Jan. 3, 1967 O. J. ALBRECHT ETAL 3,295,497

ELECTROSTATIC RECORDERS

Filed Dec. 7, 1962 4 Sheets-Sheet 1

Fig. 1

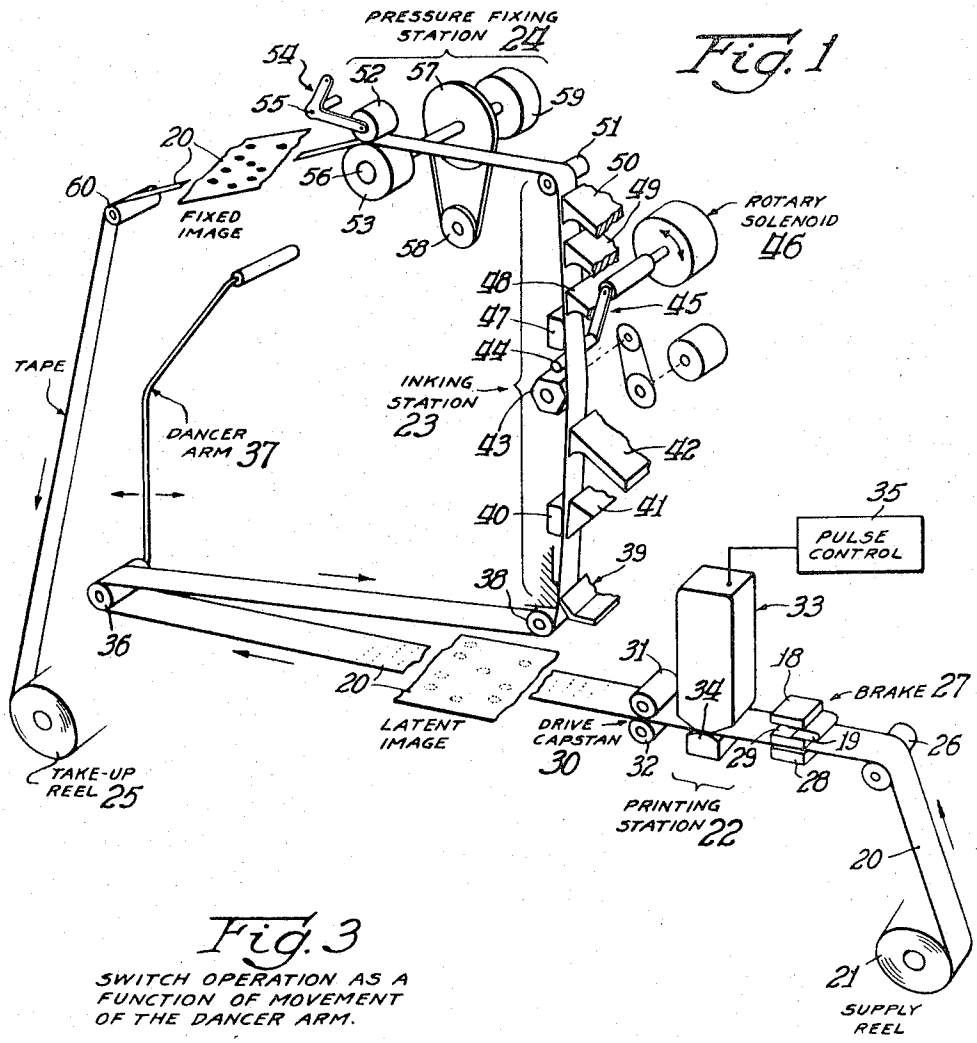
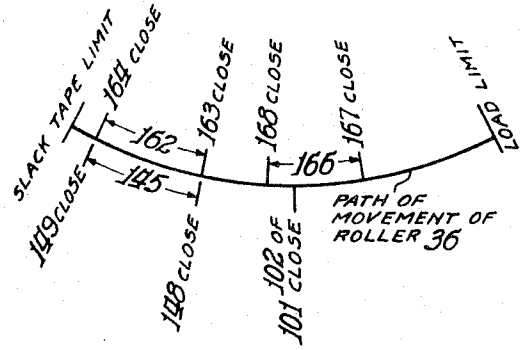


Fig. 3

SWITCH OPERATION AS A FUNCTION OF MOVEMENT OF THE DANCER ARM.



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and Percy J. Barnes
By: James S. Jennings, Jr. Atty.

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ELECTROSTATIC RECORDERS

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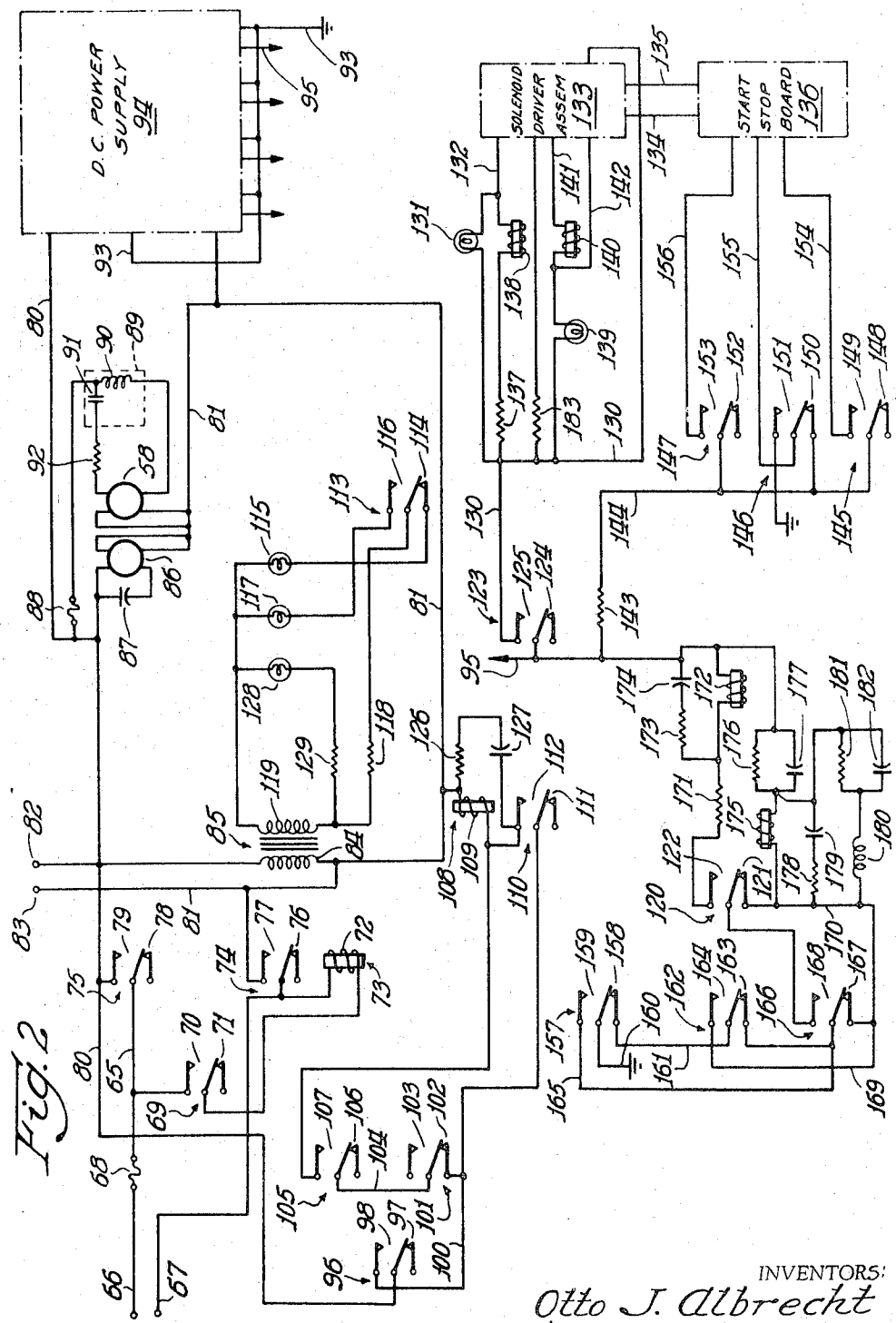

