

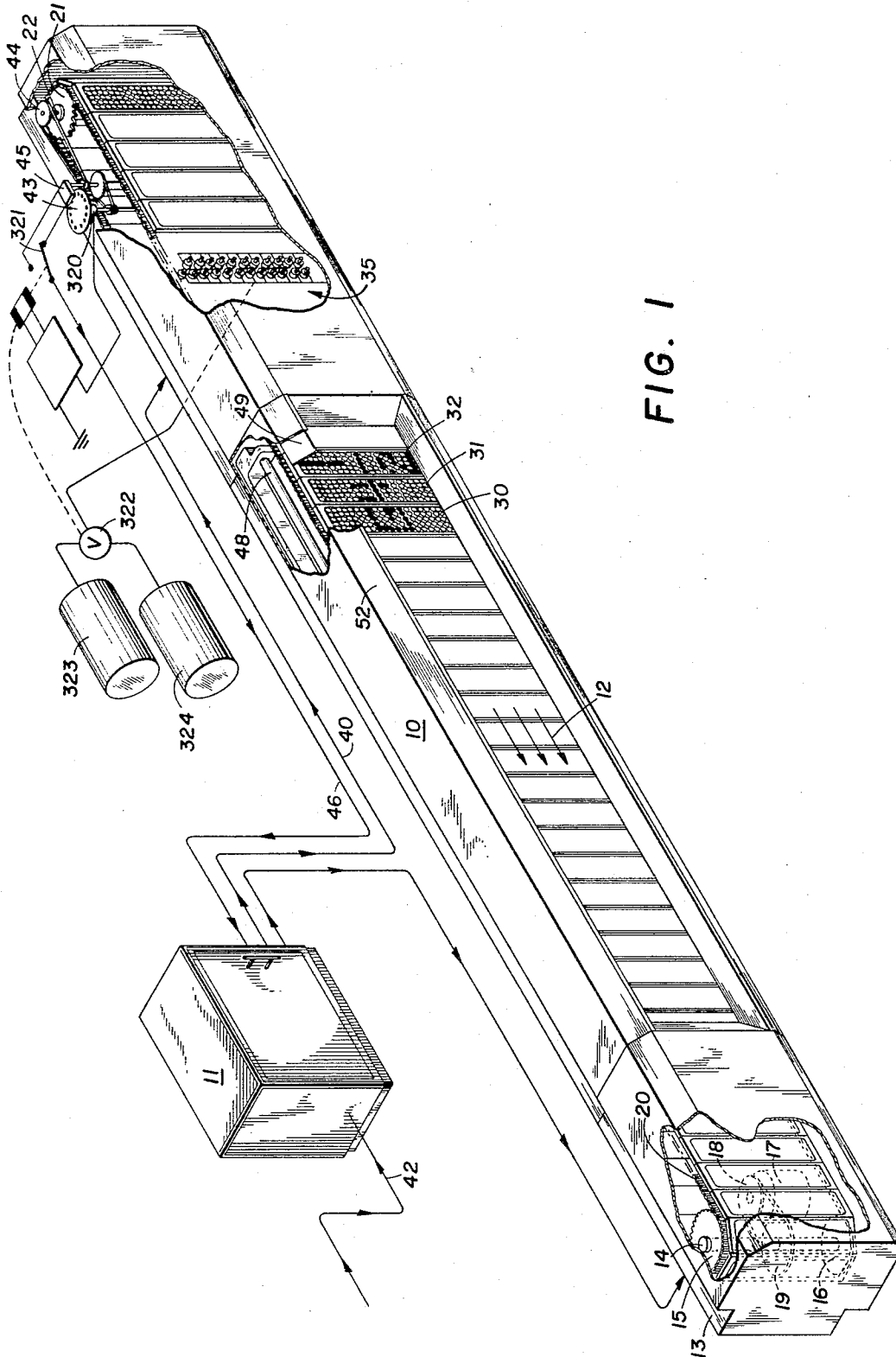
March 26, 1968

R. L. WOOLFOLK  
MOVING DISPLAY SYSTEM

3,374,565

Filed Sept. 27, 1965

5 Sheets-Sheet 1



**March 26, 1968**

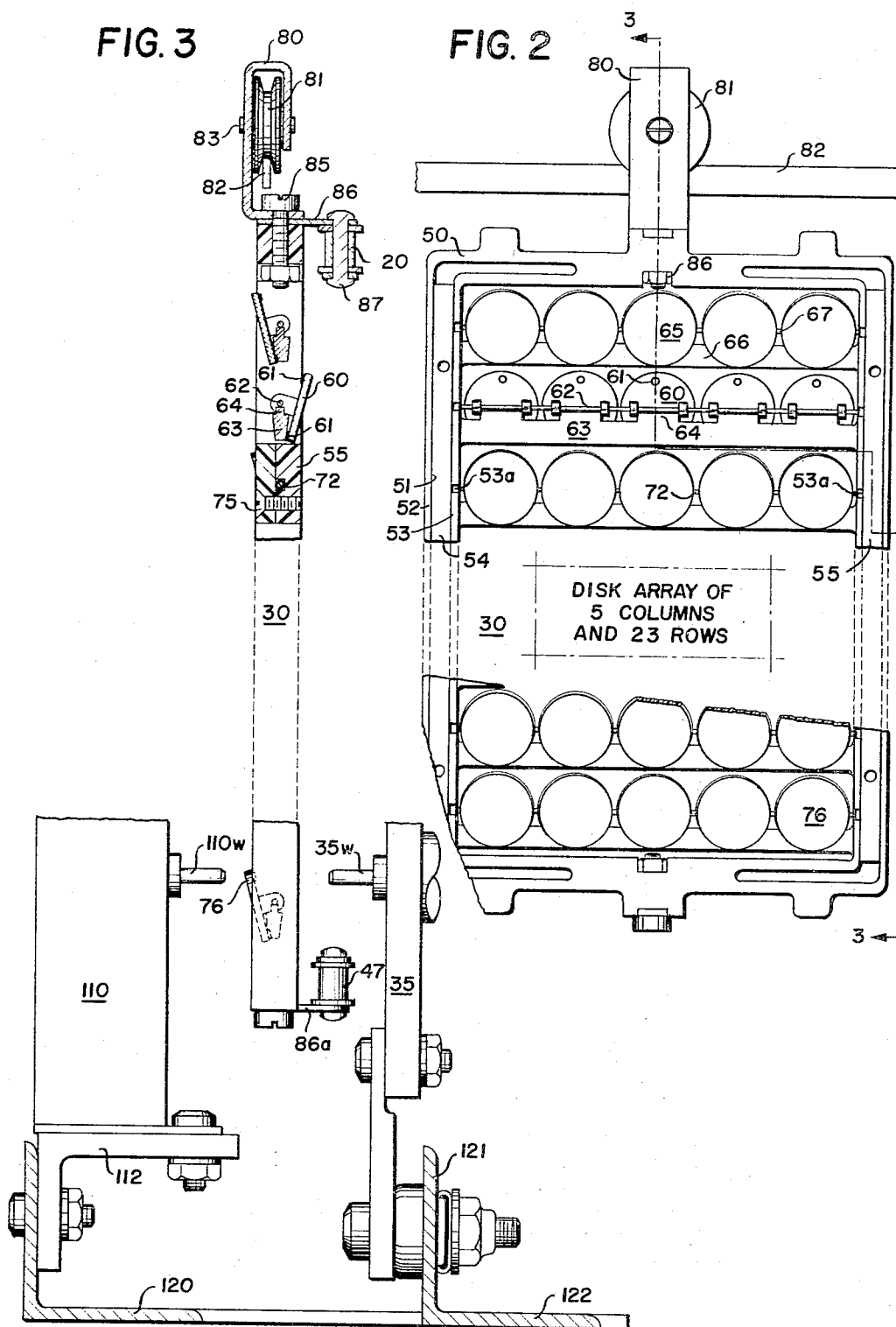
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## MOVING DISPLAY SYSTEM

