally project outwardly of the belt 62, but are movable axially within the holes. Axial movement inwardly of the holes is accomplished by a pin-driving mechanism 68 (FIGS. 1, 3 and 5) provided at a first station, this mechanism being controlled by the action of solenoids 69. The pins are returned to their normal outwardly projecting positions by a drum 70 (FIG. 3) located at a station remote from the first station but spaced from the first station in the direction in which the belt advances. Intermediate the first station and the remote station are sensing mechanisms or transducers 72 (FIGS. 1, 2, 3 and 6), each of which is electrically connected to a reciprocator 20. The transducers 72 are actuated in accordance with the position of the pins 66 as the pins pass.

Generally, in the operation of the memory device 18, when the light beam of a photoelectric unit 40 or 54 is interrupted by an article indicating the presence of a surface to be sprayed and the location of that surface, a signal is transmitted to the appropriate solenoid 69 to which that unit is coupled, and that solenoid then actuates an element of the pin-driving mechanism 68, causing it to urge a pin 66 inwardly of the belt 62 until the outer end of the pin is flush with the outer surface of the bar 65 which carries it. (For purposes of illustration, a section of the surface of the belt 62 which has already passed the pin-driving mechanism 68 and which reflects the passage of the article 12a past the scanner 16 is shown in FIG. 4.) As this bar 65 passes

each transducer 72, the fact that the pin is depressed causes the transducer to transmit a signal to its corresponding reciprocator 20, permitting that reciprocator to trigger one or more of its spray guns 22 and eject paint if other conditions, hereinafter described, are satisfied. Because of a synchronized movement of the conveyor 10 and the belt 62, the actuation of the reciprocator 20 occurs only when the article scanned is in proper proximity to the reciprocator and the gun which is triggered.

More specifically, the memory device 18 (FIGS. 2 and 3) includes a frame 74 which supports a pair of vertically disposed, horizontally spaced shafts 76 and 78 journaled for rotation about parallel vertical axes. Affixed adjacent the upper end of each shaft 76 and 78 is an upper sprocket 80, and affixed adjacent the lower end of each shaft is a lower sprocket (not shown). The upper sprockets 80 are interconnected by a link chain 82 and the lower sprockets are similarly interconnected by a link chain (not shown).

Extending between the chains 82 and 84 for movement therewith are the metal bars 65 which are vertically disposed so as to move in a plane parallel to the axes of the shafts 76 and 78. Each bar 65 is provided with a plurality of holes which extend completely through the bars. In a preferred embodiment, thirteen such holes are provided but, of course, the number may be varied depending upon the particular application for which the system is intended. There are ten evenly spaced holes providing the belt 62 with ten horizontally extending rows. In addition, an eleventh row of holes is added between the first and second rows, a twelfth row is added between the second and third rows, and a thirteenth row is added after row ten. These rows are numbered in FIG. 4 as referred to above. Each hole carries one of the pins 66, the pins being of such a diameter relative to the diameter of the holes in the bars that they are freely movable axially, therein, but not to such an extent that they will easily become dislodged. If desired, a heavy lubricant can be placed in the holes to prevent inadvertent or unintentional displacement of the pins.

The upper chain 82 and the lower chain, together with the bars 65, form the belt 62 which is in the form of a closed loop, the surfaces of which lie in a vertical plane. The belt is advanced by means of a direct connection 86 (FIG. 1) between the shaft 78 and the conveyor 10, the connection being such as to drive the belt 62 in synchronism with the conveyor, although not at the same speed as the conveyor. In a preferred embodiment, the belt 62 is advanced one inch for each twelve inches that the conveyor is advanced. Supporting rollers 88 are provided on the frame 74 intermediate the shafts 76 and 78 to support and guide the belt runs as they travel (FIG. 2).

Thus, the belt carries thirteen vertically spaced, horizontally extending rows of pins 66, while each bar 65 carries a single vertical row of thirteen pins.

The pin-driving mechanism 68 is positioned adjacent the belt 62 at what will be referred to as a first station. In the illustrated embodiment (FIG. 1), this station is located adjacent one run of the loop while the transducers 72 are located adjacent the opposite run of the loop. The pin-driving mechanism urges selected pins of a bar 65 inwardly of the loop. The traveling movement of the belt ultimately places each bar in proximity to each transducer 72, and the transducers accordingly

respond to the displacement of such pins which have been moved inwardly.