Fig. 2

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ELECTROSTATIC RECORDERS

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Fig. 4

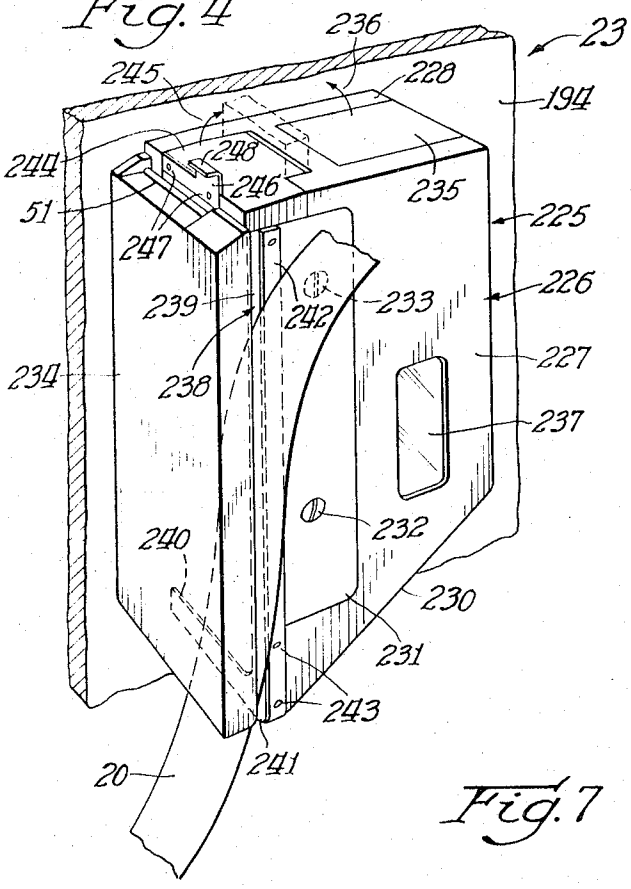


Fig. 6

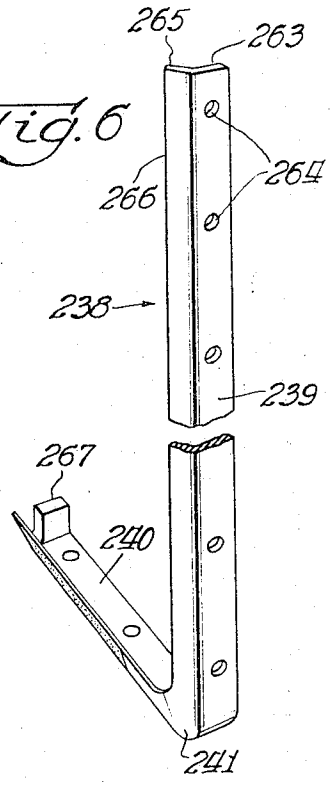
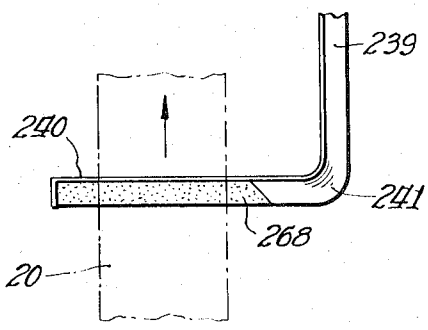


Fig. 7



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Filed Dec. 7, 1962 4 Sheets-Sheet 4

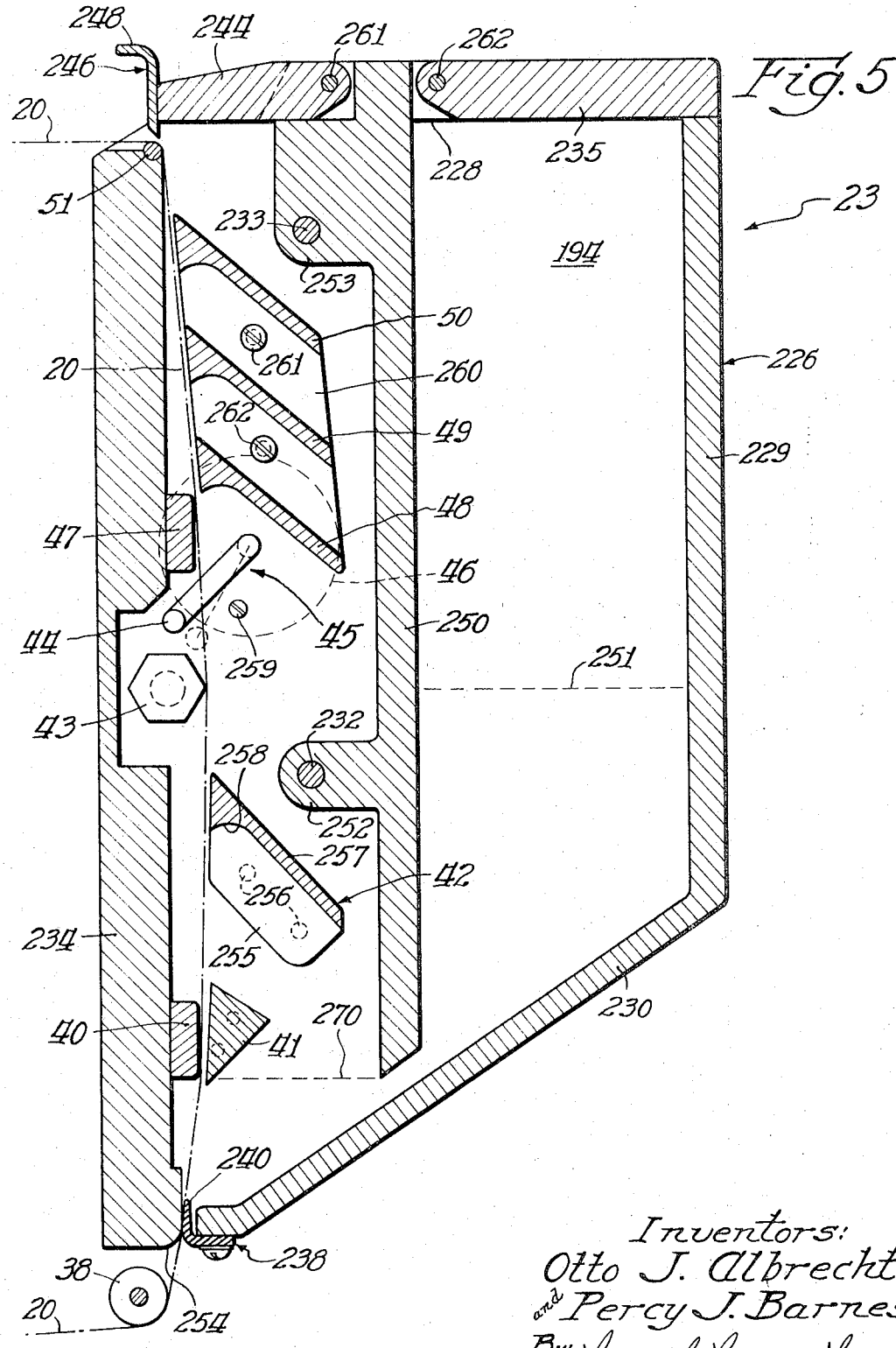

Fig. 5

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3,295,497

ELECTROSTATIC RECORDERS

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Filed Dec. 7, 1962, Ser. No. 243,078
10 Claims. (Cl. 118—637)

This invention relates in general to an electrostatic recording system for (1) "printing" or imposing electrostatic charges on selected areas of a flexible dielectric medium to define a latent image, (2) "inking" or rendering the latent image visible by applying opaque particles which adhere to the charged areas of the medium, and (3) fixing the particles in place to provide a permanent record. More specifically, the present invention is directed toward an improved inking station for use in such a system.