Filed Sept. 27, 1965

5 Sheets-Sheet 2



March 26, 1968

R. L. WOOLFOLK  
MOVING DISPLAY SYSTEM

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5 Sheets-Sheet 3

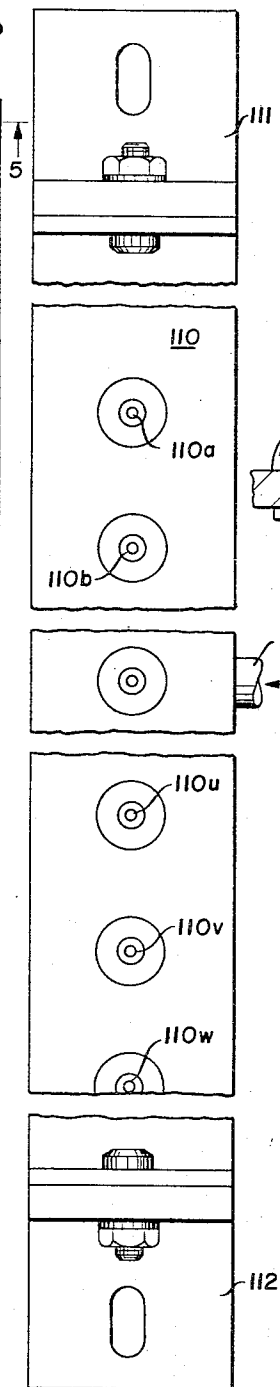
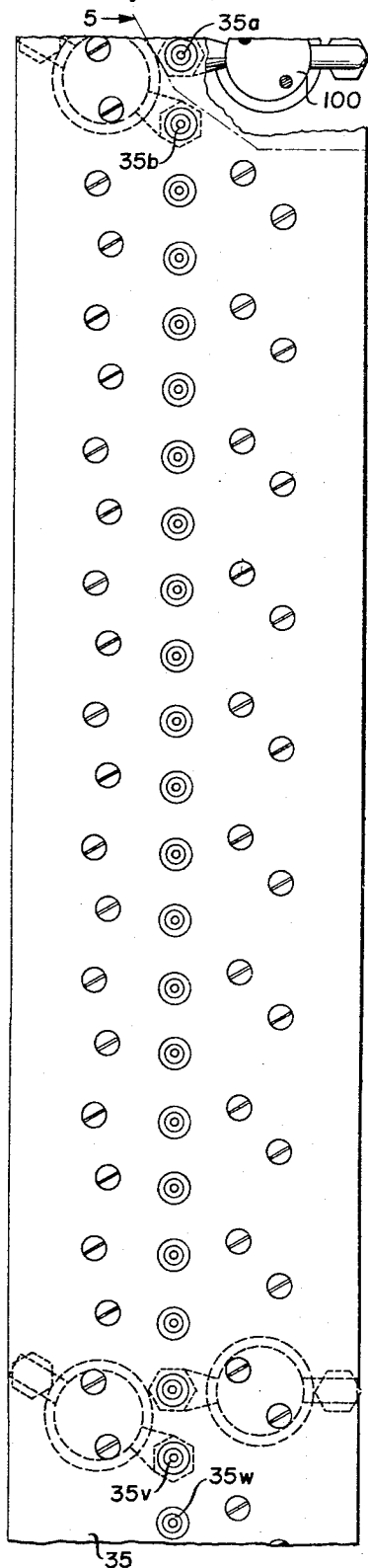
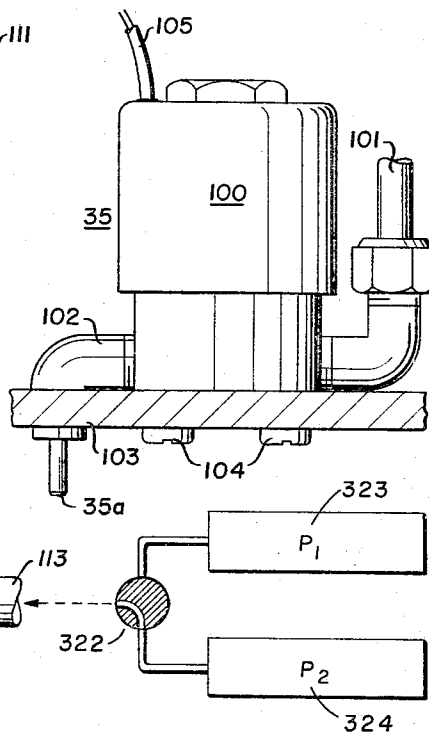