Referring more specifically to FIGS. 3 and 5, the pin-driving mechanism 68 includes a pair of brackets 92, one of which projects horizontally from the frame past the upper edge of the belt 62 and the other of which projects horizontally from the frame past the lower edge of the belt. Three rods 93 extend vertically between the brackets 92 and serve to define pivotal axes for a plurality of actuating arms 94. A total of 12 arms 94 are provided, one for all but the 13th horizontally extending row of pins 66. For reasons which will become apparent shortly, the pins of the 13th row are never displaced axially into the belt. To avoid interference between the arms and to provide space for the solenoids 69, the rods 93 are spaced successively greater distances from the surface of the belt and are spaced from each other in the direction of movement of the belt. The arms 94, which are vertically spaced from each other by suitable spacers 96, thus pivot about vertical axes within generally horizontal planes which coincide with the horizontal planes in which the twelve rows of pins travel.

Pivotaly secured adjacent one end of each arm 94 is an elongated plunger 98, the plunger being secured to the arm at approximately the midpoint of the plunger. The plunger of each arm is normally disposed with its longitudinal axis extending generally perpendicular to the adjacent surface of the belt 62, and a tension spring 100 extends between the outer end of the plunger and a cross member 102 to bias the plunger outwardly so as to maintain the inner end of the plunger in sufficiently spaced relation to the adjacent surface of the belt 62 to permit a fully extended pin 66 to pass the inner end of the plunger without contacting same if the pin is not to be displaced.

The end of the arm 94 which is opposite to that end to which the plunger 98 is attached is designated by the numeral 103 in FIGS. 3 and 5. It will be appreciated that movement of the end 103 of the arm 94 in a direction away from the adjacent surface of the belt 62, and against the biasing action of the spring 100, will move the inner end of the plunger in the direction of the belt 62 and into contact with a protruding pin 66 if one be in alignment with it. In order to effect such movement of the arm and, thus, contact with and axial movement of a pin 66 inwardly of its bar 65, the end 103 of the arm 94 is itself pivotaly connected through a link 104 to the armature of one of the solenoids 69, previously referred to, which are actuated by the photoelectric units 40 and 54. When a solenoid 69 is actuated, its armature is retracted, thereby pivoting the arm 94 and causing the plunger 98 to move toward the surface of the belt 62. A separate solenoid 69 is provided for each of the twelve arms 94. Each of the two solenoids 69 whose plungers 98 are in alignment with rows of pins eleven and twelve are connected in series with one of the two photoelectric units 40, which reflect the depth of the articles, while each of the ten solenoids 69 whose plungers 98 are in alignment with rows of pins one through ten are connected in series with one of the ten photoelectric units 54 which reflect the height and width of the articles. The plungers of the solenoids which are in series with the photoelectric units 54 are thus oriented relative to the belt 62 in a manner corresponding to the orientation of photoelectric units 54 relative to the scanner frame 24.

Referring now to the wiring diagram of FIG. 7, the operation of the control circuit for the pin-driving mechanism 68 can be described. In the circuit, a series of variable delay timers 106 are connected in parallel to a suitable voltage source. In the drawing, only four such timers are shown, but it will be understood that one timer is provided for each of the ten photoelectric units 54 and, thus, for each of the solenoids 69, arms 94, and plungers 98 of the rows of pins 1 through 10. Each timer is connected in parallel with one of the ten photoelectric cells 58 and is also connected in series with one of the solenoids 69a. These ten photoelectric cells are designated PE-1 through PE-10 in FIG. 7 and the solenoids 69a are designated S-1 through S-10 for ease of understanding. Some of the intermediate cells, timers and solenoids have been omitted as merely repetitious. In addition, the two photoelectric cells 44, designated PE-11 and PE-12, of the photoelectric units 40 are connected in parallel with each other and each is connected in series with one of the solenoids 69 whose plungers are in alignment with rows of pins eleven and twelve, these solenoids being designated S-11 and S-12 in FIG. 4. There is no timer shown in series with the solenoids S-11 and S-12. However, one could be provided if a time delay is desirable for the depth sensing feature.

Thus, when a beam of one of the photoelectric units 54 is interrupted, a switch (not shown) of its corresponding timer will be closed, thereby permitting current to flow to the corresponding solenoid 69 (S-1 through S-10) which is in series with it. The timer insures a flow of current to the solenoid for a preselected period of time after the beam of the photoelectric cell is first interrupted, for reasons which will be explained shortly. When a beam of one of the photoelectric units 40 (P-11 or P-12) is interrupted, current will flow directly to one of the solenoids S-11 or S-12.