With the advent of high-speed data-processing systems such as those including digital computers, the speed at which information can be processed has been substantially increased. Accordingly, a definite time lag has developed between the rate at which information can be handled within the computer itself and the rate at which the information can be supplied to, and/or read out from, the computer. To bridge this gap in the over-all data handling picture, various high-speed equipments have been developed. By way of example, one such equipment is an electrostatic "recorder" which forms visible, information-representing marks and/or characters on a moving tape from information supplied by a computer during readout, or compiled from other sources and inserted on the tape to provide a suitable source for feeding information into the computer at a high speed.

In certain electrostatic recorders a dielectric medium such as a tape comprised of polyethylene or vinyl plastic with a conductive backing surface is fed through a charging station, at which station a recording head issues electrical discharges which are directed onto the moving tape in certain areas to define a latent image. One such recording head is disclosed and claimed in Patent No. 3,124,804, of Herman Epstein and Edward M. Johnson, entitled Electrostatic Recording Head, which issued March 10, 1964, and is assigned to the assignee of this invention. Improvements in such recording head were subsequently made, and were set forth and claimed in the copending application of Herman Epstein, Edward M. Johnson, George A. Harris, and Thomas L. Thourson, having serial No. 241,839, filed December 3, 1962, and assigned to the assignee of this invention. Thereafter the tape carrying the charged areas is passed through an inking station which contains a supply of conductive powder, such as a mixture of resins and carbon. The particles are attracted to the charged surface areas and adhere thereto, rendering the latent image visible. Some means may be provided for removing excess powder from the background or uncharged portions of the tape, thus sharply defining the image. The inked (or, more precisely, powdered) areas on the tape are then permanently fixed by various means such as the application of heat, pressure, coating with lacquer, or other known means.

Such electrostatic recording systems are capable of very high speed operation, especially as contrasted to older systems which utilize mechanical means for punching holes or slots in a tape or card. In such punching arrangements, the tape is stepped or displaced in increments, being halted as the punch means is operated to produce apertures at the desired locations. In contradistinction to such step-by-step displacement, an electrostatic recorder effects the charging and printing operations "on the fly," with the tape continuously moving, to

minimize wear on the mechanical portions of the system. If desired, step-by-step operation can also be provided with an electrostatic system. Having thus reduced system wear while at the same time substantially increased the operating speed of the system, there still remain areas in which the efficiency of the electrostatic printing system can be improved.

It is a primary object of the present invention to provide new and improved inking apparatus for applying the conductive powder particles to the previously charged areas of the tape.

An important object of the invention is the provision of such an inking arrangement in which the tape can be simply and rapidly loaded laterally, thereby obviating the laborious threading of the flexible tape through the inking system.

Another important object of the invention is the provision of means for positively displacing the tape out of engagement with a beater or agitator within the inker to preclude any tape damage after the tape is halted.

Yet another object of the invention is the provision of novel means for removing excess powder from the background or uncharged areas of the tape, and for deflecting the cloud of particles that would otherwise be carried with the tape toward the reservoir of powder in the inker.

The foregoing and other objects are realized, in one embodiment of the invention, by providing a novel inking structure which has an extended tape insertion slot through which the flexible tape can be inserted laterally. In accordance with one aspect of the invention, a sealing means is mounted adjacent the insertion slot, and the sealing means includes a lower portion disposed adjacent the location where the tape enters the inker during system operation. The novel sealing means not only facilitates the simple side-loading of the flexible tape, but also positively precludes the egress of the "ink" or powder particles.

The inker also includes a beater or agitator to repetitively engage the tape and cause a periodic movement which tends to dislodge any particles adhering to the uncharged or background portions of the tape. In accordance with another aspect of the invention, a movable protector is mounted adjacent the agitator and is normally spaced away from the tape during system operation. Responsive to termination of tape movement, the protector is actuated to engage the tape and displace the tape away from the agitator. Such operation obviates tape damage which might otherwise be occasioned as the beater continues to strike the same spot on the tape. Further, to assist in removing excess particles, a sharp turn is provided in the tape path where the tape leaves the inker, so that surplus powder particles not already removed from the tape before it reaches such point will tend to be deflected from the tape as it makes the sharp turn and leaves the inker.

In order to acquaint those skilled in the art with the best mode contemplated for carrying out the invention, a description thereof is set forth in connection with the accompanying drawings, in the several figures of which like reference numerals denote like elements, and in which:

FIGURE 1 is a perspective illustration of an electrostatic printing system including an inking station embodying the inventive principles;

FIGURE 2 is a schematic diagram, partly in block form, depicting the intercoupling of various control and operating components of the system shown in FIGURE 1;

FIGURE 3 is an illustrative drawing representing the operation of certain components shown in FIGURE 2 as a function of the movement of another component depicted in FIGURE 1;

FIGURE 4 is a perspective view of a novel inker housing, taken on an enlarged scale, and particularly illustrating the manner of inserting the tape into the inker;

FIGURE 5 is a side sectional view, taken on a scale enlarged with respect to that of FIGURE 4, depicting various structural details of the interior of the inker housing;

FIGURE 6 is a perspective view showing a sealing means used in one embodiment of the invention; and

FIGURE 7 is an illustrative view, depicting a portion of the sealing means shown in FIGURE 6 in its relation to the path of tape movement during system operation.

GENERAL SYSTEM DESCRIPTION

In FIGURE 1 various components of the invention are depicted, and the direction of tape movement through the system is shown. In general, the flexible tape **20** is provided upon a supply reel **21**, and moves from this reel past a printing station **22**, an inking station **23**, and a pressure fixing station **24** to a take-up reel **25**. In addition to these major components or units, other cooperative elements of the system are also shown.

More specifically, tape **20** travels from supply reel **21** over an arbor or roller **26**, where its direction is changed, and approaches brake unit **27**. The brake assembly comprises a fixed lower unit or shoe **28**, and a movable upper shoe or unit **29** supported from a spring unit **19** affixed to a mounting block **18**. Although the brake unit, as well as the drive capstan unit **30** which comprises upper pinch roller **31** and a lower roller **32**, is positioned adjacent the printing station, these assemblies have nothing to do with the imprinting or positioning of the charged areas on the tape but affect only movement of the tape through the system.