FIG. 6

FIG. 4

FIG. 5



March 26, 1968

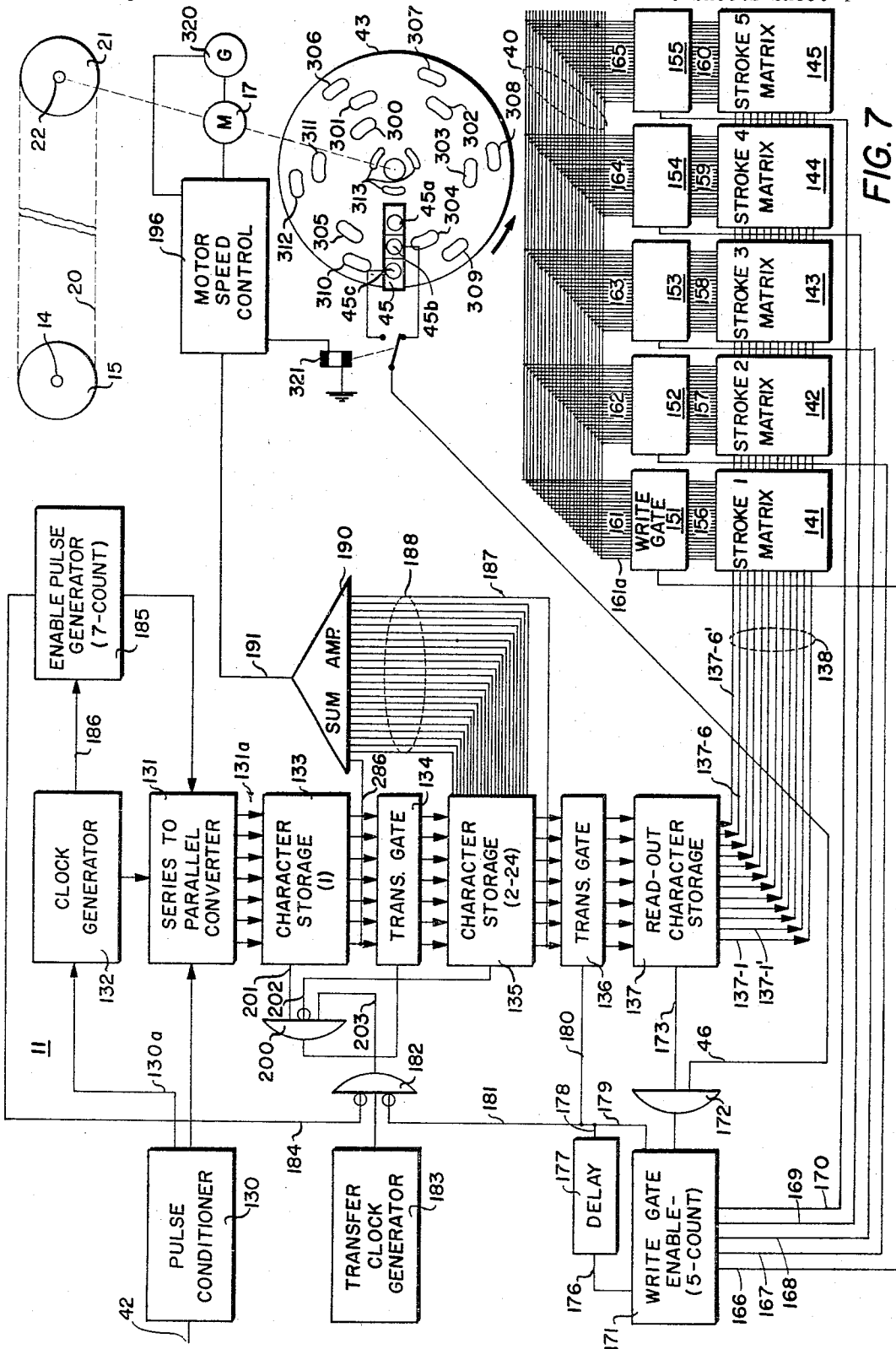
R. L. WOOLFOLK

3,374,565

MOVING DISPLAY SYSTEM

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5 Sheets-Sheet 4



**March 26, 1968**

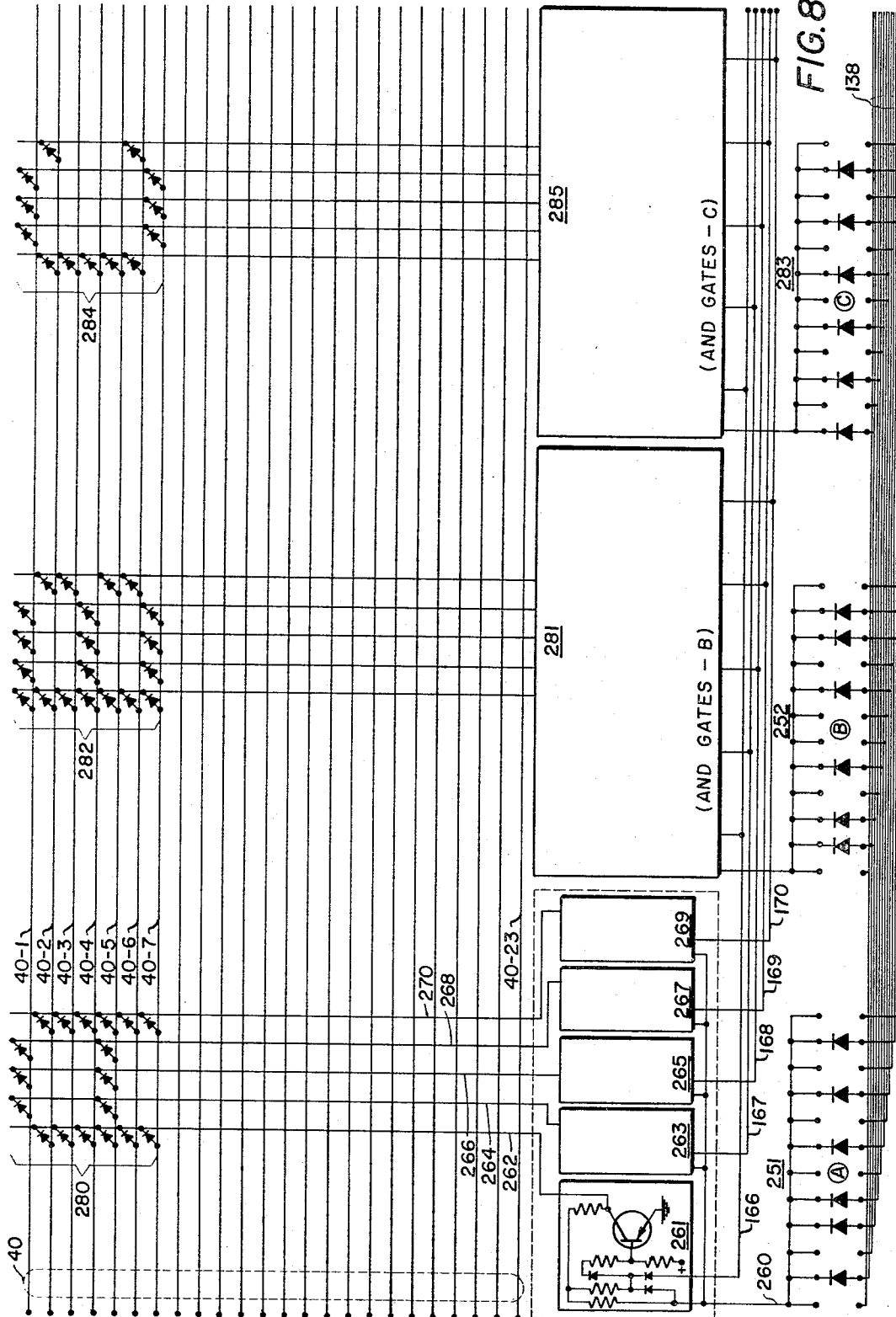
R. L. WOOLFOLK

3,374,565

MOVING DISPLAY SYSTEM

Filed Sept. 27, 1965

5 Sheets-Sheet 5



1

3,374,565

## MOVING DISPLAY SYSTEM

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16 Claims. (Cl. 40—37)

### ABSTRACT OF THE DISCLOSURE

An information display system having a continuous track for supporting and translating a plurality of display panels sequentially past a writing zone and a display zone where each panel has disks mounted for rotation about a horizontal axis having opposite faces which contrast in visual appearance. At the writing zone, air jets selectively directed onto individual disks control the face position of a disk in accordance with input language information. The panel speed may be varied in dependence upon the rate of flow of display information to the system.

This invention relates to an information display system and more particularly to a moving display in which display elements forming a planar array are selectively mechanically flipped from one position to another to form information symbols. In a further aspect, the invention relates to a system in which the rate that information is mechanically formed into symbols and moved through a display area is made dependent upon the rate at which such information is fed to the system.

Moving displays of alpha-numeric symbols have heretofore been extensively used, generally involving systems of incandescent or neon elements dynamically actuated to move character representations along a band of such elements. In systems of this type, the contrast between a given symbol and its background is dependent upon the ambient light level in the region in which the display is presented. Further, switching systems required for control of relatively high power have been found to be undesirable. Where low power illumination elements are employed, the extensive system requirements for switching to each location throughout the entire length of the display renders the system undesirably complex.