If no other provision was made, each time the light beam of a photoelectric unit 54 is interrupted, one of the solenoids 69 will theoretically be actuated, thereby moving one of the plungers 98 in the direction of the adjacent surface of the belt 62 and into contact with a pin 66. If the beam of the photoelectric unit continues to be interrupted as, for example, if a particularly wide or deep unit is passing through the pathway 26, a solenoid 69 would remain actuated and the plunger would remain extended in the direction of the belt in the path of advancing pins. While the plunger could be designed so that pins which engaged it while it was so extended would be cammed inwardly of the belt, it has been found preferable for any given plunger 98 to be moved in the direction of the belt only when a pin 66 is in alignment with that plunger, and for each plunger to be retracted after it has moved one of the pins axially so as to permit a succeeding pin to be moved into axial alignment with the plunger without first contacting it. Accordingly, a switch 110 is provided in parallel with the timers 106, with the photoelectric cells PE-11 and PE-12, and with the solenoids 69 (S-1 through S-12) and is positioned so as to be engaged successively by the pins 66 of the 13th horizontally extending row as that row passes the switch, the pins of this row being always extended as previously mentioned. Thus, in order for current to flow to any one of the twelve solenoids 69, the switch of the corresponding timer 106, as well as the switch 110, must be closed. Because of the location of the switch 110, it is only closed when a vertically extending row of pins is in alignment with the plungers

98; thus, only when the pins and plungers are in alignment can the plungers be moved in the direction of the belt. As a consequence, the plungers will not move into engagement with that portion of the belt which is between the rows of pins and, as soon as the pins have passed the switch 110, the switch will be opened, causing the extended plungers to be retracted by the springs 100 until a second row of pins passes the switch 110. Accordingly, even if a very wide article is passing through the scanning device and the beam of a photoelectric unit 54 is continuously interrupted, the solenoids will nevertheless operate intermittently and engage each row of pins successively. A light source 112 is connected in parallel with each solenoid 69 and provides a visual indication of which solenoids have been actuated, thus permitting a malfunction to be easily determined.

When very deep articles 22 are being sprayed, it may be desirable to provide a spray in advance of, above, below, and behind the article so that the spray pattern will be sufficient to coat the top, bottom, and side surfaces as well as the front and rear surfaces of the article. Accordingly, provision is made to depress pins in advance of, above and below, and rearwardly of those which would be depressed as a result of the actual interruption of beams of the photoelectric cells by the article so as to, in effect, record the configuration of the article as though it was of greater height and width than it actually is. In this way, the paint will be directed past the leading, upper, lower, and trailing surfaces and be deposited onto those surfaces.

In order to provide a spray past the trailing surface of the article, the timers 106 are selectively adjustable so that they will maintain a flow of current to the solenoids 69 for a predetermined period of time after the beams of the photoelectric units 54 have ceased to be interrupted by the article. Thus, if the article is particularly deep, it may be desirable to cause a spray pattern to extend for some distance past the trailing surface of the article and the timer 106 may be adjusted accordingly. In a preferred embodiment, the timer is adjustable to provide a delay of up to fifteen seconds.

In order that a spray may be directed over the upper surface and beneath the lower surface of the article, provision is also made for selectively connecting certain timers 106 of photoelectric units 54 not only with their own solenoid 69, but also with the solenoid of the plunger of one of the rows one through ten immediately above or immediately beneath the plunger which its own solenoid actuates as the plungers are arranged relative to the belts 62, thereby insuring a spray pattern adequate to cover the top and bottom surfaces of the article. For example, assume that the photoelectric cell designated PE-1 is the cell of the photoelectric unit 54 uppermost on the frame 24, that the cell PE-2 is the cell of the unit 54 immediately beneath it, and so forth, with the cell PE-10 being the cell of the lowermost unit 54 of the frame. Although the uppermost light beam interrupted by an article 12 is that of the photoelectric unit PE-3 which, for example, will cause the solenoid S-3 to be actuated and result in pins of horizontally extending row three (FIG. 4) to be moved inwardly, it may be desirable to also actuate the solenoid S-2 so as to also cause pins of horizontally extending row two to be inserted.

Accordingly, a three-way switch 114 is provided in series with each timer 106 and corresponding solenoid

S-1 through S-10 and includes a neutral position and a pair of contacts 116 and 118. The contact 116 of each switch 114 other than the uppermost one is connected in parallel with the solenoid of the plunger immediately above its own. The contact 118 of each switch 114 other than the lowermost one is connected in parallel with the solenoid of the plunger immediately beneath its own. One contact of the switch 114 of the uppermost timer and one contact of the switch 114 of the lowermost solenoid is a dummy, there being no adjacent upper or lower solenoids to which they can appropriately be connected.

When the arm of the switch 114 is moved to one or the other of the contacts 116 or 118 which are connected to the circuits of an adjacent solenoid 69, the effect is to cause the energization of the next adjacent solenoid even though the beam of the photoelectric unit of the timer of that solenoid was not interrupted. As a result, the spraying devices 20 will be operated as though the article has a greater vertical dimension than it actually has and the desired spray pattern will be achieved.