Printing station **22** includes a head **33** positioned over the tape and a common electrode or anvil unit **34** disposed thereunder. A pulse control unit **35** is depicted in block form, and it is this unit which supplies high voltage pulses to the printing head **33** to establish a mass of charged particles for displacement onto the tape. Because the construction and operation of assemblies for producing and applying voltage pulses of practically any desired amplitude and waveform are well known and understood in the art, no further reference will be made to the pulse control unit **35**.

After the tape passes the printing station, information is transferred by the selective deposition of charged areas on the tape so that the information is represented by the pattern of charged and uncharged areas, as shown in the enlarged tape area and identified by the legend "latent image." The tape passes to the left, as viewed in FIGURE 1, over a roller **36** supported at the extremity of dancer arm assembly **37**, the upper portion of which is journaled in a fixed support (not shown) of the equipment. Tape moves over roller **36** and to the right, passing over another roller **38** disposed adjacent and beneath the inking station.

As the tape enters the inker housing of the present invention, it passes upwardly and engages the extremity or lip of a flexible seal **39**, an important component of the invention. The tape progresses upwardly past spacer unit **40** and ink level baffle **41**, and past the face of an air deflection unit **42**. The portion of unit **42** proximate the path of tape travel is shaped to deflect air moving upwardly, redirecting the air downwardly so that minute powder particles entrained in the air stream will be returned to the bottom of the inking assembly. The tape then passes adjacent a beater **43** which in the illustrated embodiment is hexagonal in section. The beater or agitator is rotated continually when the system is energized, so that the projections of the beater successively engage and agitate the tape to displace therefrom any particles which may tend to adhere to the non-charged or background areas of the tape. Above the beater is the operating portion **44** of a lift-off arm assembly **45**, the opposite end of which is coupled to a rotary solenoid **46**. As this assembly is energized, portion **44** is displaced through a short, predetermined operating stroke to engage the tape and displace the tape away from beater **43** to prevent undesired marking of the tape. This lift-off arrangement is another salient component of the invention. Another spacer unit **47** is positioned just above the extremity **44** of the lift-off arm assembly.

Near the top of the inker three air deflecting elements **48**, **49** and **50** are shown. Such elements may be separate air deflecting elements of a configuration and purpose analogous to those of unit **42**, or they may be separate extensions of a complete assembly to facilitate fabrication and installation within the inker. At the top of the inker mechanism a guide pin **51** is positioned so that as the tape leaves the inker, a sharp and sudden turning movement is provided to assist in dislodging any particles which may adhere to the background portions of the tape.

On the tape as it leaves the inker, the information is represented visibly but as yet is not permanently affixed. The tape, with the "ink" or powder particles adhering to the charged areas, passes between upper and lower rollers **52** and **53** at the pressure fixing station **24**. A lever assembly **54** is provided and journaled about a suitable pivot **55** to effect displacement of the upper roller **52** away from and back into engagement with the lower roller, thus to facilitate the lateral insertion of the tape into this portion of the system. The lower roller **53** is journaled on a shaft **56**, and drive to the shaft is provided by a clutch unit **57** and a motor **58**. In addition a brake unit **59** is provided to halt shaft **56** as drive to other portions of the system is terminated. After the tape with the pressure-sensitive coating passes between rollers **52** and **53**, the image is permanently affixed thereon as indicated by the enlarged portion of the tape and the legend "fixed image."

The tape again changes direction as it moves over roller **60**, and then is wound on take-up roller **25**. With this general perspective of the system as a whole, the interconnection and cooperation of various portions of the control for the system will now be described.

SYSTEM INTERCOUPLING AND CONTROL

Considering first the circuitry of the equipment depicted in FIGURE 2, reference characters **66** and **67** designate input conductors over which electrical energy, in the form of alternating-current (A.C.) power, is applied to the equipment from commercial power lines (not shown). A fuse **68** is coupled between conductors **66** and **65** to function as an isolation means and prevent high current surges from damaging the equipment and likewise to prevent damage to associated units should a short circuit or other fault occur within the equipment. An on-off switch **69** is provided with a normally-open contact set **70** and a normally-closed contact set **71**. It will be apparent that the movable contact is connected to both the normally-open and to the normally-closed contact sets, with each set also including an individual fixed contact. For purposes of the present explanation, the normally-closed contact set will in general be referred to as the back contacts, or back contact set, and the normally-open contact set will be characterized as the front contacts or front contact set. The fixed contact of front contact set **70** is coupled over conductor **65** and fuse **68** to input conductor **66**, and the movable contact of switch **69** is coupled to one end of winding **72** of the power relay **73**, which includes contact groups **74** and **75**. Contact group **74** includes a back contact set **76** and a front contact set **77**, and group **75** includes a back contact set **78** and a front contact set **79**. In the operated position of relay **73**, input energy is translated from input conductors **66** and **67** over the respective contact sets **79** and **77** to conductors **80** and **81**. Terminals **82** and **83** are coupled to conductors **80** and **81**, respectively, to

provide A.C. energy for energizing associated equipment as soon as power switch 69 is thrown to operate relay 73. Power is also applied from conductors 80 and 81 across the primary winding 84 of the transformer 85, and to both sides of the capstan drive motor 86 (for driving roller 32 in FIGURE 1) and to the pressure fixer motor 58, which is depicted generally in FIGURE 1.

More specificaly, it is noted conductor 80 (FIGURE 2) is coupled over circuitry including a phase-shifting or phase-splitting capacitor 87, the other side of which is electrically coupled to motor 86. Conductor 80 is also coupled over a fuse 88 to a starting relay 89 for the pressure fixer motor, which starting relay includes a winding 90 and a contact set 91. A current limiting resistor 92 is series-coupled between one side of motor 58 and the relay unit 89, and the other side of the pressure fixer motor 58 is coupled to conductor 81.

It is also noted that conductors 80 and 81, together with a common ground conductor 92, are utilized for transferring A.C. input power to a D.C. power supply unit 94. Responsive to the application of A.C. energy, a plurality of D.C. voltages of various amplitudes and polarities appear on the respective output conductors indicated along the lower portion of unit 94. In this embodiment, only the conductor pair at the far right comprising negative conductor 95 and common ground conductor 93 will be described. Although a potential of minus fifty volts with respect to ground appeared on conductor 95 in a preferred embodiment, it will be apparent to those skilled in the art that various polarities and amplitudes can be utilized depending upon the exact equipment to be energized and the control function to be performed.