It has been found that information may be displayed in alpha-numeric form with a relatively simple encoding system for effecting selective control of the position of a plurality of display elements so that the only point at which a change is made in any given part of the system is at the writing or encoding station. Once encoded, the elements can be transported mechanically through a display zone without change of position or state of any element. Thus, a highly simplified system is made possible.

The moving display system of the present invention uses display panels which are moved as a continuous train from a writing station through an extended display zone and unique structure for control of individual display elements.

In accordance with the present invention, each display panel includes an array of elements toggle mounted on horizontal axes for gravity bias in either of two positions. One face of each element has one visual appearance. The other face is of contrasting appearance. The panels having such display elements are mounted for movement through a display zone with language information stored thereon by the selective positioning of the elements.

Control of the position of the individual elements involves moving a panel sequentially past a control station wherein each column of elements moves through

2

registration with a columnar actuator, preferably in the form of a column of air jets. The air jets are selectively actuated individually to change elements at positions in the array to form the necessary alpha-numeric symbols.

In accordance with a further aspect of the invention, the rate of travel of the array through a display zone is made dependent upon the rate at which the information to be displayed flows to the system. In a further aspect, the invention involves synchronization of the speed of movement with an effective lead time in turning air jets on and off relative to the position of each element as it approaches the registration with the jets. Further, the pressure employed in the jets is varied, being increased at high panel speeds and decreased at lower panel speeds to assure adequate energy to flip each of the display elements.

In one form the display system included an array of display elements each having one face of one visual appearance and an opposite face of a contrasting visual appearance and mounted for rotation about horizontal axes. Means are provided for driving the array past a writing station and thence through a display zone. Writing means at the writing station are selectively actuated for rotating the elements to position a given one of the faces outward or inward. Means are provided for controlling the writing means in synchronism with movement of the array and in dependence upon language information symbols.

For a more complete understanding of the present invention and for further objects and advantages thereof, reference may now be had to the following description taken in conjunction with the accompanying drawings in which:

FIGURE 1 is a perspective view, partially broken away, illustrating one embodiment of the present invention;

FIGURE 2 is an enlarged view of one information panel taken from the unit of FIGURE 1;

FIGURE 3 is a sectional view taken along lines 3—3 of FIGURE 2 with portions of the writing and erasing units added;

FIGURE 4 is a face view of the writing unit 35 of FIGURE 1;

FIGURE 5 is a sectional view, including one valve assembly from the writing panel of FIGURE 4, as taken along line 5—5 of FIGURE 4;

FIGURE 6 is a face view of the erase unit of FIGURE 1;

FIGURE 7 is a detailed circuit diagram of the control system 11 of FIGURE 1; and

FIGURE 8 illustrates the control matrix of FIGURE 7.

In FIGURE 1, a display unit 10 and a control unit 11 are employed to provide a moving display wherein alpha-numeric symbols appear on panels which move in the direction of arrow 12 along a closed loop path in the unit 10 which includes a display traverse.

The unit 10 includes an elongated housing 13 in which a vertical shaft 14 is supported at the left end thereof. A pair of sprocket wheels 15 and 16 are mounted on shaft 14. Shaft 14 is driven by a variable speed motor 17 which is coupled by a belt 18 to a pulley 19 on the shaft 14. A link chain 20 is driven by the sprocket wheel 15. The chain 20 extends the length of the housing 13 and passes around a second sprocket wheel 21 which is mounted on an idler shaft 22. A second link chain extends along the bottom of the housing 13, being driven by the sprocket wheel 16 and supported by a second sprocket (not shown) at the bottom of shaft 22.

Information panels in number sufficient to fill the entire length of chain 20 are mounted for movement with the chain 20, thus forming an endless loop of vertically suspended display panels. While the display elements of

FIGURE 1 have not all been illustrated in detail in FIGURE 1, it will be noted that display element 30 is made up of an array of one hundred and fifteen disks arranged in five columns and twenty-three rows. Each of the display panels supported by the chain 20 will be similarly arranged. The disks, as will hereinafter be shown, are mounted for rotation on horizontal axes, all of which are in a vertical plane. The disks are mounted and balanced as toggle devices in such a way that they will normally come to rest in either of two positions. One face of each disk is preferably painted with a bright fluorescent color with the other side of a dull, non-reflective color. The entire surface of the panel 30 not occupied by disks is also of a dull black or non-reflective finish. A given character or symbol is formed by selectively rotating the disks to position the bright face outward to show various character strokes or identifying characteristics on a dull non-reflective background. As illustrated in FIGURE 1, the panel 30 has the symbol "6" displayed thereon. Panel 31 has the symbol "4" displayed thereon. Panel 32 has a symbol "1/2" displayed thereon.

Each character occupies a five-by-seven matrix of turn-around disks selectively positioned to form the selected symbol. The flipping of the disks from one position to another is accomplished by selectively controlling a plurality of small jets of relatively high pressure air emitted from orifices in a writing unit 35. Air jets are directed at the top of selected disks so that a given disk may be rotated either clockwise or counterclockwise to expose either the fluorescent face or the dull black face.

Prior to writing a given character or symbol, all information is preferably erased by setting all disks in the black-out position.

With the motor 17 energized, the chain 20 drives the elements 30, 31, 32, etc. past the writing unit 35. Character setting signals are supplied from the control unit 11 by way of channel 40 to valves in air lines leading to the jets in the writing unit 35. The display panels may be moved past the writing station at relatively high speed, as high as fifteen characters or ninety inches per second. In accordance with one aspect of the present invention, the speed at which the information moves across the display zone is dependent upon the rate at which information is fed to the control unit 11 by way of an input line 42.

A control disk 43 is driven by way of a belt linkage from a pulley 44 on shaft 22. A photo-sensing unit 45 provides timing signals by way of channel 46 to the control unit 11.

Ultra-violet lamps, including lamp 48, are mounted as to extend the length of the display zone in the unit 10. A mirror or reflector 49 is mounted on the underside of the housing cover to reflect the ultra-violet light onto the exposed faces of the disks to illuminate the fluorescent faces of the disks which are facing outwardly. Thus, a moving display of alpha-numeric symbols appears on a background having high contrast which is substantially independent of the light level of the area in which the display system is mounted. The fluorescent disk surfaces on a non-reflective background form clearly discernible characters.

Each panel with twenty-three rows of disks is of height sufficient to accommodate three symbols in each panel. Thus, a fraction can be presented as on panel 32. Two additional symbols could be displayed on panel 30 along with the centrally located symbol "6" to fill the panel. In the example herein described, only one symbol will be written on each panel.

FIGURE 2 is a front view of display panel 30 with all disks, except the second row, set to face outward. The panel comprises an outer rectangular frame 50 having a central channel 51 extending between an outer peripheral rib 52 and an inner peripheral rib 53. The inner rib 53 has slots such as slot 53a at uniformly spaced points so that the shafts on which the various rows of disks are mounted can be accurately positioned and locked in place.

A pair of rectangular bars 54 and 55 have one face slotted to fit over the shafts. The bars 54 and 55 fit into the channel 51 and are secured therein by screws which extend through the back of the channel and are tapped into the bars 54 and 55.

The disk construction and mounting thereof is shown in FIGURES 2 and 3. Disk 60 is provided with two rearwardly extending cushion stops 61 one on top and one at the bottom rear face. The shaft 62 passes through a hole in two horizontally displaced rearwardly extending tabs. The shaft 62 is positioned immediately above and parallel to the upper surface of a stop 63. The stop 63 has a crown 64 which extends upwardly between two tabs on disk 60. Five such crowns are formed on stop 63 to maintain the five disks adjacent thereto spaced properly along the shaft 62.