In order that the operation of the transducers 72 may be most clearly understood, the reciprocators 20, the operation of which they control, will be described first. Referring to FIG. 1, two such reciprocators are shown positioned after the scanner 16 in the drawing, one of which is designated 20a and is designed to spray the rearward surface of the articles 12, i.e., those surfaces concealed from view in the drawing, and the other of which is designated 20b and is designed to spray the opposite or front surface of the articles 12. The reciprocators 20 are of standard construction and are housed within cabinets 120. Although various forms of such devices are available, those employed in a preferred embodiment are identical and include eight vertically reciprocating spray guns 22, these guns being supported in two sets of two each with the guns of each set being stacked in vertical alignment and with the two stacks spaced horizontally from each other. For convenience of description, the stack of each reciprocator 20 nearest the scanner 16 will be referred to as the forward stack and is designated by the numeral 122 in the drawing. The remaining stack will be referred to as the rearward stack and is designated by the numeral 124 in the drawing. The lowermost or bottom gun of each stack is designated 22B in the drawing and the gun uppermost or top is designated 22T.

In the illustrated embodiment, the guns of each of the two stacks 122 and 124 are mounted on rigid plates 130 and 132 in fixed vertically spaced relation to each other. Each plate is, in turn, mounted for vertical reciprocating movement in a suitable guideway provided within the cabinet 120 and suitable means (now shown) are provided for reciprocating the plates continuously. Both plates 130 and 132 move in unison, i.e., both move upwardly or both move downwardly together.

In the operation of the reciprocators 20, although the plates 130 and 132 and, hence, the guns 22 are continuously reciprocated vertically by a common drive means, paint is not continuously sprayed from the guns. Rather, the guns spray only when they receive an appropriate signal from a transducer 72. One transducer 72 is provided for each stack 122 or 124 of guns 22 of each reciprocator 20. Thus, in the illustrated embodiment, four transducers 72 are provided. The transduc-

ers 72, in turn, send a signal only when the data implanted on the belt 62 indicates that there is a surface to be sprayed in the spray zone of their corresponding stack. In this manner, the guns fire only selectively and a minimum amount of paint is used.

It will be appreciated that the determination of whether or not any particular gun should spray at any given point in time depends not only on the location of the article relative to the vertical plane within which the gun reciprocates, but also on the position of the gun in that plane. The location of the plane of reciprocation is, of course, fixed and can be related to the transducer 72 by properly locating the corresponding transducer 72 along the surface of the belt 62 a distance from the pin-driving mechanism 68 which is proportional, based on the relative speeds of the conveyor 10 and belt 62, to the distance between the scanner 16 and the stack of that transducer. However, the vertical position of a particular gun within its plane of movement is constantly changing and this position is also a factor in determining whether the gun should be fired at any given point in time. Thus, a gun 22 will not fire if it is too far above or too far below a surface to be sprayed of the article.

Accordingly, means are provided to enable the location of the guns within their path of travel to be taken into consideration along with the location of the surfaces to be sprayed insofar as the firing of the guns is concerned. In this regard, a cam shaft 134 is provided within each of the cabinets 120 of the reciprocators 20a and 20b and is drivingly connected to the gun reciprocating means within the cabinet so as to rotate in synchronism with the reciprocating movement of the guns. A series of cams 136 are mounted on the shaft 134, there being five cams provided in the illustrated embodiment but any suitable number can be used. Positioned adjacent each cam is a microswitch 138 which includes a cam follower 140 and which is closed by virtue of the contour of the cam during only a portion of a complete rotation thereof. For convenience of description, the cams are designated as 136a through 136e, and the microswitches 138 and cam followers 140, respectively, will likewise be referred to by the corresponding subscript.

Each cam is designed to reflect the position of the guns during a portion of their total travel. For example, cam 136a may close its associated microswitch only during the period in which the guns are at the bottom 20 percent of their path of travel, cam 136b may close its associated microswitch during the period when the guns are at the second 20 percent (from the bottom) of their total path of travel, etc. Thus, the microswitch which is closed will indicate where the guns are relative to their total path of travel. If the total path of travel is thirty inches, one microswitch will be closed for each six inches of travel.

As previously pointed out, a transducer 72 is provided for each stack of spray guns 22. Thus, four transducers are provided in the illustrated embodiment. The transducer 72 for each stack is located relative to the pin-driving mechanism 68 a distance measured along the belt 62 which is proportional to the distance between the scanner 16 and the stack to which that transducer corresponds. For example, if the belt 62 travels 1 inch for each 12 inches the conveyor 10 travels, and if the distance between the scanner 16 and the front stack 122 of the first reciprocator 20a is 20 feet, then

the distance, as measured along the belt, between the pin-driving device 68 and the transducer 72 corresponding to the guns of the stack 122 of reciprocator 20a will be 20 inches.