A microswitch 96 is provided with its armature or movable contact coupled to conductor 80. This switch includes a back contact set 97 and a front contact set 98, with no electrical connection made to the fixed contact of the back contact set. The contacts of switch 96 are in the position indicated when the rollers 52 and 53 (FIGURE 1) of the pressure fixing station are spaced apart from each other, and front contacts 98 are closed as roller 52 is moved downwardly to press the tape firmly between the pair of rollers. The fixed contact of set 98 is coupled over conductor 100 to another position-sensitive switch 101, which includes back contacts 102 and front contacts 103. Switch 101 is in the illustrated position with contacts 102 closed when the dancer arm 37 is displaced from the position indicated in FIGURE 1 to the right, to the "load" position of the equipment. The point at which contacts 102 close as the dancer arm is moved to the right is shown in FIGURE 3. As will be made clear hereinafter, the drive equipment for the pressure fixing station is adjusted so that motor 58 tends to drive the tape past this station at a speed approximately ten per cent faster than the rate at which capstan unit 30 moves the tape. Thus, to avoid tape breakage, clutch 57 must be regulated to continually interrupt and return positive drive to roller 53, and this regulation is obtained from the position of the dancer arm. Upon energization of the system the tape is initially displaced only at drive capstan 30. Accordingly, the position of dancer arm 37 must be such that it can move in a clockwise direction, as viewed in FIGURE 1, to take up slack tape during the initial operation of the system and start the driving of roller 53 (by closure of contacts 168) at the proper time. Before this operation commences, when the roller 36 at the bottom of the dancer arm is positioned at the right, in the load position, contacts 102 are closed, and these contacts extend the potential appearing on conductor 100 over conductor 104 to another switch 105, including back contacts 106 and front contacts 107. Switch 105 is a ready switch, and is actuated momentarily to effect the operation of ready relay 108, which includes a winding 109 coupled to front contacts 107 of the ready switch. The ready relay further comprises a first contact group 110, including back contacts 111 and front contacts 112, which function to provide a holding circuit for the relay; a second contact group 113, having a back contact set 114 coupled to an indicator lamp 115 and a front contact set 116 coupled to another indicator lamp 117 with the common or movable contact of this group being coupled over a resistor 118 to one end of the secondary winding 119 of the transformer 85; a third contact group 120, having back contacts 121 and front contacts 122, with this contact group being used in controlling selective driving and braking of the pressure fixer unit and lift-off solenoid in a manner to be explained hereinafter; and a fourth contact group 123, having unconnected back contacts 124 and a front contact set 125 for extending the control potential on conductor 95 toward the control circuits for regulating the tape drive and braking at the capstan drive unit adjacent the printing station. Another indicator lamp 128 is series-coupled with resistor 129, and this combination is coupled in parallel across secondary winding 119 of transformer 85. A resistor 126 and a capacitor 127 are series-coupled, and this combination of elements is connected in parallel across winding 109, to regulate the operating characteristics of this relay.

The fixed contact of front contact set 125 is coupled to a common conductor 130, which conductor is coupled over an indicator lamp 131 and conductor 132 to the solenoid driver assembly unit 133, which assembly is in turn coupled over conductors 134 and 135 to a start/stop board assembly 136. For purposes of the present explanation, it is sufficient to note that, responsive to signals applied from the start/stop board over conductors 134 and 135, circuitry within the solenoid driver assembly 133 provides a connection between a plane of reference potential, such as ground, and one of the conductors shown at the left of unit 133, to complete an energization circuit for either the movable brake shoe or pinch roller 31. Coupled in parallel with indicator lamp 131 is a series combination of a dropping resistor 137 and an energizing winding 138 for displacing the capstan pinch roller 31 into its operating position. Accordingly, when an operating potential appears across winding 138 the capstan pinch roller 31 is displaced into its operating position to start movement of the tape, and it is therefore evident that lamp 131 is utilized as a start conductor for the system.

Also coupled in series between common conductor 130 and assembly 133 is another indicator lamp 139 and a control winding 140 for regulating displacement of the movable upper brake shoe 29 depicted in FIGURE 1. Resistor 183, through circuitry (not illustrated) within solenoid driver assembly 133, is coupled to winding 140, and functions as a dropping resistor to limit the voltage applied to this winding. One end of brake winding 140 is coupled not only to the stop indicator lamp 139 but also over the conductor 142 to assembly 133. Other circuitry, not shown, within solenoid driver assembly 133 is utilized to effect selective and incremental energization of capstan unit 30 and brake unit 27 to provide tape stepping in those applications where continuous "on-the-fly" printing is not desired.

Below contact group 123 a resistor 143 is coupled between conductor 95 and another conductor 144, in its turn is coupled to each of three different contact groups 145, 146, and 147. Conductor 144 is coupled to the center or movable contact of group 145, having back contacts 148 and front contacts 149. Conductor 144 is further coupled to the fixed contact of back contacts 150 of group 146, which group further includes a front contact set 151. In addition conductor 144 is coupled to the movable contact of group 147, generally engaging the fixed contact of back contacts 152 and displaceable to engage the fixed contact of front contact set 153. The

contact group 145 is in the position shown when dancer arm 37 (FIGURE 1) is nearer the load position than the slack tape position. As the dancer arm is displaced in the clockwise direction as viewed in FIGURE 3 past the point referenced "148 CLOSE" to the point "149 CLOSE," at the latter point contacts 149 close and thus contacts 148 open. This circuit operation extends a signal over conductor 154 to start/stop board 136. Contact group 146 is utilized as a momentary switch, operating simultaneously with group 157, to alternately effect the transmission of start and stop signals over conductor 155 to board 136. Lastly, contact group 147 is momentarily energized in unison with contact group 105 as the ready switch is momentarily depressed, and translates a corresponding signal over conductor 156 to start/stop board 136.

As poted above contact group 146 is operated concomitantly wtih contact group 157, shown near the lower left hand portion of FIGURE 2. This contact group includes back contacts 158 and front contacts 159, with the movable or common contact coupled over conductor 160 to ground. The fixed contact of set 158 is coupled over conductor 161 to the movable contact of group 162, which group includes a back contact set 163 and a front contact set 164. Contact group 162 is in the position illustrated when the dancer arm is displaced to the right of the position indicated by the legend "163 CLOSE" in FIGURE 3. Front contact set 164 is closed and set 163 is opened, as the dancer arm is displaced to the left and passes the position identified "164 CLOSE." The fixed contact of set 159 is coupled over conductor 165 to the movable contact of contact group 166 which includes back contacts 167 and a front contact set 168. Conductor 165 is also utilized to extend the potential at the fixed contact of set 159 to the fixed contact of set 163. Another conductor 169 extends the potential at the fixed contact of set 164 both to the fixed contact of set 167 and to a common conductor 170. Contact group 166 is in the position illustrated when the dancer arm is in the load position or when there is a little slack in this part of the system. As the amount of slack increases and the dancer arm is displaced to the left as viewed in FIGURES 1 and 3, contact set 168 is closed at the point indentified "168 CLOSE" to extend the potential appearing on the movable contact of that set to the movable contact of group 120. The fixed contact of set 122 is coupled over a resistor 171 and winding 172 of clutch 57 (FIGURE 1) to conductor 95, to which the operating potential is applied. A resistor 173 is series-coupled with a capacitor 174, and this combination is coupled in parallel across winding 172. Common conductor 170 is coupled over energizing winding 175 of brake 59 (FIGURE 1) and the parallel-connected combination of resistor 176 and capacitor 177 to conductor 95. Elements 176 and 177, together with the series-coupled resistor 178 and the capacitor 179 which are connected across winding 175, provide suitable operating characteristics of the brake. Common conductor 170 is also coupled to one side of operating winding 180 of rotary solenoid 46 (FIGURE 1), and the parallel-connected combination of resistor 181 and capacitor 182 is coupled between the other side of winding 180 and the side of brake winding 175 remote from conductor 170. Accordingly, the lift-off solenoid 46 in FIGURE 1 is energized simultaneously with each energization of brake 59 to halt the movement of the tape through the pressure fixing equipment.

Considering now the operation of the control equipment shown in FIGURE 2 in relation to the elements depicted in FIGURE 1, a suitable wall plug (not shown) or other conventional means is utilized to apply an energizing A.C. potential over conductors 66 and 67, fuse 68 and conductor 65, to the back contact sets of relay 73. Conductor 66 can be considered the "hot" line and conductor 67 the "common" line, which extends to one side of winding 72 of the power relay.