The disk 65 facing outward in the top row rests against stop 66. The disk 65 is mounted on shaft 67.

The mounting for the shaft 72 for the third row is shown in section in FIGURE 3. The shaft 72 is positioned in a slot 53a in the bar 55. The shaft has an end cap of cylindrical form and of larger diameter than the shaft 72. A screw 75 passing through the frame 50 is threaded into a hole in the bar 55 to clamp bar 55 in the channel 50.

A bracket 80, FIGURES 2 and 3, is secured to the top of the panel 30 and serves to support a wheel 81. The wheel 81 is grooved and rests on top of a track 82. The track 82, while not shown in FIGURE 1, is supported in a housing 13, FIGURE 1, to form a loop slightly larger than the loop formed by the chain 20. Thus, the track 82 serves as the vertical support for all of the display panels. The chain 20, driven by the motor 17, serves to propel the panels in the path defined by the track 82.

In FIGURE 3, the bracket 80 is illustrated in section and is secured to the top protrusion on the panel 30. The bracket 80 includes an inverted U-shaped top in which the wheel 81 is journaled on a shaft 83. The lower end of the bracket 80 is secured to the panel 30 by bolt 85. A bar 86 formed as a part of a link of chain 20, secured as by chain pin 87, is connected to the panel 30 by the bolt 85. Thus, the track 82 supports the panel 30 and also supports the chain 20. The chain, propelled by the motor 17, moves the panels along the orbit dictated by the track 82.

The positional relationship between the nozzles on the writing panel 35 and the nozzles on the erase unit 110 is also shown in FIGURE 3. The bottom of panel 30 is shown in position between the nozzles 35w and 110w. The bottom chain 47 is shown coupled by link 86a to the bottom of the panel 30. The disk 76 in the bottom row in the panel 30 is illustrated in position to be flipped by flow of air through the nozzle 110w. The disk 76 is moved to have its luminous face outward by actuating air jet 35w. Jet 110w and companion jets, which are actuated continuously, serve to erase all information on a given panel as it moves from the erase station through columnar registration with the writing unit 35. The unit 110 is coupled, by means of the angle bracket 112, to a frame member 120. Similarly, the writing panel 35 is shock-mounted by coupling 121 to a frame member 122.

FIGURE 4 illustrates the face of the writing panel 35. Nozzles 35a-35w are mounted on a vertical column immediately behind the path of the display panels. The flow of air through the nozzles 35a-35w is individually controlled as by means of valves such as the valve 100 associated with nozzle 35a.

As best shown in FIGURE 5, the valve 100, shown somewhat enlarged, is coupled to a supply line 101 at its input port and is coupled, by way of fitting 102 to nozzle 35a for controlling the air jet when the valve 100 is open.

The valve 100, in one embodiment of the invention, was of the type C2DA1251, two way solenoid valve, manufactured and sold by Skinner Precision Industries of New Britain, Conn. The valve 100 is mounted on a panel 103 by means of screws 104. Upon application of a voltage to the valve actuator line 105, the nozzle 35a will be

opened for air flow from the supply line 101 which leads from an air pressure tank (not shown). As the successive columns in each given panel move through registration with the nozzles 35a-35w, air jets selectively flip the disks from a blank position to a position in which the luminous face is visible.

FIGURE 6 illustrates an erase or reset unit 110 which is to be secured by brackets 111 and 112 at the top and bottom of the housing 13. Unit 110 is located in front of the path of the display panels with the air jets from the orifices 110a-110w continuously blowing onto the front of the panels and onto the top of the disks to flip all of the disks into a blank position before they reach the writing unit 35. Air is supplied to the unit 110 by way of line 113 with the pressure being maintained at levels hereinafter described.

In FIGURE 7, the control system 11 has been illustrated wherein control is provided for applying control signals to the solenoid driver units by way of channels 40 which are representative of the input signals applied to the system 11 by way of input channel 42. The input channel 42 may be a conventional teletype line. Input data on the channel 42 appears in serial form. The data is applied to a pulse clipper 130 which conditions the pulses and applies them to a serial-to-parallel converter 131. The converter 131 is controlled by a clock 132 which also is connected by way of channel 130a to the clipper 130.

Input data applied to the converter 131 in serial form is converted into a seven-bit code and applied, in parallel, by way of channels 131a to a first level character storage unit 133. The character storage unit 133 is connected by way of a transfer gate 134 to a character storage unit 135. The character storage unit 135 includes a plurality of stages, each of which may be a duplicate of the unit 133. In the present example twenty-three such units are employed in unit 135 and are coupled together by transfer gates, such as the transfer gate 134. The output of the twenty-fourth (or *n*th) level in character storage unit 135 is applied by way of transfer gate 136 to an output character storage unit 137. The storage system is of the drop-chute character such that data is stored in all of the lower stages of the character storage unit 135. The storage system will fill up as data is fed to unit 133 faster than data is extracted from unit 135. In this system, twenty-four transfer units were employed, one of which, the unit 133, is shown and twenty-three of which are included in unit 135.

The output unit 137 is coupled by way of twelve lines 138 to each of five stroke matrix units 141-145. The twelve lines represent the positive and the negation for each of six bits in the code employed in the storage system. The stroke matrix units 141-145 correspond with the five columns of disks in each of the display panels. The matrix units 141-145 are connected by five sets 156-160 of twenty-three channels each to write gates 151-155. The latter gates serve to energize selected ones of the valves in the write unit 35 (FIGURE 1) in synchronism with successive registrations between disk columns 1-5, respectively, with the write unit 35. As shown, the matrix 141 is connected by way of channels 156 to write gate 151. Similarly, the channels 157-160 connect stroke matrix units 142-145 to write gates 152-155, respectively.

Each write gate has twenty-three output channels, that is, write gate 151 has twenty-three output channels 161. When line 161a is energized, a jet of air will pass through nozzle 35a when the first column in the panel 30 is in registration with the column of jets in the write unit 35. The output channels 161 are selectively energized by the code impressed upon the matrix 141 so that the first stroke of a character to be impressed on the panel will be encoded by flipping the proper disks in the first column.

The write gates 151-155 are sequentially enabled by application of control pulses to channels 166-170. The lines 166-170 are energized by way of a five-count writ-

ing gate 171. The writing gate is controlled by an AND gate 172 having a first input channel 173 which is enabled when a character is stored in the output unit 137. The character thus stored is represented by voltages on lines 138. The latter voltages in the stroke matrices are to be selectively transferred to gates 151-155. Successive control voltages are applied to the AND gate 172 by way of channel 46 from the control unit 45 of FIGURE 1. Control pulses appear on channel 46 coincident in time with the registration of each successive column of disks in each panel. Thus, five successive pulses appearing on channel 46 are counted by the counter 171 with output pulses appearing sequentially on lines 166-170 respectively.