The four transducers 72 are all mounted adjacent one run of the belt 62 and on the opposite side of the loop formed by the belt from the pin-driving mechanism 68 (FIGS. 2 and 3). In this regard, a pair of brackets 142 (FIG. 3) projects outwardly from each of the upper and lower portions of the frame 74 of the memory device 18 and each supports a pair of horizontally disposed, horizontally spaced rails 144. Adjustably secured to the rails 144 so that their position along the rails and, thus, their location relative to the pin-driving mechanism 68 may be adjusted, are four supports 146, each of which forms a part of one of the transducers 72. Each support 146 includes three vertically extending, horizontally spaced parallel bars (FIG. 3) interconnected at their upper and lower ends by cross members 150 which are, in turn, adjustably secured to the rails 144.

Extending through all three bars and in horizontal alignment with one of the horizontally extending rows of pins 66 of the belt 62 is a rod 152 (FIGS. 3 and 6), there being thirteen such rods provided, one for each of the horizontally extending rows of pins. The inner end of each rod, i.e., the end adjacent the belt 62, is offset to provide an arm 154 which is slightly curved and extends away from the shank or mid-portion of the rod at approximately a right angle thereto. Mounted on the bar 148 farthest from the belt 62 are 10 microswitches 156, one switch being provided adjacent each of the rods 152 which is aligned with one of the horizontally extending rows of pins 1 through 10 (FIG. 4). Mounted on the intermediate bar 148 are three microswitches 156, one being provided adjacent each of the rods 152 which is aligned with one of the horizontally extending rows of pins 11 through 13. Secured to each rod adjacent its respective switch is a second arm 158.

The rods 152 and their respective arms 154 and 158 are so arranged that when an extended pin 66 passes in vertical alignment with a rod 152, it will engage the inner arm 154 of the rod and apply a rotative force to the rod so as to urge the outer arm 158 of that rod into engagement with the contacts of the corresponding microswitch 156. The arm 154 of the rod may be gravity-biased or spring-biased into engagement with the passing pins 66. The microswitches 156 are of the normally closed type so that as long as the arm 158 remains in such engagement, the microswitch is open. In order that the passage of a succession of outwardly extending pins 66 past a rod 152 will be effective to maintain the arm 158 in contact with the microswitch 156, the arm 154 is long enough to be supported by one outwardly projecting pin until it is engaged by the next. However, if a withdrawn pin passes the rod 152, i.e., a pin which has been moved axially into the belt 62 by the pin-driving mechanism 68, the rod is free to pivot, thereby moving the arm 158 out of engagement with the contact of the microswitch 156 and permitting the switch to close. As will become apparent shortly, if the withdrawn pin was in one of rows one through ten, this permits current to flow to a solenoid 160 of one of the guns of a reciprocator 20, permitting that gun to fire if the gun is in the proper position in its path of travel as determined by the cams 136. On the other hand, if the withdrawn pin was in either of rows eleven or twelve,

this permits current to flow to the solenoids 48 which control the pressure at which paint is ejected from the guns, or to the control means for the piston-cylinder arrangement 52 which physically moves the reciprocators.

Thus, as the pins of rows one through ten pass the transducers 72, the outwardly extending pins will maintain the microswitches 156 in an open position to prevent the guns 22 from being fired. However, when a pin which has been inserted passes the transducers 72, the corresponding switch is opened and the guns can fire if other conditions are also met. The pin-driving mechanism 68 in moving the pins inwardly of the belt thus sets up a condition which ultimately will cause a gun to fire or the pressure solenoid 48 of a reciprocator 20 to alter the pressure at which the paint is ejected when that condition is detected by the transducers 72. It will be appreciated that the insertion of a pin 66 will be sensed by all four transducers successively and will therefore affect the operation of each of the four stacks of guns.

When articles of significant depth are being sprayed, it is frequently desirable to initiate the spray prior to the actual entry of the article into the spray pattern, i.e., to provide for some lead time so that the leading surface of the article will also be sprayed. This can easily be accomplished with the present memory device 18 by merely advancing the transducers 72 slightly along the rails 144 in the direction of the pin-driving mechanism 68.

In order to insure that the pin-driving mechanism 68 will only insert the pins 66 into the belt until their outer ends are flushed with the outer surface of the bars 65 which define the belt, and no further, a plate 162 (FIG. 3) is positioned within the belt loop behind the pin-driving mechanism 68 and is engaged by the pins as they are fully inserted, thereby limiting the degree to which they are inserted. The drum 70, previously referred to, is provided in encircling relation to the shaft 78 which supports the belt and is effective to move the inserted pins back to their original position after they have passed the last of the transducers 72. A slightly inclined aligning plate 166 is provided adjacent the outer surface of the belt 62 immediately prior to the pin-driving mechanism 68 to insure that the outer ends of the pins will be generally in a common plane as the pins approach the pin-driving mechanism 68.