Power switch 69 is displaced and at its front contact set 70 completes an obvious energizing circuit for winding 72 of relay 73, which operates and effects the closure of its respective front contact sets 77 and 79 to extend the A.C. energizing potential to conductors 80 and 81. The energizing potential on these conductors is applied to the capstan drive motor 86 and to the pressure fixer motor 58. Motor 86 drives lower capstan roller 32 but at this time pinch roller 31 is spaced from the tape and from roller 32, so tape movement is not commenced. Further, there is no tape movement at the pressure fixing station by motor 58 until clutch winding 172 is energized. Power is also passed over conductors 80 and 81 to the D.C. power supply 94, which in its turn extends an operating potential over conductor 95 to back contact set 124 of contact group 123, over conductor 144 to contact groups 145–147, and to one side of each of clutch winding 172, brake winding 175, and lift-off solenoid winding 180. From FIGURE 3 it is apparent that with back contacts 167 closed, the dancer arm is positioned to the right of its mid-point of travel. Under these conditions it is not desired to energize the pressure fixer drive motor by energizing clutch winding 172 but rather to maintain this drive equipment deenergized until more slack tape is provided in the system. Accordingly ground potential is extended over conductor 160, contact set 158, conductor 161, and contact sets 163 and 167 to common conductor 170, thus completing energizing circuits both for brake winding 175 and the lift-off solenoid winding 180. Thus brake 59 in FIGURE 1 is operated to preclude any tape movement in this portion of the system, and rotary solenoid 46 is operated and displaces arm 44 to engage the flexible tape and move it out of engagement with beater 43. This "stop" condition of the system is indicated by the energization of indicator lamp 128 over transformer 85, the primary winding of which is coupled to conductors 80 and 81. It is noted that lamp 128 signifies the operation of power relay 73 after switch 69 is actuated.

The potential appearing on conductor 80 is also extended to back contacts 97, and as the pressure fixer rollers 52 and 53 are displaced into engagement with each other, front contacts 98 are closed and this potential is extended over conductor 100 to back contacts 102 of the dancer load switch 101, and also to back contacts 111 of group 110. Thus after the pressure fixing rollers are positioned for operation and contacts 98 are closed, relay 108 is conditioned for operation by the momentary actuation of ready switch 105, provided that back contacts 102 are closed to indicate the dancer arm is nearer the load than the slack tape position. Even before ready relay 108 is operated, however, it is noted that the D.C. energizing potential appearing on conductor 95 is extended over resistor 143, conductor 144, back contacts 150 and conductor 155 to start/stop board 136.

The ready switch 105 is momentarily actuated to close contacts 107 and complete an obvious energizing circuit for winding 109 of ready relay 108, which operates and at its contacts 112 completes an obvious holding circuit to maintain the flow of energizing current through the relay winding after the momentary switch 105 is released. At its contacts 114 ready relay 108 effects the interruption of the energizing circuit for the "load" indicator lamp 115 and at its contacts 116 completes an energizing circuit for the "ready" lamp 117. In its operation relay 108 also closes front contact set 122, but inasmuch as the dancer arm is to the right of its center position at this time, contacts 168 are open and therefore ground potential is not extended to the left side of clutch winding 172. Relay 108 in its operation also effects the closure of contacts 125 and thus extends the operating potential from conductor 95 to common conductor 130. Accordingly, whether pinch roller actuat-

ing winding **138** or the movable brake shoe actuating winding **140** will be energized at this time depends upon selective application of ground potential to one or other of the conductor **132** and **141**, which in turn depends upon the receipt of control signals over conductors **134** and **135** from start/stop board **136**.

To commence driving of the tape through the system, the start/stop switch **146** is momentarily depressed, closing each of contact sets **159** and **151**. Closure of contact set **159** does not otherwise affect the circuitry, in that the dancer arm is still to the right of its center position and contact set **168** is still open. Accordingly, brake winding **175** and lift-off solenoid winding **180** are still energized. Closure of contact set **151** of switch **146** is effective to extend ground potential over conductor **155** to start/stop board **136**. The circuitry within board **136** translates over conductors **134** and **135** a signal which, in effect, applies ground potential to conductor **132** adjacent solenoid driver assembly **133**. In that operating potential has already been applied over contacts **125** to conductor **130**, control winding **138** is energized and pinch roller **31** is displaced downwardly to positively engage the tape between rollers **31** and **32**, driving the tape past the printing head, and at the same time start lamp **131** is illuminated to signal this operation. It is noted that the tape is still stationary at pressure fixing station **24**.

As the tape begins to move past the drive capstan, the amount of slack increases and the dancer arm is displaced to the left under the urging of a bias unit (not shown) such as a spring, past the center position, effecting the opening of contacts **167** and the closure of contacts **168**. The opening of contact set **167** interrupts the energizing circuit for fixer brake winding **175** and lift-off solenoid winding **180**, thereby deenergizing these units. Closure of contacts **168** extends ground potential from conductor **160** over these contacts and contact set **122** to the left side of fixer clutch winding **172**, completing the previously prepared energizing circuit for this unit and energizing clutch **57** to drive roller **53** and positively displace the tape through the pressure rollers toward the take-up reel. Because tape speed at this location is about ten percent higher than tape speed at the capstan, the amount of slack tape diminishes, and the dancer arm moves to the right (FIGURE 1). Such movement opens contacts **168** to deenergize clutch winding **172**, and closes contact set **167** to energize both brake winding **175** and lift-off solenoid winding **180**. The amount of slack tape again increases, the dancer arm moves to the left, contacts **168** close and **167** open, clutch **57** is again energized as the brake and lift-off solenoid are deenergized, and this cycle is continually repeated during system operation as the dancer arm is displaced back and forth through the interval designated **166** in FIGURE 3.

To halt movement of tape through the system, the momentary start/stop switch **146** can be actuated to again effect a momentary closure of contact sets **151** and **159**. The ground potential signal is extended over conductor **155** and through suitable flip-flop circuits in the start/stop board and the solenoid driver assembly to remove ground potential from conductor **132** and to apply ground potential to conductor **141**, completing the energizing circuit for actuating winding **140** which regulates the displacement of movable brake shoe **29**. Removal of ground potential from conductor **132** interrupts the energizing circuit for pinch roller control winding **138**. Accordingly a retarding force is provided by brake unit **27** even as pinch roller **31** is displaced away from the tape and from roller **32** to effect positive halting of the flexible tape. However, momentarily there remains some movement of thetape between the pressure fixing rollers **52** and **53**. The amount of slack in the system rapidly diminishes, moving the dancer arm **37** from the slack position as illustrated in FIGURE 1 toward the right into the load or no-slack position. In this position contact set **168** is opened to interrupt energization of clutch winding **172**, and contact set **167** is closed, completing the energizing circuit for brake control winding **175** and lift-off solenoid winding **180**. Thus the two positive drives, adjacent the printing station and at the pressure fixing station, are removed from the system while the brake unit **27** is energized to rapidly and positively halt tape movement. Use of brake **59** at the pressure fixing station precludes any inadvertent tape movement which might otherwise be caused by residual magnetism in clutch **57**.

INKING STATION

Inking station **23** includes a housing **225** as shown in FIGURE 4. Housing **225** is affixed to a support wall **194**, which in the illustrated embodiment effectively forms a side wall of the housing. The housing includes a main enclosure unit **226**, having a side wall portion **227**, a top wall **228** defining door areas to be described hereinafter, and (as shown in FIGURE 5) a rear wall **229** and a sloping bottom wall **230**. In FIGURE 4, side wall **227** defines a large opening which is effectively closed by an access door **231**, shown in place by a pair of quarter-turn fastening screws **232** and **233**. This access door is the second of the three major units of the housing, the third being a guide plate **234**, affixed to support wall **194** and supported by suitable screws or similar fasteners (not shown) extending through the wall into the guide plate. An ink chamber door **235** is hinged near the top central portion of the inker housing for movement as indicated by arrow **236** upwardly, thereby to facilitate the insertion of conductive powder particles in the inker housing. A transparent window area **237** is provided to afford easy and rapid inspection of the level of the conductive particles within the housing.