The last count of each five-count series produced by the unit 171 is applied by way of channel 176 to a delay unit 177. The output from the delay unit 177 is applied to an output line 178 which leads to a reset input 179 on the counter 171; to a transfer gate input 180 on the gate 136; and, by way of a channel 181, to the negation input of an AND gate 182. A transfer clock unit 183 also supplies the AND gate 182. A second negation input to the AND gate 182 is supplied by way of a channel 184, leading from the seven-count enabling pulse unit 185 which is supplied from clock 132 by way of channel 186. Gate 182 enables a first input of the transfer gate 134 which, in turn, is controlled by an AND gate 200. The AND gate 200 has three inputs. The second input 201 is fed from the character storage unit 133 and will have a signal thereon when a character is present in storage unit 133. The third input 202 is supplied from the character storage unit 135, and is a negation input. Thus, the AND gate 200 will be enabled when there is (a) a signal in storage unit 133; (b) a vacancy in the storage unit 135; (c) a clock signal from clock 183; (d) no reset signal on line 178; and, (e) no signal at the output of counter 185. Each transfer gate in unit 135 will have similar control logic so that the bottom stage or stages of the storage system will be kept full for transfer to output unit 137.

The speed of the chain drive is varied by sensing the amount of information in the drop-chute storage system. Line 286 applies a voltage to a summing amplifier 190 when a character is stored in unit 133. Similarly, line 187 applies a like voltage to amplifier 190 when a character is stored in the last storage stage in unit 135. Lines 188 supply summing amplifier 190 with input voltages in number depending upon the number of characters in storage. The output of amplifier 190 is proportional to the quantity of information in storage at any instant. The amplifier output is supplied by way of channel 191 to a motor speed control 196 which drives the motor 17. The gain of the amplifier 190 is adjusted such that the motor 17 will be driven at a given speed for a selected level of data in the storage unit 135. If data on channel 42 is supplied to the unit 11 at a high rate so that data in the storage units 135 exceeds the selected level, the motor 17 will be driven faster. The faster motor 17 is driven, the more frequent will control pulses appear on channel 46, and the more rapidly the data will be dumped downward through the storage units into the output unit 137.

On the other hand, if data appears on line 42 at a very low rate, the motor 17 will slow down or approach zero speed so that the level of data in the storage system will control the motor speed and the data readout speed.

The timing disk 43, FIGURE 7, is coupled to the shaft 22 so that it makes one complete revolution during travel of the display panels through a distance such that like points on two adjacent panels pass the same fixed reference point. The panels are dimensioned such that the disks occupy five-sixths of the width of a given panel.

The timing disk 43 has six spaced slots formed therein on each of two circles and a single slot 300 on a third circle. Slot 300 is positioned on the inner circle with ref-

erence to photodetector unit 45a such that an output pulse will be produced on line 46, FIGURE 1, at an instant corresponding with registration of a leading edge of each panel with the column of write nozzles. A signal is produced by a photocell 45b during the intervals represented by slot 301. This signal normally is applied to line 46 when the first column of disks in a given panel registers with the write nozzles. Similarly, like signals are produced by passage of slots 302-305 coincident with registrations between the write nozzles and second to the fifth columns of disks respectively.

As above noted, the motor speed varies in dependence on the rate at which information is fed to the system. It will be appreciated that a given amount of energy is required to flip a given disk, regardless of the speed at which it travels. It is therefore desirable to alter the instants at which the solenoid valves are opened relative to a given position of the disk as it approaches registration with the nozzles. For this reason, slots 306-310 are formed on an outer circle in the disk 43 for cooperation with a third photocell 45c.

The slots 311 and 312 are not used. The three centrally located slots 313 are provided to permit adjustment of the position of the disk 43 on its shaft.

The motor speed may vary such that the display panels will move at any speed from zero to ninety inches per second. A generator 320, FIGURES 1 and 7, is driven as is disk 43, by motor 17. Channel 46 is switched by relay 321 from detector 45b to detector 45c when the motor speed increases from below to above a preset level. In the example used herein, relay 321 was switched when the speed reached fifty inches per second. With disk 43 rotating counter-clockwise, slots 306-312 are advanced relative to slots 301-306. Thus, at speeds of fifty inches per second and higher, the write nozzles will be turned on sooner than in a low speed cycle.

As shown in FIGURE 1, the pressure of the air supplied to the write unit 35 is also changed by solenoid operated valve 322 in dependence upon motor speed. At low speeds, low pressure air of about five pounds per square inch from tank 323 is employed, whereas at the higher speed, higher pressure air from tank 324 of about ten pounds per square inch is employed. Thus, valve 322 is actuated at an intermediate point in the speed range to connect the supply line leading to the nozzles from tank 323 maintained at a low pressure to tank 324 maintained at a higher pressure. In the embodiment of the example above discussed, orifices of 0.052 inch diameter were employed in the write nozzles with air pressures and with display velocities at the above ranges.

FIGURE 8 is a more detailed illustration of the circuit for coding the output from unit 137 to the control lines 40. Each pair of lines leading from unit 137 is characterized by a voltage level on one line and the absence of a voltage level on the other. If a bit is present in the first bit position, the line 137-1 will have an output voltage level and line 137-1' will have zero voltage level. If no bit is present in the first position in the storage unit 137, then the line 137-1 will have a zero output level and line 137-1' will have a voltage signal level.

A code panel 251 is provided for coding a first symbol or letter. A similar panel 252 is provided for a different symbol or letter. Similar coding panels will be provided, one for each symbol or for each letter to be displayed. The lines 138 are connected selectively by diodes to an output line 260 which leads to an AND gate 261. The line 166 is connected to a second input of the AND gate 261. The output line 262 is then selectively connected to the lines 40-2 to 40-7 inclusive by way of diodes, one for each of the latter lines. A like gate 263, having an output line 264, is connected at one input to the output line 260 and at a second input to the line 167. Output line 264 is diode coupled only to lines 40-1 and 40-5. AND gate 265 having output line 266 is connected at its inputs to lines 260 and 168. AND gate 267 having output line 268

is connected at its inputs to lines 260 and 169. Output lines 266 and 268 are diode coupled only to lines 40-1 and 40-5. The fifth AND gate 269 having output line 270 is connected at its inputs to lines 260 and 170. Output line 270 is diode coupled to lines 40-2 to 40-7 inclusive. When a signal on lines 138 represents the code for an A, for example, connections shown in FIGURE 8 would be employed in the code panel 251. As a result, when the first disk column in a display panel registers with the write unit 35, the actuators for nozzles 35b-35g will be energized. When the second, third and fourth disk columns are in registration, AND gates 263, 265 and 267 will operate successively to cause actuators for nozzles 35a and 35e to be energized. When the fifth column is in registration, gate 269 is operated to cause nozzles 35b-35g to be energized.

With the connections thus described, character A will appear encoded in the top seven rows in the display panel. This is because of the code connections in the subpanel 251 and the connections through the diode matrix 280 which interconnects the outputs of the AND gates 261, 263, 265, 267, and 269 to the top seven output channels 40-1 to 40-7 inclusive.

If character B is encoded on lines 138 when the second panel passes registration with the write unit 35 then, by reason of the connections in panels 252, the operation of the bank 281 of AND gates, and the diode matrix 282, character B will be encoded in the top seven rows of disks on the second panel. Similarly, the diodes in panel 283 are coded to represent character C. The diode matrix 284 similarly is coded to output lines 40-1 to 40-7 inclusive for character C. All other letters and other symbols that are to be displayed can similarly be produced on the display panels.

It will be noted that the matrices 280, 282, and 284 are associated with the top seven output lines 40-1 to 40-7 inclusive. The symbols can be coupled to the output lines for appearance anywhere along the height of a given display panel. Furthermore, a wide variety of symbols, numerals, and characters can be displayed. Table I includes one set of characters which is employed in one embodiment of the invention. The code shown in Table I is given by way of example of a code adequate for forming the characters of an alphabet, numerals 0-9, and certain special symbols that have been found to be desirable. In considering Table I, it is to be understood that symbols in the left-hand symbol column (A-&) are formed with a pulse omitted from the line 137-6 and with a negation pulse present on line 137-6' of FIGURE 7. The reverse is true when any symbol in the right hand symbol column (1-□) is to be formed. With the foregoing in mind, it will be noted that Table I permits complete encoding, on lines 138, all of the symbols in the two symbol columns. Table I shows one code for forming the alphabet, numerals and other symbols on the display system. The connections have been made between lines 262, 264, 266, 268 and 270 and lines 40 to form the letter A. Diode connections are included on board 251 from terminals 137-1', 137-2', 137-3, 137-4, 137-5, and 137-6 in accordance with the code of Table I.

TABLE I

| Display Symbol | States of Lines 138-1 to 138-6' |     |     |     |     |    | Display Symbol |
|----------------|---------------------------------|-----|-----|-----|-----|----|----------------|
|                | 1                               | 2   | 3   | 4   | 5   | 6  |                |
| A              | yes                             | yes | no  | no  | no  | no | 1              |
| B              | yes                             | no  | no  | yes | yes | no | 2              |
| C              | no                              | yes | yes | yes | no  | no | 3              |
| D              | yes                             | no  | no  | yes | no  | no | 4              |
| E              | yes                             | no  | no  | no  | no  | no | 5              |
| F              | yes                             | no  | yes | yes | no  | no | 6              |

TABLE I--Continued

| Display Symbol | States of Lines 138-1 to 138-6' |     |     |     |     |    | Display Symbol |
|----------------|---------------------------------|-----|-----|-----|-----|----|----------------|
|                | 1                               | 2   | 3   | 4   | 5   | 6  |                |
| G              | no                              | yes | no  | yes | yes | no | 7              |
| H              | no                              | no  | yes | no  | yes | no | 8              |
| I              | no                              | yes | yes | no  | no  | no | 9              |
| J              | yes                             | yes | no  | yes | no  | no | □              |
| K              | yes                             | yes | yes | yes | no  | no | □              |
| L              | no                              | yes | no  | no  | yes | no | s<br>s         |
| M              | no                              | no  | yes | yes | yes | no | \$             |
| N              | no                              | no  | yes | yes | no  | no |                |
| O              | no                              | no  | no  | yes | yes | no |                |
| P              | no                              | yes | yes | no  | yes | no | s<br>t         |
| Q              | yes                             | yes | yes | no  | yes | no | ¼              |
| R              | no                              | yes | no  | yes | no  | no | □              |
| S              | yes                             | no  | yes | no  | no  | no | s              |
| T              | no                              | no  | no  | no  | yes | no | ½              |
| U              | yes                             | yes | yes | no  | no  | no |                |
| V              | no                              | yes | yes | yes | yes | no | ¾              |
| W              | yes                             | yes | no  | no  | yes | no | ½              |
| X              | yes                             | no  | yes | yes | yes | no | ¾              |
| Y              | yes                             | no  | yes | no  | yes | no | ¾              |
| Z              | yes                             | no  | no  | no  | yes | no | ¾              |
| Pr             | no                              | no  | yes | no  | no  | no | □              |
| □              | no                              | yes | no  | no  | no  | no | c              |
| w<br>i         | no                              | no  | no  | yes | no  | no | o              |
| r<br>t         | yes                             | yes | yes | yes | yes | no |                |
| &              | yes                             | yes | no  | yes | yes | no | B              |
|                | no                              | no  | no  | no  | no  | no | □              |

In the foregoing, a preferred embodiment of the present invention has been described. It will be further understood that changes may be made within the scope of the present invention.

In FIGURE 3, jets 110w and 35w are shown as directed towards the top portion of disk 76. It will be recognized that if the stop strip below the shaft on which disk 76 is mounted were perforated or not solid, the jets could be directed to the bottom portion of the disk. With such stop construction, it would be possible to have both the erase and write columns of jets mounted on the same side of the display panel, either front or back. However, it has been found to be preferable to use a solid stop bar such as the bar 63 of FIGURE 3 and to direct the air jets onto the top portions of the disks.

Toggle-mounting each disk for rotation on a horizontal axis spaced from a horizontal line which passes through the center of mass of the disk provides for a gravity bias of the disks in either of two positions. While the disks have been shown as having planar front faces, other surface configurations may be employed to provide a striking contrast between the front face and the background. The planar face is preferred because the planar disk is more readily controlled by the air jets.

The loop structure forming the track supports display panels to form a train of panels which extends along the track. Each of the panels has a plurality of disks arrayed in rows and columns with each disk toggle-mounted for free rotation through 180° about a horizontal axis and with one face of each of said disks being of one visual appearance and the other face being of

contrasting visual appearance. Drive means coupled to each of said panels propels the panels in a path defined by the track.

The first columnar position control means is fixed in location and is spaced from the path of the panels. It has transmitting means such as air jets positioned to register with the rows of disks for transmitting forces through space to the disks to set all disks in the same position as they pass the first control means.

A second columnar position control means is spaced from the path of the panels and has transmitting means positioned to register with the rows of the disks. They transmit forces through space to said disks downtrack from said first control means.

Means are provided for selectively actuating the latter transmitting means in accordance with selected information symbols to flip selected disks on each panel from the positions set by the first control means to form and display such symbols as each panel travels past and beyond the second control means.

By toggle-mounting the disks and transmitting forces thereto as by the air jets or the like, a fixed control station may be employed, greatly simplifying the moving panel structure. No electrical connections are required on the moving panels. At the same time, positive control is afforded and a distinctive display is possible.

Having described the invention in connection with certain specific embodiments thereof, it is to be understood that further modifications may now suggest themselves to those skilled in the art and it is intended to cover such modifications as fall within the scope of the appended claims.

1. In an information display system, the combination which comprises:

- (a) an array of display elements each having one face of one visual appearance and an opposite face of contrasting visual appearance and toggle mounted at a center region thereof on horizontal axes to be gravity biased in either of two positions,
- (b) means for driving said array past a writing station and thence through a display zone,
- (c) writing means at said writing station for selectively rotating said elements about said horizontal axes against said gravity bias to position a given one of said faces inward or outward, and
- (d) means for controlling said writing means in synchronism with movement of said array.

2. The combination set forth in claim 1 in which means are provided for varying the rate of movement of said array relative to said writing station in dependence upon the rate of flow of information to said system.

3. In an information display system, the combination which comprises:

- (a) an array of display elements each having a luminous face and a non-reflective face and toggle mounted for rotation about vertically spaced horizontal axes to be gravity biased in either of two positions,
- (b) means for driving said array past a writing station and thence through a display zone,
- (c) writing means at said writing station for selectively rotating the information elements about said horizontal axes against said gravity bias to position the luminous faces either inward or outward, and
- (d) means for controlling said writing means in synchronism with movement of said array.