The operation of the sensing means and firing of the spray guns can now be readily understood with reference to the circuit diagrams of FIGS. 8 and 9. In FIG. 8, it will be seen that the five cam microswitches 138, designated C-1 through C-5 in the drawing, are connected in parallel with each other and with a suitable voltage source and are connected in series with relays designated R-1 through R-5, respectively. These relays are, in turn, connected in parallel with relays designated R-1a through R-5a, respectively. Thus, for example, when the cam microswitch C-1 is closed, current flows through the relays R-1 and R-1a. Relays R-1 and R-1a can be combined as one relay if desired.

In FIG. 9, switches R-1 through R-5 shown are controlled by the corresponding relays R-1 through R-5 and each is connected in series with the microswitches 156 of one of the transducers 72 and in series with the solenoids 160 which trigger the spray guns 22 of the reciprocators 20. In FIG. 9, the switches 156 of the four transducers 72 are designated TA-1 through TA-10

and TB-1 through TB-10, TC-1 through TC-10 and TD-1 through TD-10. By this designation, the letters A, B, C, or D refer to one of the four transducers as they are spaced from the pin-driving mechanism 68, and the numerals 1 through 10 devote the row of pins to which that switch corresponds. The solenoids 160 of the four spray guns 22 are designated according to their location. Thus, the designation FBG_a refers to the solenoid of the front bottom gun of reciprocator 20a, and BTG_b refers to the back top gun of reciprocator 20b, etc. A light source or bulb 168, preferably mounted on the cabinet 120 of each reciprocator 20, is connected in parallel with each solenoid 160 which triggers the guns 22 and is lit when each gun fires, thereby providing a visual indication of the firing of the guns which can be observed remotely from the guns.

From the foregoing, it will be appreciated that in order for current to flow to any given gun solenoid 160 to initiate a firing of that gun, a switch (R) actuated by the cams 136 and a second switch (T) of a transducer 72 must both be closed. Thus, a gun will fire only when it is in the proper position in its path of travel, as indicated by the cam controlled switch, and when there is a surface to be sprayed before it, as indicated by the transducer switch.

For example, referring to FIG. 9, it will be seen that current will not flow to the solenoid of the front top gun of reciprocator 20a (FTG_a) unless switch R-1, controlled by a cam 136, and switch TA-1, of the first of the four transducers 72A, are closed. Thus, if a withdrawn pin 66 passes the first transducer TA causing the switch TA-1 to be closed, current will not flow to the solenoid of gun FTG_a to cause that gun to fire unless the cam controlled switch R-1 is also closed, i.e., unless the gun is in proper firing position. Appropriately, cam switch R-1 is only closed when the guns are in the top twenty percent of their travel, thereby corresponding to the location of the switch TA-1 which is the switch controlled by the upper row of pins, i.e., row one.

While various structural features of the system have been shown and described, it will be apparent that various modifications may be made therein without departing from the scope of the invention.

Various of the features of the invention are set forth in the following claims.

What is claimed is:

1. Apparatus for spray coating individual articles moved along a given path by a conveyor, said apparatus comprising:

- stationary sensing means positioned at a given location along said path and including an array of discrete sensing units for sensing in a plane aligned generally transversely of and extending across said path to provide signals indicative of the size, shape and disposition of each of said articles as they are moved through said plane by said conveyor,
- a memory device for receiving said signals from said sensing means and for continuously storing data indicative of said size, shape and disposition of each of said articles in response to said signals,
- a spray coating device positioned along said given path a predetermined distance downstream of said stationary sensing means and
- control means for operating said spray coating device in response to said stored data to provide a spray pattern for each article in accordance with its size, shape and disposition when each respective article

is in a predetermined physical relationship relative to said spray coating device.

2. Apparatus according to claim 1 comprising means for continuously moving said spray coating device in a vertically reciprocating pattern, and means for providing signals indicative of the positions of said spray coating device, said control means including means for operating said spray coating device in response to said position signals and said stored data indicating said predetermined physical relationship between said spray coating device and said article to be sprayed.

3. An apparatus for spray coating individual articles, said apparatus comprising a conveyor for advancing the articles in spaced relation along a given path, means along said path for scanning the articles in a common plane extending transversely across said path and for producing signals corresponding to the size, shape and disposition of the portion of the articles located in the plane, the signals varying according to changes in size, shape and disposition of the articles as they move along the path and pass through said plane, a memory device receiving signals from said scanning means and temporarily storing data corresponding to said signals and relating to the size and shape of the articles scanned, and at least one spray coating device disposed along the path of the articles downstream of said scanning means connected to and controlled by said memory device so as to provide a spray pattern for each article in accordance with its size and shape, said scanning means including means for providing at least two generally vertically disposed, horizontally spaced light beams along the path of the articles and means for detecting the interruption of either of said beams by an article moving along said path, thereby providing an indication of the depth of the article being advanced by said conveyor.

4. An apparatus in accordance with claim 3, wherein said scanning device is effective to transmit signals to said memory device corresponding to the depth of the articles being scanned, and wherein said spray painting device includes means for altering the pressure of the spray at that surface of the article being sprayed which is immediately adjacent the spray painting device in accordance with the depth of the article being sprayed.