In accordance with an important feature of the invention, a seal **238** is provided. As shown in FIGURE 6, the seal is flexible and generally L-shaped, including a leg portion **239** extending from approximately the top of the inker housing downwardly to the bottom thereof, and a base portion **240**, extending horizontally in this embodiment across the lower portion of the inker housing and joined to the leg portion **239** by an arcuate curving portion **241**. Important to the successful construction and operation of the invention is the provision of such a juncture or mating portion **241** which does not include any angularly joined surfaces, but instead comprises only a continuous and regularly curving area between the leg and base portions of seal **238**. The seal can be a unitary member formed of molded neoprene, or a similar flexible material. Other important aspects of the seal will be explained hereinafter.

The seal is held in place by a fastening strip **242** (FIGURE 4), which is positioned over a reference portion of the seal and defines a plurality of spaced apart apertures into which screws **243** or other suitable fasteners are inserted. Corresponding apertures **264** are provided in the seal (FIGURE 6), and disposed in registration with the apertures in fastening strip **242** to facilitate the fastening of the outer or reference portion of the seal in place. The spacing of the guide plate with respect to the main body of the housing is such that an elongated entrance aperture or slit is defined along the side of the inker housing between the guide plate and the seal. This entrance aperture extends not only along the side of the housing but continues around the lower corner of the housing, adjacent curved portion **241** of the seal, and along the bottom of the inker housing, adjacent base portion **240**. In the generalized showing of FIGURE 1, a part of base portion **240** is identified by numeral **39**.

In the top of the housing a tape chamber door **244** is provided and also pivoted about a suitable pin or hinge mounting (not shown) near the center of the top wall. A plate member **246** is affixed to the front of door **244** by a pair of rivets or screws **247**. Member **246** includes an upwardly extending tongue portion **248**, which can be easily grasped to displace door **244** upwardly generally

as indicated by arrow 245 to the position depicted in broken lines. With door 244 in such position it is possible to insert the tape laterally as indicated in FIGURE 4 by sliding it sideways against the restraining action of the outer lip portion of the seal to the interior of the inker housing. After the tape is inserted into the housing, the upper portion of the tape 20 is positioned to pass over stationary guide pin 51, and the tape chamber door 244 is returned to the horizontal or illustrated position to effectively complete the inker enclosure.

Certain components in the interior of the inker housing are shown in FIGURE 5. The housing unit 226 also includes an interior wall portion 250, which cooperates with rear wall 229 to define a storage chamber for the conductive powder particles. The height of the mass of particles is indicated by broken line 251. The wall portion 250 also defines a pair of conventional receptacle portions 252 and 253 for receiving the locking screws 232 and 233 of the access door.

At the location where tape 20 enters the lower portion of the inker, the tape passes over a guide lip 254 of guide plate 234 and also passes adjacent the lip of base portion 240 of the flexible seal. It is thus evident that, although the flexible seal facilitates the simple and rapid insertion of the flexible tape laterally within the inker housing, it also positively retains all the powder particles within the inker housing not only during insertion of the tape but also during operation of the system.

As the tape moves upwardly from the bottom of the housing, it slides along rectangular guide 40, which is spaced from ink level baffle 41. Each of these two members is secured to the rear support wall by suitable screws or other fastening units (not shown). In the illustrated embodiment baffle 41 is of rectangular configuration but baffles of other shapes can be utilized. Efficient operation has been attained with at least the lowermost portion of baffle 41 extended below the bottom of wall 250, so that the level of the conductive particles referenced by numeral 270 abuts ink level baffle 41 rather than touching the tape where it enters the channel between spacer 40 and baffle 41. This structure not only prevents excess particles from being carried upwardly by the tape, but also maintains level 270 at the proper height. If such level is too low, insufficient ink is applied to the tape to provide good definition after fixing of the image. Conversely, if the ink level is too high, the charge can be "wiped off" as the tape passes through the ink particles between seal 240 and the top of the powder mass at level 270.

A first air deflecting assembly 42 includes a land portion 255, fastened to the support wall 194 by suitable screws or rivets 256, and a deflector portion 257 which extends at substantially right angles to the back wall and land portion 255. The deflector includes a curved portion 258 which tends to catch the air stream displaced upwardly by movement of the tape, and to turn the air stream around, deflecting it toward the bottom of the inker housing. Accordingly the miscellaneous powder particles entrained in the air stream will be returned to the mass of particles at the bottom of the housing.

A beater or agitator 43, hexagonal in shape, is affixed in the central portion of the inker housing. The projections on the beater successively engage tape 20 as the beater is rapidly rotated whenever the system is energized. The rapid and repeated engagement of the beater with the tape sets up a vibration in the tape which tends to dislodge particles which otherwise may adhere to the uncharged or background areas of the tape. However, if the tape were to be halted while the beater remained in operation, a permanent mark could be produced on the tape by the continued striking of the beater and the abrasive action of the particles. Accordingly, in accordance with one aspect of the invention, a protector means is provided to positively engage the tape and displace it away from the agitator 43 whenever the tape movement ceases.

In a preferred embodiment the protector means includes a lift-off arm assembly 45, actuated by a rotary solenoid 46 and including an arm portion 44 which is displaced to the position shown in broken lines when the rotary solenoid is operated, to engage the tape and displace the tape away from the periphery of beater 43. A stop means, shown as a set screw 259 affixed in the back wall 194, is provided as shown to halt movement of the lift-off arm after the tape has been safely displaced away from the agitator.

As the tape progresses upwardly, it engages a smooth edge of guide unit 47, and passes adjacent curved edge portions of three air deflectors 48, 49 and 50. In a preferred embodiment, all three deflectors 48–50 are integrally formed with a common base portion 260, the base portion being affixed to the back wall by suitable fasteners such as screws 261 and 262. By providing a single assembly, the installation and adjustment of the three deflectors is substantiially simplified. It is noted that the deflectors do not actually touch the tape, but rather catch the moving air stream and deflect it downwardly in the same manner as the lower deflector assembly 42.

At the top of the housing, hinge rod 261 provides the pivotal connection for the tape chamber door, and another hinge rod 262 is provided for the ink chamber door 235. The lip portion 248 of member 246 extends upwardly to facilitate opening of door 244, and the lower edge of member 246 is positioned to the left of the right-hand extremity of guide pin 51. Accordingly excess particles thrown from the tape as the tape curves around a part of pin 51 tend to strike member 246 or door 244, and drop downwardly to the mass of ink particles. The lower edge of member 246 acts as a retaining wall to catch the ink particles displaced from the tape.

Details of the seal are visible in FIGURE 6. As there shown the upper leg portion 239 includes a reference portion 263 of substantially uniform thickness. The upper leg portion further comprises a lip 265 which extends from the reference portion 263 at an angle approximately midway between a straight angle and a right angle. It is further noted that the lip portion 265 is of substantially the same thickness as reference portion 263 where it adjoins this portion, and the lip is gradually tapered toward its outer edge 266. The same reference and tapered lip portions are provided in the lower base portion 240, and this portion also includes a small pedestal 267 which abuts back wall 194 when the seal is fixed in place.

The continuous curvature of the juncture 241 is also visible in FIGURE 6. The smooth and continuous conformation is important to the successful provision of a sealing means which positively retains the powder particles within the housing while simultaneously affording insertion of the tape sideways into the housing.

Another important feature of the seal is better depicted in FIGURE 7. A portion of the base 240 is molded to provide a recess of relief area, extending along the lip of the base portion and, although it is not as clearly visible in FIGURE 7, also along the bottom of the reference part of the base portion. The relief area may be only a few thousandths of an inch below the surface of the remainder of the seal. In accordance with another aspect of the invention, a wear-resistant material 268 is fixed in this relief area to build the area back up to the thickness of the adjacent portions of the seal. One commercially available material found suitable for use in the relief area is Rulon, a glass-filled Teflon. The provision of the wear-resistant material in the relief area of the seal markedly increases the life and wearing properties of the seal without damaging the tape 20 as it enters the inker housing.

SUMMARY

The novel inker of the invention includes a flexible seal arrangement d'sposed to facilitate lateral insertion of the tape and simultaneously operative to retain the powder particles within the housing during tape insertion and during system operation in which the tape passes through the inker at a high speed. The sealing is obtained by the L-shaped seal which includes a smooth and regularly curved area at the junction of the leg and base portions, and further comprises a relief area with wear-resistant material in the base portion of the seal to obviate abrasion of the flexible seal by the rapidly moving tape. The tape in this system is protected against undesired marking by the provision of the lift-off arm assembly which operates, responsive to halting of the tape movement, to displace the tape out of engagement with the beater and thereby prevent the repeated striking of the tape in one location by the beater. In addition, as the tape leaves the inker housing and passes over the guide pin, a sharp and sudden turning movement of the tape is effected, thus tending to dislodge any stray particles which may otherwise adhere to the background areas of the tape. A preferred embodiment of the invention is incorporated in an electrostatic printer, designated Model ETR-7, commercially available from Omnitronics, Inc., 511 North Broad Street, Philadelphia 23, Pennsylvania.

While a particular embodiment of the invention has been illustrated and described in setting forth the inventive principles, it is manifest that modifications and alterations may be made therein. It is therefore the intention in the appended claims to cover all such modifications and alterations as may fall within the true spirit and scope of the invention.

What is claimed is:

1. In a system in which information is represented by affixing powder particles to previously charged areas of a tape, an inking station comprising a housing for retaining the particles, said housing defining an entrance for admitting the tape into the housing during system operation, means in said housing defining an entrance slit through which the tape can be loaded by insertion laterally without opening said housing to provide the entrance slit, and sealing means affixed to said housing adjacent said slit, said sealing means being flexible to facilitate insertion of the tape and to positively retain powder particles within the housing both when the tape is originally inserted and when the tape is moved through the housing in normal system operation.

2. In a system for representing information by the application of powder particles to charged areas of a flexible d'electric medium, said system having an inking station including a housing for retaining the powder particles therein, the improvement which comprises means in said housing defining an extended slit along one side thereof for admitting the dielectric medium laterally without opening said housing to define the extended slit, and flexible sealing means supported by said housing adjacent said slit, said flexible seal normally retaining the powder particles within the housing and yielding to facilitate the lateral insertion of the dielectric medium.

3. For use with an electrostatic printing system in which information is depicted by the application of conductive particles to charged areas of a flexible tape, a housing having side and bottom portions for retaining the particles therein, said housing including means defining an elongated entrance aperture extending along one side and across at least a portion of the bottom, a generally L-shaped flexible seal having a leg portion and a base portion extending at approximately right angles to said leg portion, the leg portion being positioned adjacent the elongated entrance aperture on said one side and the base portion of the seal being disposed adjacent the bottom entrance aperture, said housing further defining an entrance area at an upper portion thereof across the top of the housing, and door means mounted for pivotal movement from a first position in which the door means effectively closes said entrance area to complete the housing enclosure, to a second position which exposes the entrance area to facilitate lateral insertion of the tape, said flexible seal being yieldable upon lateral insertion of the tape and being effective to retain the conductive particles in the housing.

4. A system as set forth in claim 1 in which said sealing means includes a base portion defining a relief area in the location adjacent said entrance, and wear-resistant material affixed in said relief area to extend the service life of the seal without detracting from the sealing and tape-admitting characteristics of the seal.

5. A system as set forth in claim 3 in which both the upright leg portion and the base portion of said flexible seal, as viewed in cross-section, include a reference portion of preassigned thickness defining a plurality of fastening apertures at spaced intervals, and a lip portion extending from said reference portion at an angle between a straight angle and a right angle, said lip portion being substantially of said preassigned thickness where it joins said reference portion and diminishing in thickness toward its outer edge to afford the desired tape-admitting and particle retaining characteristics.

6. A system as set forth in claim 3 in which the base portion and the upright leg portion of said flexible seal are joined by an arcuate portion of continuous curvature and no angularly mating surfaces, to afford good sealing characteristics in this area of the flexible seal.

7. In an electrostatic printing system for depicting information by applying conductive powder particles to charged areas of a flexible tape, said system including housing means for retaining the powder particles therein, means in said housing defining an extended entrance aperture, sealing means disposed adjacent the extended entrance aperture to facilitate lateral insertion of the tape and positively retain the powder particles within the housing, agitation means supported within said housing for periodically engaging the tape and vibrating it to remove any powder particles which tend to adhere to non-charged areas, and protection means disposed adjacent said agitation means operable to engage the flexible tape and displace the tape away from said agitation means to obviate the tape damage when operation of the system is halted.

8. In an electrostatic printer in which powder particles are positioned to adhere to previously charged areas of a movable tape, housing means for retaining powder particles, therein, a beater having at least one projection for periodically engaging the tape to effect a vibration of the tape and displace therefrom any particles which tend to adhere to uncharged areas of the tape, the improvement which comprises a lift-off arm positioned adjacent said beater and normally retained in a first position out of engagement with said tape, and means operative responsive to halting of the tape to effect displacement of the lift-off arm from the first position to a second position in which said tape is displaced out of engagement with the beater to obviate any damage to the tape.

9. In an electrostatic printing system for depicting information by selectively imposing electrical charges on preselected areas of a flexible tape and thereafter applying conductive powder particles which adhere to the charged areas, said system including housing means for retaining the powder particles therein, the improvement which comprises means in said housing defining an extended entrance aperture to facilitate lateral insertion of the tape without opening said housing to define the extended entrance aperture, sealing means affixed to said housing adjacent the extended entrance aperture to facilitate insertion of the tape and positively retain the powder particles within the housing, and guide means positioned within said housing to provide a sharp change in the

direction of movement of the tape after the particles adhere to said charged areas, whereby particles tending to adhere to uncharged background areas of the tape will be thrown off as the tape goes through the sudden change of direction.

10. In an electrostatic printing system in which conductive powder particles are affixed to previously charged areas of a tape, the improvement which comprises a housing having means including interior wall means effectively defining a powder reservoir and an outlet at the bottom of said reservoir through which powder particles descend by gravity into the working portion of the housing, and ink level baffle means disposed in said working portion and spaced from said interior wall means and from said tape, the lowermost portion of said baffle means being positioned lower than the level of the powder particles in said working portion to maintain the surface of the particle mass out of engagement with the tape and minimize turbulence in the particle mass which would otherwise be occasioned by the rapid movement of the tape during system operation.

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