4. An information display system which comprises:

- (a) belt means,
- (b) a plurality of display units supported by said belt means in side-by-side relation and each having a plurality of disks arrayed in rows and columns with each disk toggle mounted for free rotation through 180° about a horizontal axis, one face of each of said disks being of one visual appearance and the other face being of contrasting visual appearance,

11

- (c) a stationary column of air jet means positioned for directing jets of air onto said disks individually to control the positions thereof as they move through positional registration with said jet means, and
- (d) means for controlling said jet means during movement of said belt means to set the positions of selected ones of said disks in accordance with human language information.
- 5. An information display system which comprises:
  - (a) an endless belt means supported for movement relative to a pair of spaced vertical axes with the runs between said axes being horizontal,
  - (b) a plurality of display panels supported by said belt means in side-by-side relation and each having a plurality of disks arrayed in rows and columns with each disk toggle mounted for free rotation through 180° about a horizontal axis, one face of each of said disks being of one visual appearance and the other face being of contrasting visual appearance,
  - (c) a stationary column of air jet means positioned adjacent to said belt for directing jets of air onto said disks individually to control the positions thereof as they move through columnar registration with said jet means, and
  - (d) means for controlling said jet means during movement of said belt means to set the positions of selected one of said disks in accordance with human language information.
- 6. A moving display system which comprises:
  - (a) an elongated continuous supporting track,
  - (b) a plurality of display panels individually supported on said track to form a continuous train of panels extending the full length of said track, each of said panels having a plurality of disks arrayed in rows and columns with each disk toggle mounted for free rotation through 180° about a horizontal axis and with one face of each of said disks being of one visual appearance and the other face being of contrasting visual appearance,
  - (c) a chain adapted to be driven along a course corresponding with the course of said track and coupled to each of said panels for propelling said panels in an orbit defined by said track,
  - (d) a first column of air jets directed onto one face of said panels and aligned with the tops of the rows of said disks for setting all disks in the same position as they pass said column,
  - (e) a second column of air jets adjacent said first column but downtrack thereof and directed onto the opposite face of said panels, and aligned with the tops of the rows of said disks, and
  - (f) means for selectively actuating the jets of said second column in accordance with selected information symbols to flip selected disks on each panel to form and display such symbols as each panel travels past said second column and through said orbit to said first column.
- 7. The combination set forth in claim 6 in which means are provided for driving said panels at a speed dependent upon the rate of flow of information to said system.
- 8. The combination set forth in claim 7 in which control means actuates the jets in said second column in advanced time for higher panel speeds and retarded time for lower panel speeds.
- 9. The combination set forth in claim 7 in which the means responsive to the speed of said panels changes the pressure of air supplied to the jets in said second column from a low pressure at low panel speeds to a high pressure at high panel speeds.
- 10. A panel for moving display which comprises:
  - (a) an open rectangular frame having a plurality of transverse uniformly spaced shafts horizontally extending across said frame,
  - (b) a plurality of toggle-mounted disks supported on each shaft for rotation about a horizontal axis to

12

- thereby be gravity biased in either of two positions,
- (c) a stop member extending across said frame immediately below each said shaft to limit rotation of each disk on a given shaft to about 180°, and
- (d) means aligned in columns and carried by said stop members for indexing the disks on each shaft to predetermined spacing.
- 11. The combination set forth in claim 10 in which the total width of said frame is equal to the spacing between the centers of the end disks on each shaft plus twice the distance between the centers of two adjacent disks on said shaft.
- 12. The combination set forth in claim 10 in which said frame, said stops, said shafts, and the toggle side of said disks are of a dull, non-reflecting finish and the face of each of said disks is of a luminous finish.
- 13. A panel for a moving display which comprises:
  - (a) an open rectangular frame having a plurality of horizontal, vertically spaced shafts extending across said frame,
  - (b) a plurality of disks for being gravity biased in either of two positions supported on each shaft by a pair of laterally spaced tabs extending from the back of each of said disks and through which one of said shafts extends to form a toggle support for each of said disks,
  - (c) a stop member extending across said frame below each said shaft to limit rotation of each disk on a given horizontal shaft to about 180°, and
  - (d) means aligned in columns carried by said stop members and extending between each said pair of tabs for indexing the disks on each shaft to predetermined spacing.
- 14. A moving display system which comprises:
  - (a) an elongated continuous supporting track,
  - (b) a plurality of display panels individually supported on said track to form a continuous train of panels extending the full length of said track, each of said panels having a plurality of disks arrayed in rows and columns with each disk mounted for rotation about a horizontal axis spaced from a horizontal line passing through the center of mass thereof and with one face of each of said disks being of one visual appearance and the other face being of contrasting visual appearance,
  - (c) stop means below each said horizontal axis a distance less than the radius of each said disk to limit the disk rotation to about 180°,
  - (d) chain means adapted to be driven along a course corresponding with the course of said track and coupled to the top and the bottom of each of said panels for propelling said panels in an orbit defined by said track,
  - (e) a first column of air jets directed toward one face of said panels with one jet aligned with the top portion of each of said rows to set all disks in the same position as they pass said first column, and
  - (f) a second column of air jets, each individually actuatable and positioned down said track from said first column and directed toward the opposite face of said panels with at least one jet thereof aligned with the top portion of each of said rows.
- 15. A moving display system which comprises:
  - (a) an elongated continuous supporting track,
  - (b) a plurality of display panels individually supported on said track to form a continuous train of panels extending the full length of said track, each of said panels having a plurality of disks arrayed in rows and columns with each disk mounted for rotation about a horizontal axis spaced from a horizontal line passing through the center of mass thereof and with one face of each of said disks being of one visual appearance and the other face being of contrasting visual appearance,
  - (c) stop means below each said horizontal axis a dis-

13

- tance less than the radius of each said disk to limit the disk rotation to about 180°;
- (d) chain means adapted to be driven along a course corresponding with the course of said track and coupled to the top and the bottom of each of said panels for propelling said panels in an orbit defined by said track, 5
- (e) a first column of air jets directed toward one face of said panels with one jet aligned with the top portion of each of said rows to set all disks in the same position as they pass said first column, 10
- (f) a second column of air jets, each individually actuatable and positioned down said track from said first column and directed toward the opposite face of said panels with at least one jet thereof aligned with the top portion of each of said rows, and 15
- (g) means for selectively actuating the jets of said second column in accordance with selected information symbols to flip selected disks on each panel to form and display such symbols as each panel travels past said second column and through said orbit to said first column. 20
16. A moving display system which comprises:
- (a) loop structure forming a supporting track,
- (b) a plurality of display panels individually supported on said track to form a train of panels extending along said track, each of said panels having a plurality of planar disks arrayed in rows and columns with each disk toggle-mounted for free rotation through 180° about a horizontal axis and with one face of each of said disks being of one visual appearance and the other face being of contrasting visual appearance, 25
- 30

14

- (c) drive means coupled to each of said panels for propelling said panels in a path defined by said track,
- (d) a first fixed columnar position control means spaced from said path having transmitting means positioned to register with the rows of disks for transmitting forces through space to said disks to set all disks in the same position as they pass said first control means,
- (e) a second fixed columnar position control means spaced from said path having transmitting means positioned to register with the rows of said disks for transmitting forces through space to said disks down-track from said first control means, and
- (f) means for selectively actuating the transmitting means of said second control means in accordance with selected information symbols to flip selected disks on each panel from the positions set by said first control means to form and display such symbols as each panel travels along said path past said second control means.

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