5. An apparatus in accordance with claim 4, wherein said means for altering the pressure of the spray at that surface of the article being sprayed which is immediately adjacent the spray painting device includes means for moving the said spray painting device toward and away from the path of the articles.

6. An apparatus in accordance with claim 4, wherein said means for altering the pressure of the spray at that surface of the article being sprayed which is immediately adjacent the spray painting device includes means for adjusting the pressure at which the paint is emitted from the spray painting device.

7. An apparatus for spray coating in a spray zone, individual articles moved along a given path by a conveyor, said apparatus comprising:

- stationary sensing means positioned at a given location along said path for providing signals corresponding to the respective size and shape of the articles, and to the respective disposition of the articles relative to the spray zone, in response to scanning of said articles as each article moves past said sensing means,
- a memory device responsive to said signals from said sensing means for storing data indicative of said

size, shape and disposition of each of the articles moving past said sensing means, said memory device including means defining a surface movable at a speed proportional to the speed of said conveyor, means for selectively altering said surface at a first station in a manner corresponding to the size and shape of the articles passing said scanning device, a spray coating device positioned along said given path a predetermined distance after said stationary sensing means, said spray coating device being movable in a predetermined pattern relative to said spray zone, means for providing an indication of the position of said spray coating device as it moves in said predetermined pattern, and control means for operating said spray coating device in response to said position indication and the manner in which said surface was altered at said first station when the respective articles and said spray coating device are in a predetermined physical relationship relative to each other, so that the individual articles are coated by said coating device according to their respective individual size, shape and disposition within said spray zone.

8. An apparatus in accordance with claim 7, wherein said scanning means includes a series of vertically spaced photoelectric units, each unit including a light source and a photoelectric cell.

9. An apparatus in accordance with claim 8, wherein said scanning means includes a reflective surface disposed on one side of said path, wherein the light source of each photoelectric unit is disposed on the side of said path opposite said reflective surface and adapted to focus a beam of light on said reflective surface, and wherein the photoelectric cell of each photoelectric unit is disposed adjacent its respective light source and in the path of the reflected beam of its said light source.

10. An apparatus in accordance with claim 8, wherein each of said light sources and said photoelectric cells are spaced vertically from each other on said opposite side of said path.

11. An apparatus in accordance with claim 7, wherein a spray coating device is provided for each of opposite sides of said path, along which said articles are advanced, wherein means are provided at said second station for sensing the manner in which said surface of said memory device was altered at said first station and for transmitting a signal to one of said two spray coating devices corresponding to the manner in which said surface was altered at said first station, and wherein means are provided at a third station for sensing the manner in which said surface of said memory device was altered at said first station and for transmitting a signal to the other of said two spray coating devices corresponding to the manner in which said surface was altered at said first station.

12. An apparatus in accordance with claim 7, wherein said means defining a surface movable at a speed proportional to the speed of said conveyor defines a plurality of holes extending through said surface, wherein a pin is disposed in each of said holes so as to be movable axially therein, wherein means are provided for assuring a predetermined disposition of said pins in relation to said surface as said pins approach said first station, and wherein said means for selectively altering said surface at said first station includes means for selectively moving selected ones of

said pins axially relative to said surface, the arrangement of said selected pins relative to one another, corresponding to the shape and being proportional to the size of the articles passing said scanning device.

13. An apparatus in accordance with claim 12, wherein said pins are arranged in rows, and wherein said means for selectively moving selected ones of said pins axially in a predetermined manner includes a finger for each of said rows effective when moved axially to engage a pin in alignment therewith and move it axially relative to said surface and means responsive to a predetermined signal to move said finger axially.

14. An apparatus in accordance with claim 7, wherein said first station of said memory device is spaced from said second station a distance measured along the surface defined by said memory device which bears the same proportion to the distance between said sensing means and said spray painting device along said given path that the speed of said surface bears to the speed of said conveyor.

15. An apparatus in accordance with claim 7, wherein means are provided for automatically causing said spray coating device to provide a spray pattern larger than that indicated to be necessary by said sensing means so as to insure coating of the top, bottom and sides of the article.

16. An apparatus in accordance with claim 7 wherein said spray coating device includes a spray gun and said control means includes means for causing said gun to continue to emit a spray after the article has passed through the spray pattern of said gun to as to effect a coating of the trailing surface of the article.

17. An apparatus in accordance with claim 7 wherein said spray coating device includes a plurality of spray guns, and said control means includes selectively operable means for actuating any gun only when said gun and the article to be sprayed are in a predetermined physical relation to each other.

18. An apparatus in accordance with claim 7 comprising means for moving said spray coating device in a reciprocating pattern transverse to said given path of article movement.

19. An apparatus in accordance with claim 18 wherein said reciprocating pattern of movement of said coating device is a predetermined constant distance from said stationary sensing means measured along said given path of article movement.

20. An apparatus in accordance with claim 7 wherein the individual articles to be sprayed move along said given path in a longitudinal plane, said sensing means comprises an array of discrete sensing units arranged in a plane parallel to said longitudinal plane and aligned generally transverse to said given path to provide said signals corresponding to the size, shape and disposition of each article as it passes said array.

21. An apparatus in accordance with claim 7 comprising means for driving said spray coating device in reciprocating movement, said means for providing an indication of the position of said spray coating device including a cam shaft drivably connected to said driving means to rotate in synchronism therewith, a plurality of cams on said shaft, and a switch associated with each of said cams, each cam being contoured so as to actuate its respective switch during only a portion of a complete rotation thereof, and each switch being actuated during a different portion of the reciprocating movement of said coating device.

22. An apparatus for spray coating individual articles, said apparatus comprising a conveyor for advancing the articles in spaced relation along a given path, means along said path for scanning the articles and for producing signals corresponding to the size and shape of the articles, a memory device for receiving signals from said scanning means and temporarily storing data relating to the size and shape of the articles scanned, and at least one spray coating device disposed along the path of the articles downstream of said scanning means connected to and controlled by said memory device so as to provide a spray pattern for each article in accordance with its size and shape, said memory device including means defining a surface movable at a speed proportional to the speed of said conveyor, means for selectively altering said surface at a first station in a manner corresponding to the size and shape of the articles passing said scanning device, and means at a second station for sensing the manner in which said surface was altered at said first station and for transmitting a signal to a spray coating device corresponding to the manner in which said surface was altered at said first station, said means defining a surface movable at a speed proportional to the speed of said conveyor defining a plurality of holes extending through said surface, a pin disposed in each of said holes so as to be movable axially therein, means for assuring a predetermined disposition of said pins in relation to said surface as said pins approach said first station, and said means for selectively altering said surface at said first station including means for selectively moving selected ones of said pins axially relative to said surface, the arrangement of said selected pins relative to one another, corresponding to the shape and being proportional to the size of the articles passing said scanning device, and said surface-defining means comprising an endless belt formed of a plurality of interconnected bars moved transversely of their length along a predetermined path defined by a pair of sprockets rotatable about spaced parallel axes.

23. An apparatus in accordance with claim 22, wherein said belt is altered at said first station by moving pins inwardly of the closed loop in such a manner that the configuration of the articles scanned will be outlined on said belt by the contrast between the overall appearance of the pins moved with the overall appearance of the pins not moved.

24. An apparatus for spray coating individual arti-

cles, said apparatus comprising a conveyor for advancing the articles in spaced relation along a given path, means along said path for scanning the articles and for producing signals corresponding to the size and shape of the articles, a memory device for receiving signals from said scanning means and temporarily storing data relating to the size and shape of the articles scanned, and at least one spray coating device disposed along the path of the articles downstream of said scanning means connected to and controlled by said memory device so as to provide a spray pattern for each article in accordance with its size and shape, said memory device including means defining a surface movable at a speed proportional to the speed of said conveyor, means for selectively altering said surface at a first station in a manner corresponding to the size and shape of the articles passing said scanning device, and means at a second station for sensing the manner in which said surface was altered at said first station and for transmitting a signal to a spray coating device corresponding to the manner in which said surface was altered at said first station, said means defining a surface movable at a speed proportional to the speed of said conveyor defining a plurality of holes extending through said surface, a pin disposed in each of said holes so as to be movable axially therein, means for assuring a predetermined disposition of said pins in relation to said surface as said pins approach said first station, and said means for selectively altering said surface at said first station including means for selectively moving selected ones of said pins axially relative to said surface, the arrangement of said selected pins relative to one another, corresponding to the shape and being proportional to the size of the articles passing said scanning device, said means for sensing the manner in which said surface was altered at said first station including a rod pivotably mounted with one of its ends adjacent said surface, a follower carried by said one end of said rod and extending transversely thereof, means biasing said rod for pivotal movement tending to urge said follower into engagement with pins projecting from said surface and effective to cause said rod to pivot when a pin socket is moved past said follower, the pin of which has been moved out of a position in which it would be engaged by said follower, and a switch coupled to said rod effective to sense such pivotal movement of said rod.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,777,702

Dated December 11, 1973

Inventor(s) Carl E. Fitzgerald

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 22, "principle" should be --principal--.
Column 3, line 55, "of" should be --or--.
Column 10, line 67, "seris" should read --series--.
Column 11, line 54, "(now shown)" should read --(not shown)--.
Column 18, Claim 16, line 31, "to as to" should be --so as to--.

Signed and sealed this 9th day of April 1974.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents