

May 28, 1957

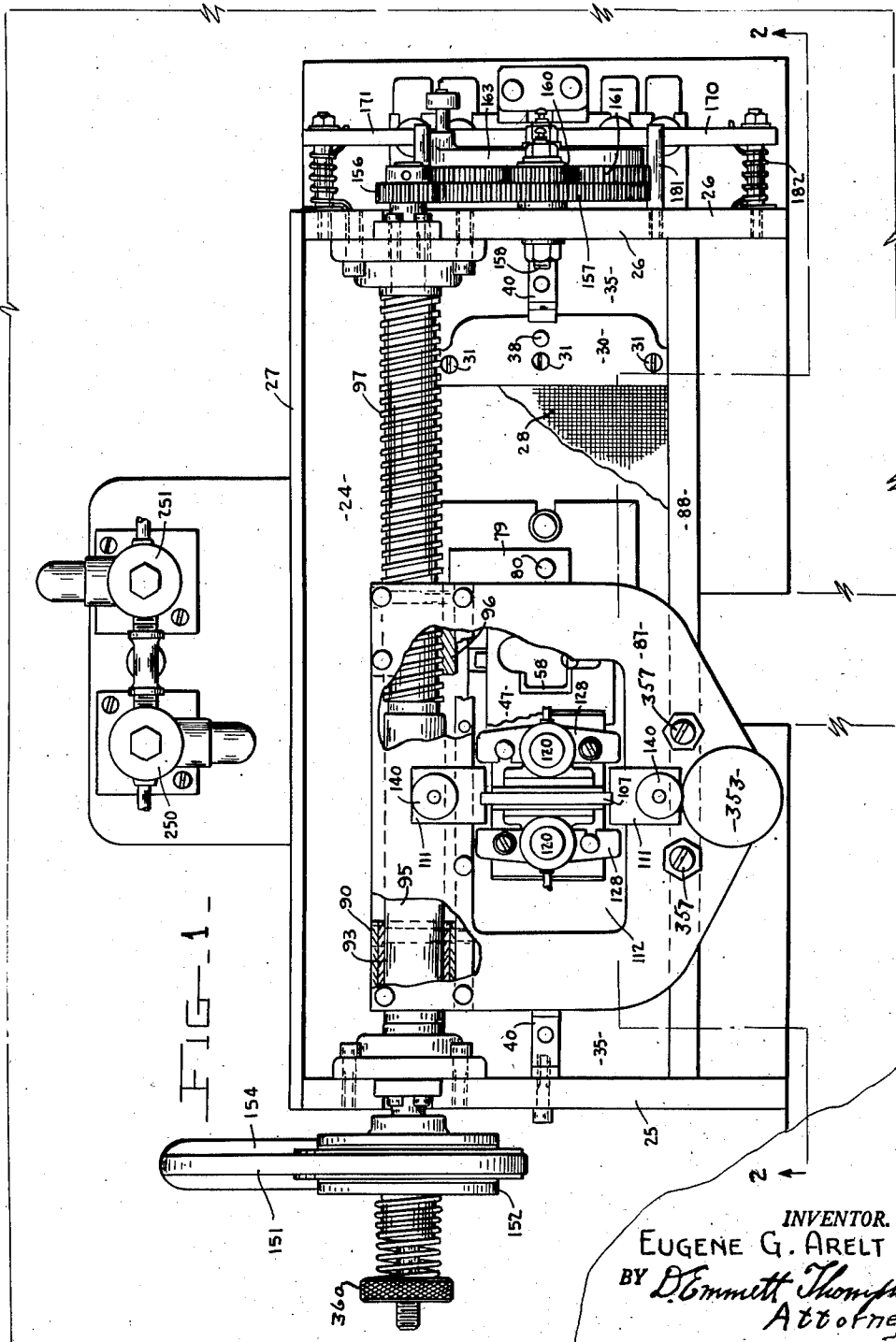
E. G. ARELT

2,793,586

SCREEN PRINTING APPARATUS

Filed Jan. 11, 1954

10 Sheets-Sheet 1



May 28, 1957

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SCREEN PRINTING APPARATUS

Filed Jan. 11, 1954

10 Sheets-Sheet 2

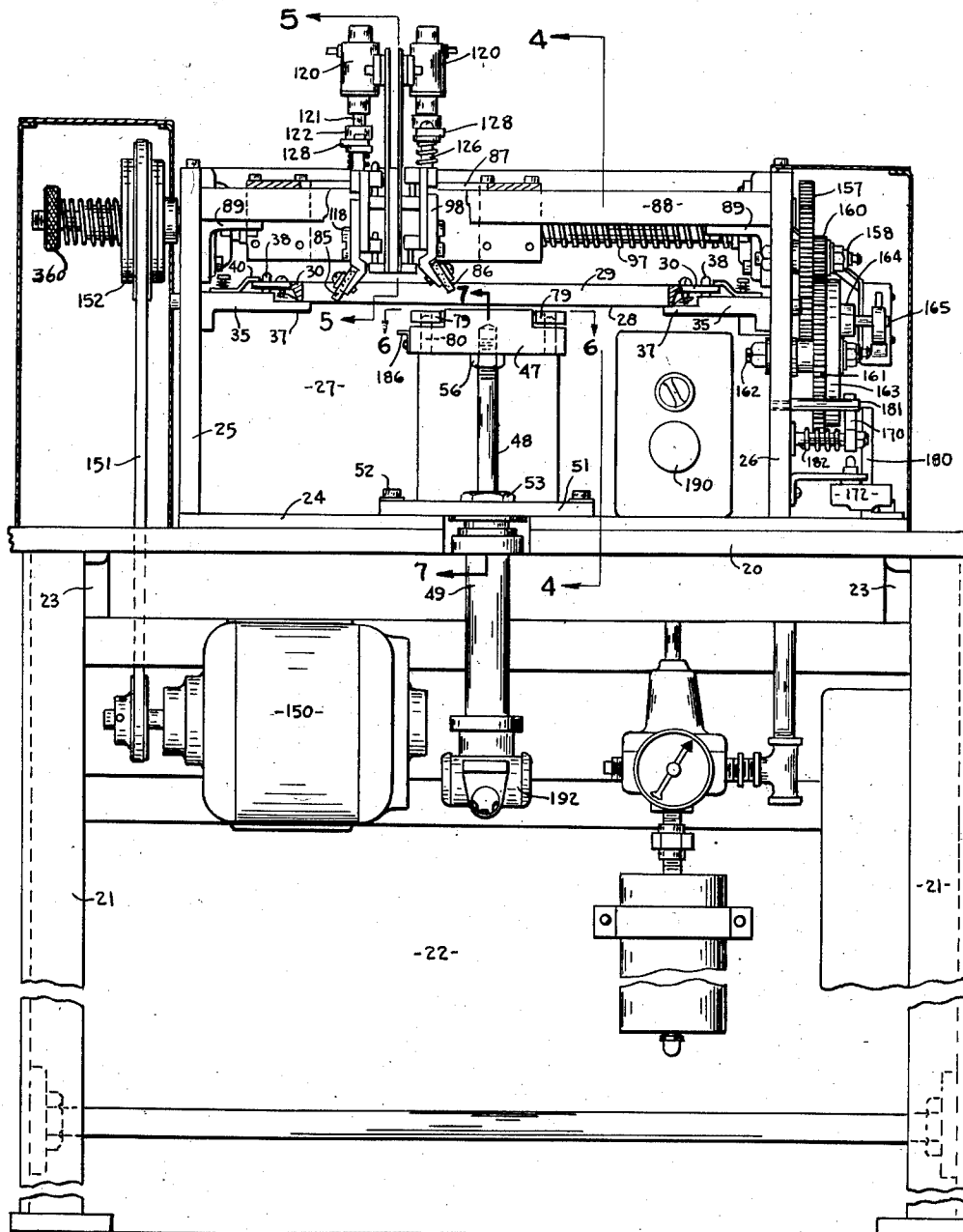


FIG. 2

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10 Sheets-Sheet 3

FIG-3-

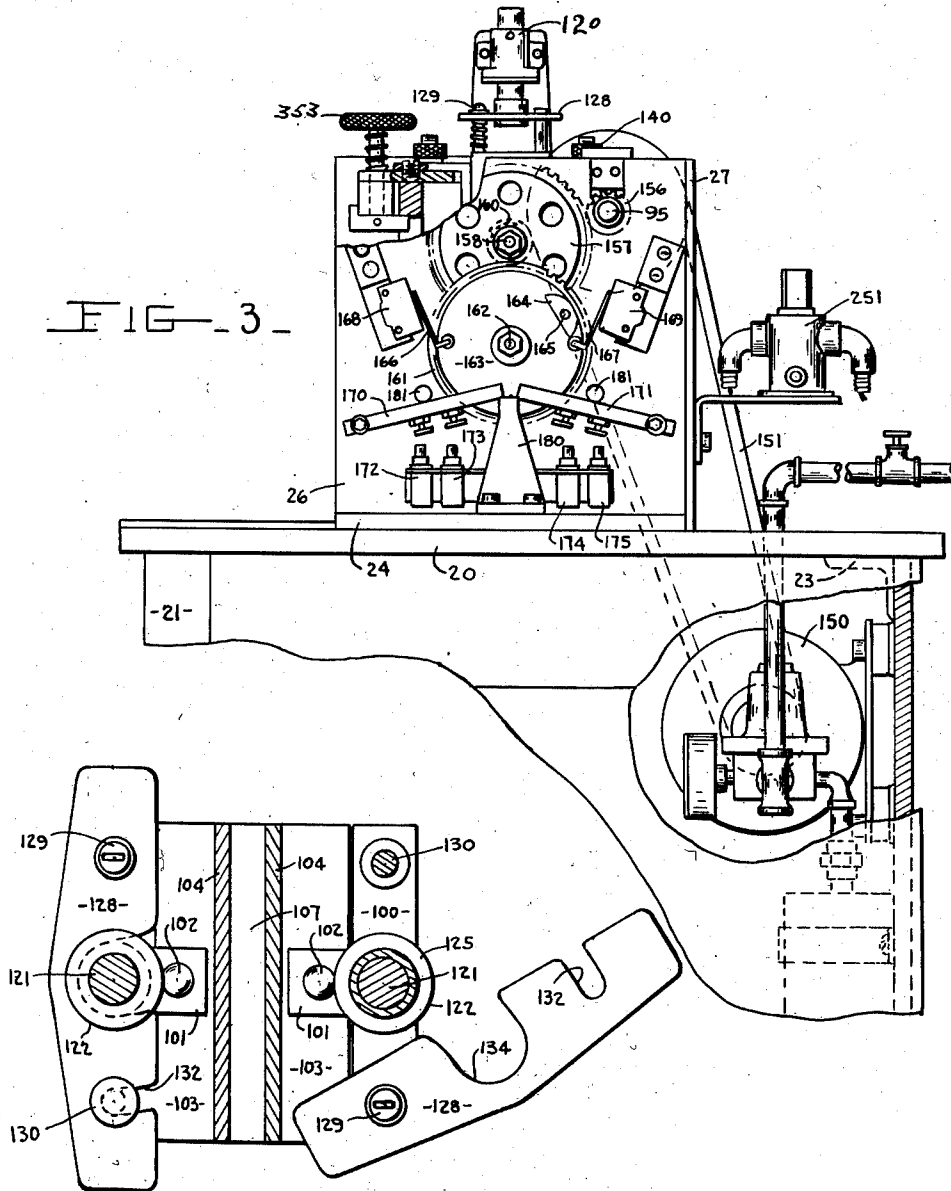


FIG-9-

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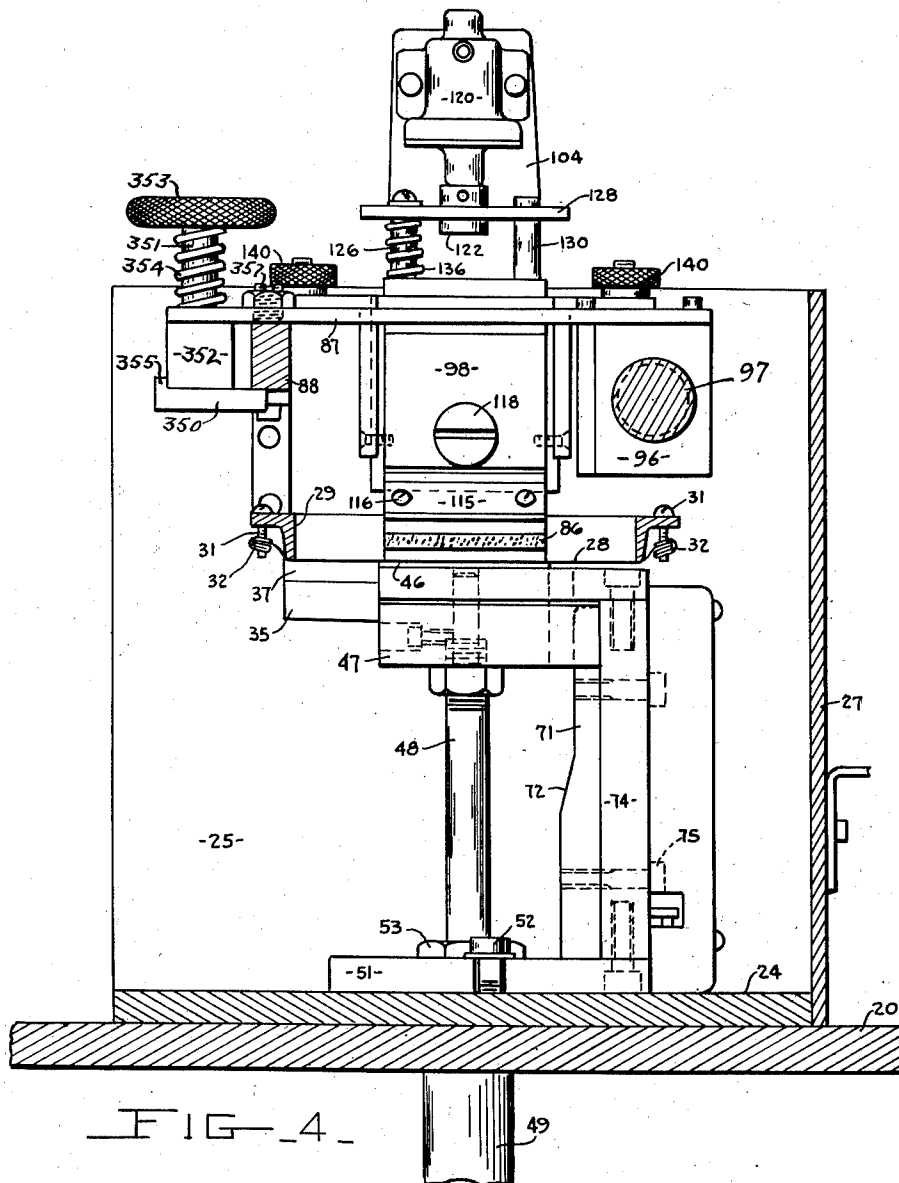
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10 Sheets-Sheet 4



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10 Sheets-Sheet 5

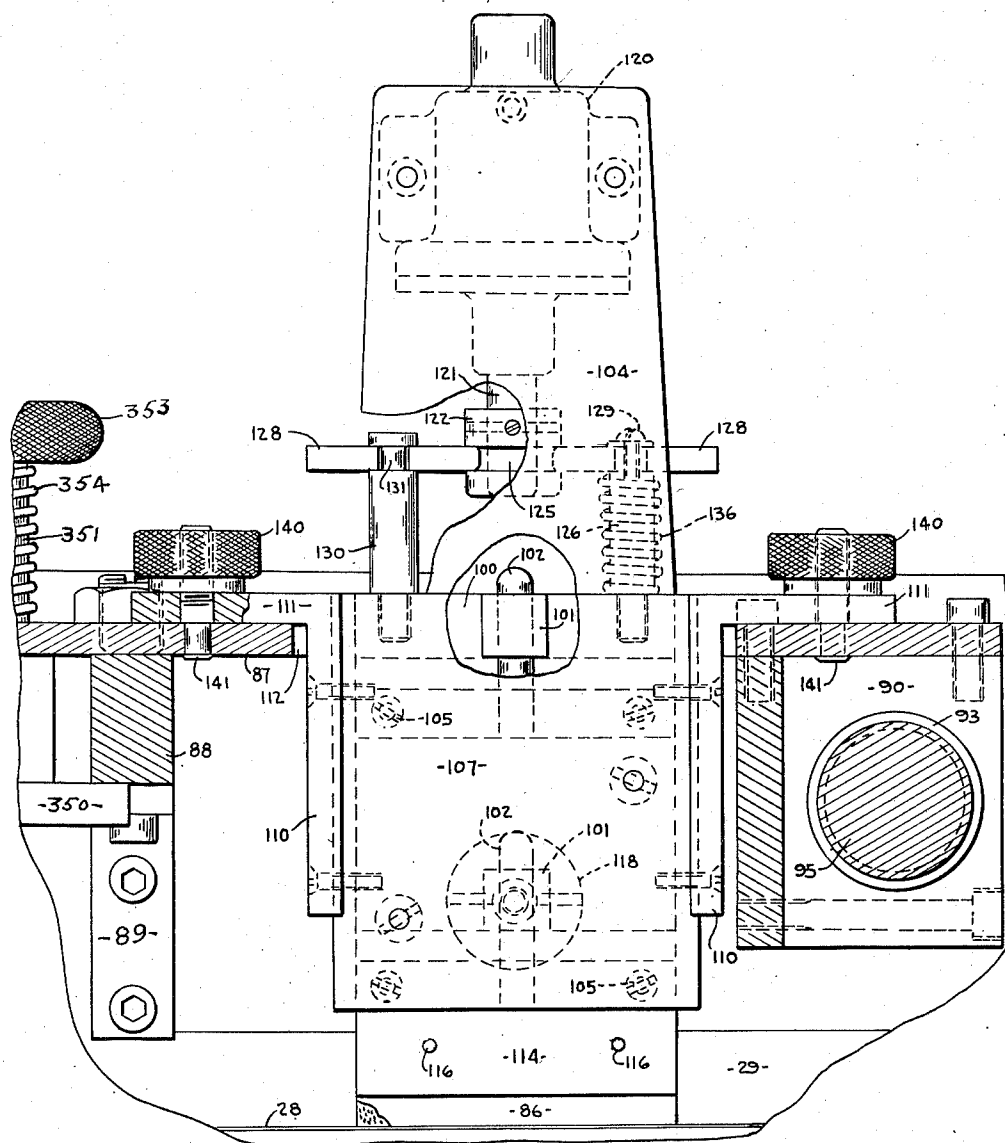


FIG-5-

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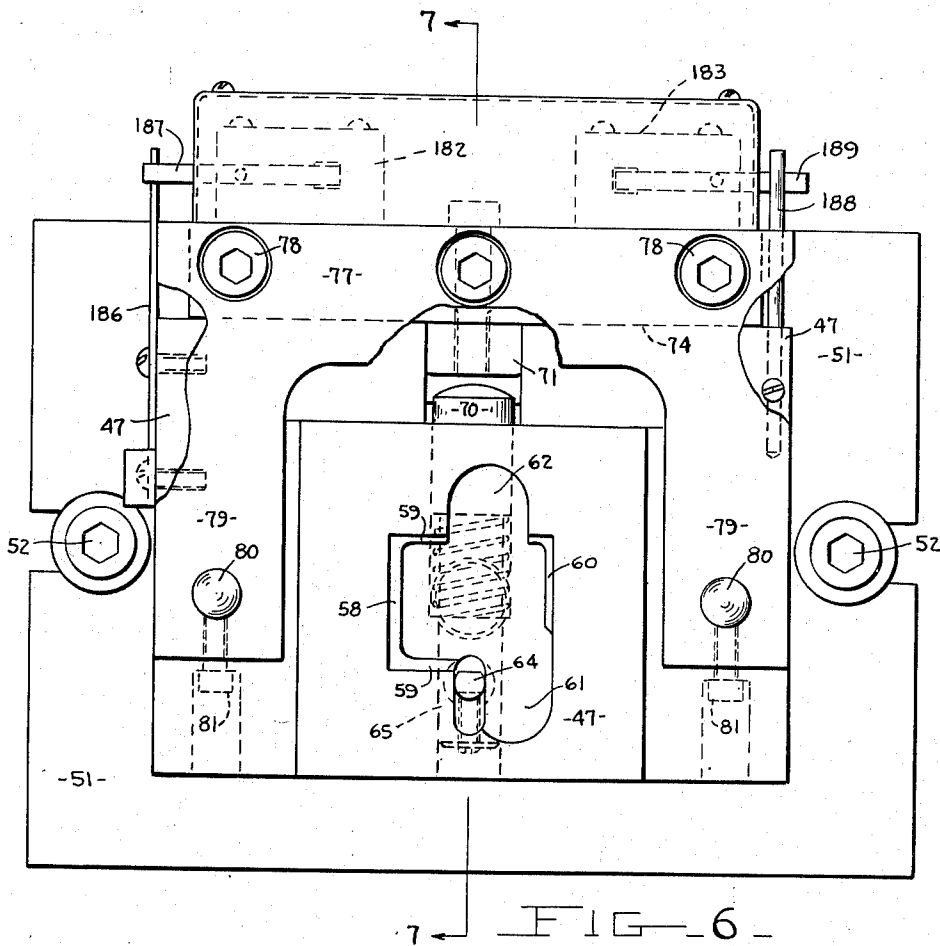
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SCREEN PRINTING APPARATUS

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10 Sheets-Sheet 6



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SCREEN PRINTING APPARATUS

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10 Sheets-Sheet 7

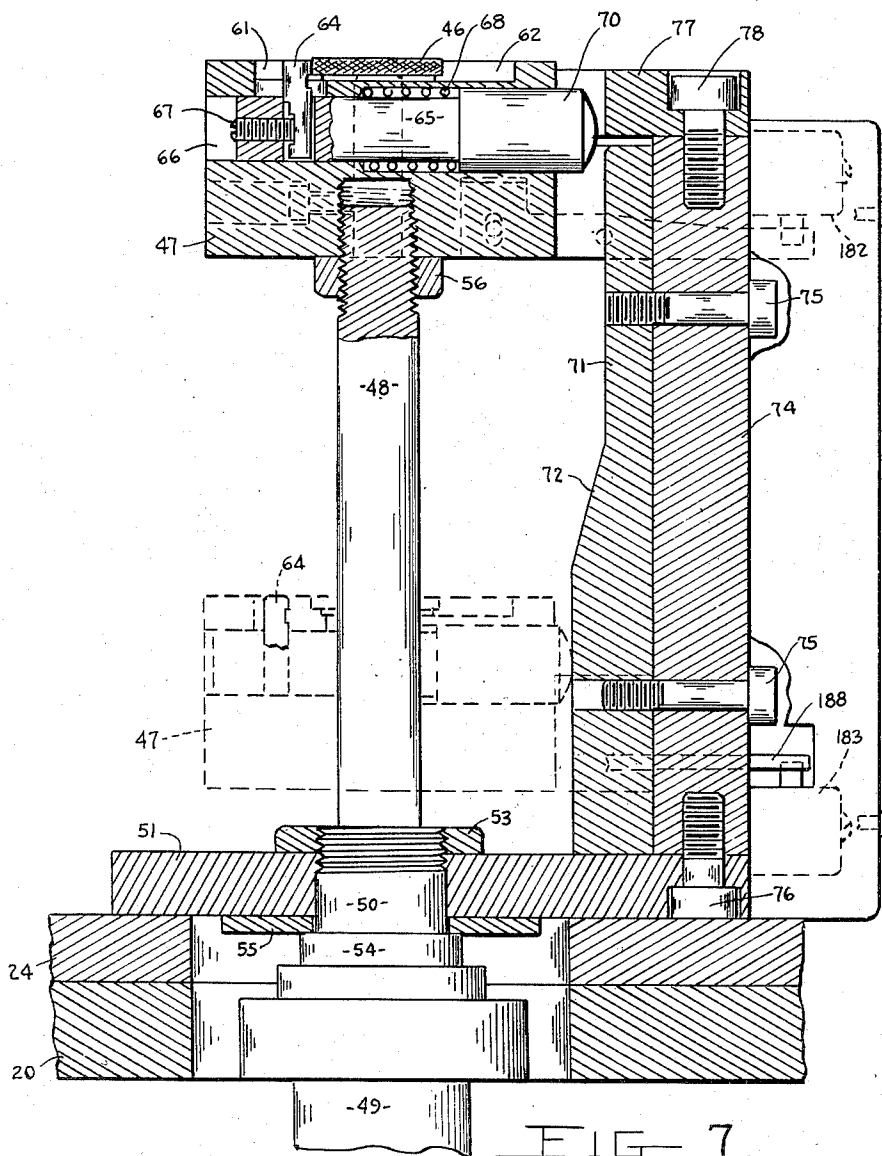


FIG. 7

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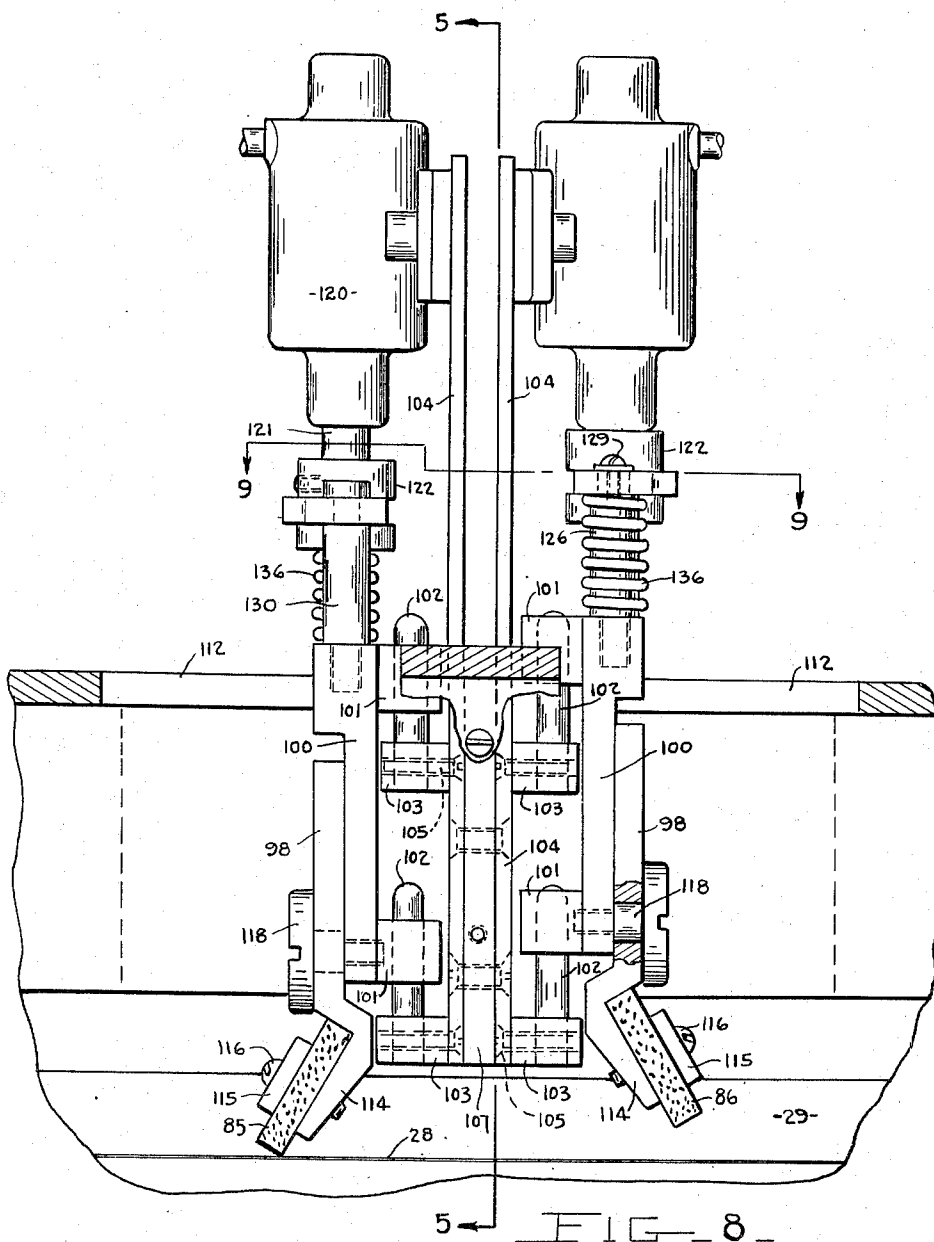
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SCREEN PRINTING APPARATUS

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10 Sheets-Sheet 8



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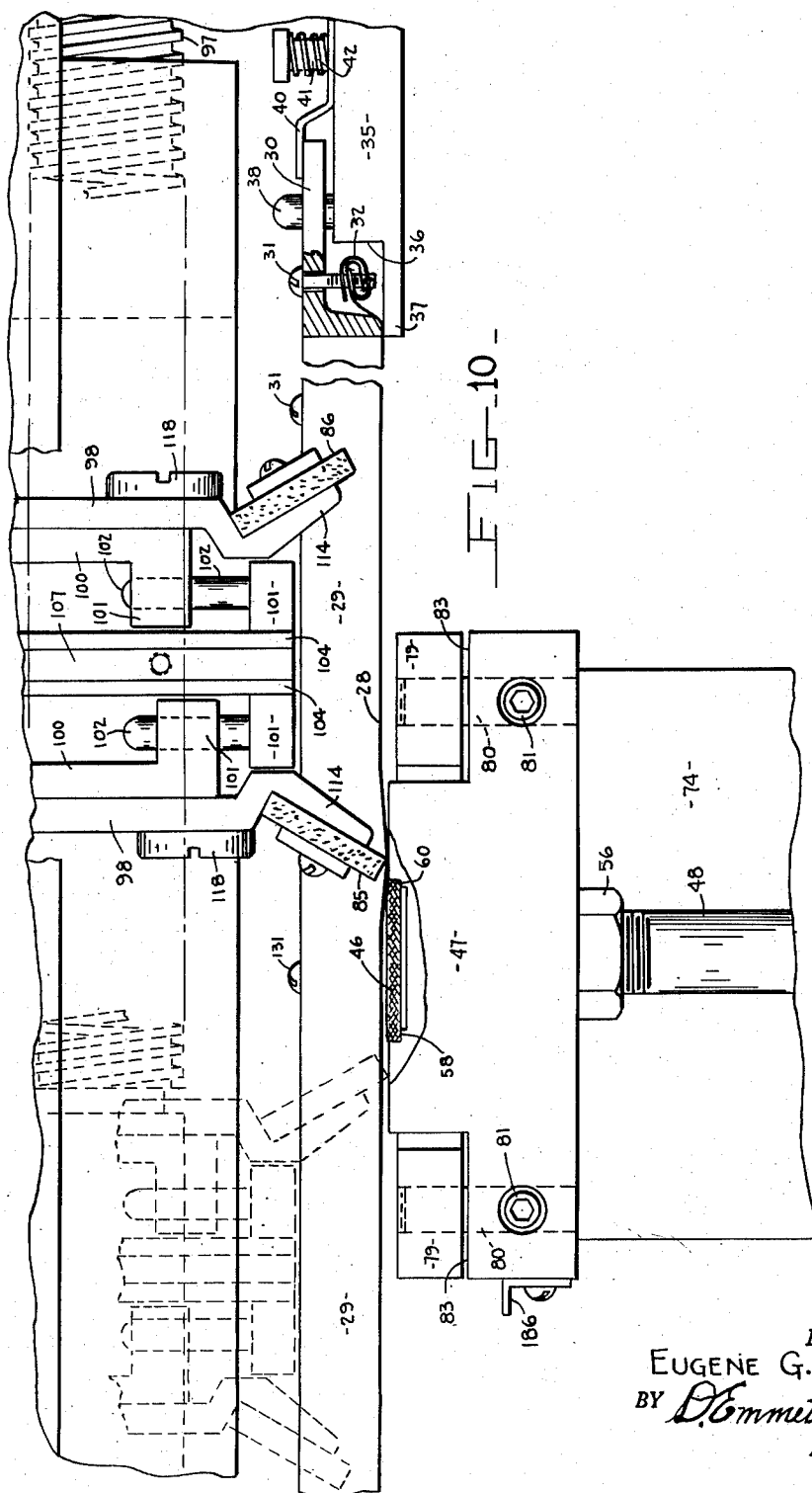
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SCREEN PRINTING APPARATUS

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10 Sheets-Sheet 9



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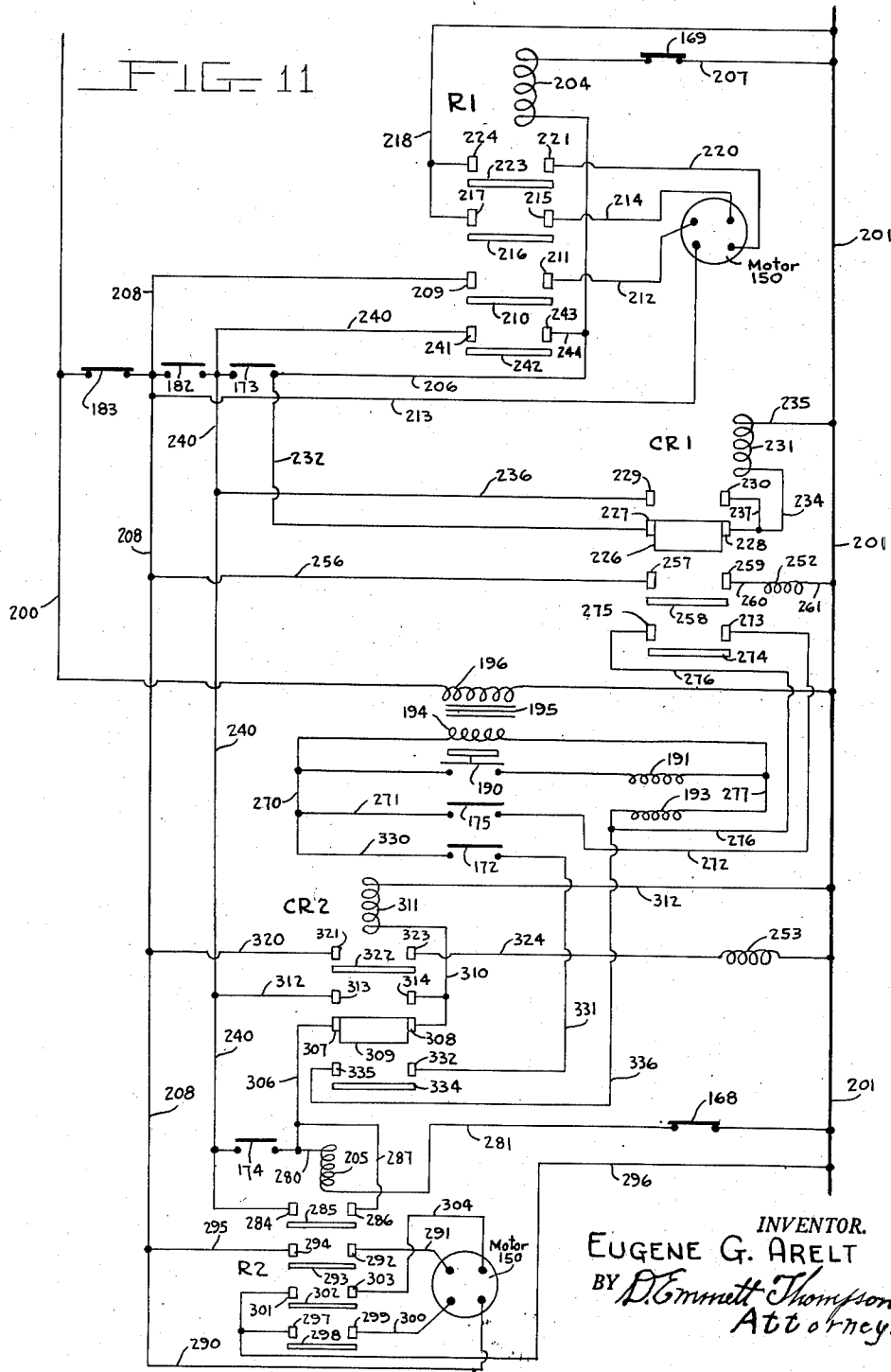
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SCREEN PRINTING APPARATUS

Filed Jan. 11, 1954

10 Sheets-Sheet 10



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2,793,586

SCREEN PRINTING APPARATUS

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Application January 11, 1954, Serial No. 403,321

13 Claims. (Cl. 101-123)

This invention relates to screen printing apparatus. Such apparatus is used extensively for high grade print work in the graphic arts, the machines including structure for moving a squeegee transversely of a silk screen to form the printing mix through the stencilled portion of the screen onto the paper or other material being printed. Heretofore, in the use of screen printing apparatus in the graphic arts, the amount of the print mix deposited on the material being printed and the thickness of the deposited layer, was not of particular importance. The important features in such printing were the clearness and sharpness of the printing.

In recent years, components for electronic apparatus have been produced by what is known as the printed circuit method. In this method, certain components of a circuit, such as conductors, resistors, capacitors, etc., are produced by being printed on a dielectric material which usually consists of a fired ceramic sheet. In the printing of certain of these components, particularly resistors, it is extremely important to control the thickness of the print mix material deposited on the dielectric. Usually these printed circuit components are exceedingly small in dimension—often being only a fraction of an inch in width and length, and on this surface, constituting only a fraction of one square inch, there may be a multiplicity of resistors printed. Accordingly, the thickness of the printed resistors must be controlled with extreme precision in order to obtain uniform resistivity and uniform electrical characteristics.

Heretofore, attempts have been made to carry on this printing process by the silk screen method. However, the amount of print mix and the thickness of its deposit vary over such wide ranges that on the average only two or three percent of the printed circuit components so produced were serviceable for the purpose for which they were intended.

This invention has as an object a screen printing apparatus embodying a structural arrangement which functions to effect printing by the screen medium in such manner that the print mix is deposited upon the work piece with great uniformity, both as to the amount of material deposited and the thickness of the deposited layer, whereby printed circuit components printed with the apparatus of this invention possesses electrical characteristics of great uniformity and especially in the printing of resistors. The resistivity thereof is consistently well within the tolerance permitted in the electronic apparatus in which such components are used.

The invention consists in the novel features and in the combinations and constructions hereinafter set forth and claimed.

In describing this invention, reference is had to the accompanying drawings in which like characters designate corresponding parts in all the views.

Figure 1 is a top plan view of a screen printing apparatus embodying my invention with parts broken away, and parts in section.

Figure 2 is a view taken on line 2-2, Figure 1.

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Figure 3 is an end elevational view, looking to the left, Figure 1.

Figure 4 is a view taken on line 4-4, Figure 2.

Figure 5 is a view taken on line 5-5, Figures 2 and 8.

Figure 6 is a top plan view of the work support taken on line 6-6, Figure 2.

Figure 7 is a vertical sectional view of the work support taken on line 7-7, Figure 2.

Figure 8 is an enlarged view of the squeegee mechanism, as shown in Figure 2, with parts broken away and parts in section.

Figure 9 is a view taken on line 9-9, Figure 8.

Figure 10 is an enlarged front elevational view of the lower portion of the squeegee mechanism and work support, with a portion of the latter broken away to show the position of the work piece.

Figure 11 is an across the line diagram of the electrical circuit.

The apparatus is mounted on a cabinet top 20 supported at its forward edge by vertical angle members 21 and at its rear edge by a wall member 22 which is secured to the top by angle members 23.

The frame of the apparatus consists further of a base plate 24 on which are mounted end plates 25, 26, and a rear plate 27. The screen 28 is mounted in a rectangular frame 29 formed at each end with a laterally extending projection 30. The screen 28 is drawn taut over the lower edge of the frame by screws 31. The screws 31 extend through the lateral marginal portion of the frame and thread into nut members 32 formed of relatively thin sheet metal, the marginal edge of the screen 28 being attached to the nut members 32, whereupon the screen is drawn tightly over the lower edge of the frame 29, see Figures 4 and 10. The screen is supported by brackets 35 extending inwardly from each of the end plates 25, 26, see Figures 2 and 10. The upper face of the brackets is recessed as at 36, and the screen rests upon the reduced portion 37 of each bracket. The laterally extending projections 30 are apertured to be slidably mounted on positioning pins 38 carried by the brackets, and the screen frame is held downwardly by a clip 40 mounted upon a stud 41 which is encircled by a compression spring 42, whereby the frame and screen are readily removable from the supporting brackets 35.

The work piece 46, see Figures 4 and 7, is supported by a support 47 mounted on the upper end of a piston rod 48 slidably mounted for vertical movement in a cylinder 49 formed at its upper end with a reduced portion 50 extending through an aperture in a plate 51 mounted upon the base plate 24, as by screws 52, see Figures 2 and 7. The cylinder is clamped in the plate 51 by a nut 53 threaded on the upper end of the reduced portion 50, drawing a collar portion 54 of the cylinder against the under side of the plate 51, or a spacing washer 55 inserted between the collar and the plate. The upper end of the piston rod 48 is threaded into the work support 47 to permit vertical adjustment of the support, the same being locked in place by a jam nut 56.

The upper surface of the work support 47 is recessed to receive the work piece 46 which, in this instance, is a thin, rectangular plate formed of ceramic material. The recess is initially formed complementary to the shape of the work piece with a bottom wall, appearing in the drawing as a ledge 58 extending along one side of the recess and extending part way along the adjacent sides of the recess, as at 59, Figure 6. The bottom wall of this recessed portion also includes a ledge 60 on the side opposite the ledge portion 58. The center portion of the recess between the ledges 58, 59 and 60 is considerably deeper and extends forwardly at 61 and rearwardly at 62. The purpose of these enlarged and deeper portions 61, 62 of the recess is to permit the operator to conveniently

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ly insert and remove the small work piece 46 with her fingers, the ledges 58, 59, 60, determining the vertical position of the work piece relative to the support, and the square corners of the recess in proximity to the ledges determining the position of the work piece. The arrangement is such that the top surface of the work piece extends slightly above the top surface of the work support 47, as indicated in Figure 10.

The work piece is yieldingly clamped against the rear wall of the recess in which it is mounted by a pin 64 which is mounted vertically in a plunger 65 slidably mounted in a bore 66 formed on the work support and which extends forwardly and rearwardly. The pin 64 is detachably secured in the plunger, as by a set screw 67. The forward portion of the plunger 65 is encircled by a compression spring 68, this spring acting against an inner enlarged portion 70 of the plunger, urging the plunger inwardly, or to the right, Figure 7. The inner portion 70 of the plunger projects through the rear edge of the work support for engagement with a vertically extending member 71 having an angular cam surface 72 whereby, when the piston rod 48 moves downwardly to lower the work support to the dotted outline in Figure 7, the plunger 65 is urged outwardly, or toward the operator, moving the clamp pin 64 outwardly from the forward edge of the work piece 46, whereby it may be removed by the operator and a new work piece inserted. The vertical cam member 71 is attached to a vertically extending plate 74, as by screws 75, this plate 74 being attached to the plate 51, as by screws 76. There is a U shaped plate 77 attached to the vertical plate 74, as by screws 78, the leg portions 79 of this plate extending forwardly at each side of the work support 47, see Figure 6. The leg portions 79 are apertured to receive dowel pins 80 which are mounted in the work support 47, as by screws 81. The central portion of the work support 47 extends upwardly from the side portions 83 to permit the central portion to move upwardly between the legs 79 of the plate 77, so that the work piece 46 will be positioned slightly above the top surface of the plate 77. In this position, the top surface of the work piece is positioned against the under side of the screen 28.

The printing medium is forced through the apertures in the screen by a pair of squeegees 85, 86, mounted on a carriage movable transversely of the work piece 46. The carriage consists of a horizontally arranged plate 87. The front portion of this plate is slidably mounted on a supporting bar 88 mounted at its ends on brackets 89 carried by the end plates 25, 26. A bearing block 90 is secured to the under side of the plate 87 at one rear corner thereof and is provided with a bushing 93 slidably receiving a shaft 95, see Figures 1 and 5. A block 96 is secured to the plate at its opposite rear corner and is threaded internally to receive the threaded portion 97 of shaft 95. With this arrangement, the shaft 95 serves as a screw which, upon rotation, effects movement of the squeegee carriage transversely of the machine looking at Figures 1 and 2.

Referring particularly to Figures 4, 5, 8 and 10, the squeegee pads 85, 86, are formed of rubber, or like material, and are mounted on plates 98 which, in turn, are mounted on supporting members 100. These members 100 are also in the form of plates extending vertically and being provided on their inner surfaces with vertically spaced projections 101 apertured to slidably receive pins 102 vertically fixed in cross members 103 mounted on elongated vertically extending plates 104, as by screws 105. The plates 104 are fixedly mounted on opposite sides of an intermediate plate 107. The intermediate plate is also fixed to vertically depending leg portions 110 of angle brackets having horizontal portions 111 overlying the front and rear portions respectively of the main carriage plate 87. The central part of the plate 87 is formed with a rectangular aperture 112 in which the squeegee assembly thus far described is mounted.

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The lower end portions of the plates 98 are formed with portions 114 offset and inclined relative to the vertical plane of the plates, and the squeegees are detachably secured or clamped to these inclined portions, as by clamp bars 115 and screws 116. The plates 98 are pivotally mounted to the supporting plates 100 on an axis extending parallel to the screen 28 and perpendicular to the plane of the plates. This is accomplished by shouldered screws 118 extending through the plates 98 and threading into the supporting plates 100. This permits the screen contacting edges of the squeegees to move into exact parallelism with the surface of the work piece.

Each squeegee is, by the inclination of the portions 114 of plates 98, inclined upwardly from the screen in the direction in which the squeegee is moved across the screen. For example, with the left hand squeegee in Figure 8 moved downwardly into contact with the screen, the carriage will be moved to the right. While the squeegee 85 is being moved across the portion of the screen contacting the work piece, the squeegee 86 is maintained in elevated position, as shown in Figure 8. Upon completion of the movement of the carriage to the right, the squeegee 85 is raised and the squeegee 86 is moved downwardly into engagement with the screen 28 upon movement of the squeegee assembly to the left.

This individual vertical movement of the squeegee is accomplished by fluid operated means such as piston and cylinder structures individual to each squeegee. A cylinder 120 is fixedly mounted on the upper end of each of the plates 104. The piston rod 121 of each cylinder is provided with a collar 122 formed with a circumferential groove 125. A stud 126 is fixed to the upper edge of each supporting plate 100 and the upper ends of these studs of reduced diameter to pivotally receive a cross member 128. These cross members are retained on the reduced shouldered portions of the studs as by screws 129. There is also a stud 130 fixed to each plate 100 in spaced relation to the studs 126. The upper end portions of the studs 130 are formed with a reduced neck 131, see Figure 5, and the free end of each cross member is formed with a notch 132 to receive the neck portion 131. The intermediate portion of each cross member is formed with a larger notch 134, see Figure 9.

With this arrangement, when the cross members are swung about their pivot studs 126, the notch portion 134 engages the groove 125 in collars 122, and the notched end portions 132 engage the neck portion of the studs 130. In this manner, the piston rods are operatively connected to the plates 100. A coil compression spring 136 encircles each of the studs 126 and serves to yieldingly restrain movement of the cross members 128 about the axis of the studs 126. The cross member 128, shown at the left in Figure 9, is in collar engaging position, while the cross member to the right in that figure is swung outwardly out of collar engaging position. Thus the plates 100 carrying the squeegee plates 98 can be quickly and conveniently connected and disconnected to the actuating piston rods 121. When the cross members 128 are moved out of engagement with the collars 122, the supporting plates and the squeegee plates 98 carried thereby may be removed from the squeegee assembly by simply lifting the plates 100 upwardly off from the pins 102. Also the entire squeegee assembly may be readily removed from the supporting plate 87 by removing nuts 140 from studs 141 which are fixedly mounted in the top plate 87 and which extend through the horizontal leg portions 11 of the squeegee supporting brackets, see Figures 1 and 5. The rods 121 are moved upwardly by spring means arranged in the cylinders 120.

Rotation of the screw 97 is effected by a reversible motor 150 operatively connected to the screw by means of a belt 151 trained over a pulley 152 mounted on one end of the shaft 95. The motor 150 is mounted on the framework below the top member 20 which is apertured

at 154 to permit the drive belt to extend upwardly to the pulley 152.

The shaft 95 is provided on the opposite end to the pulley 152 with a pinion 156 arranged in mesh with a gear 157 journaled upon a stud 158 carried by the end plate 26. The gear 157 has associated with it a pinion 160 arranged in mesh with a gear 161 mounted upon a stud 162 also carried by the end plate 26. The gear 161 has associated with it a cam disk 163 provided with a cam lobe 164, see Figures 1, 2 and 3, and a pin 165 extending outwardly from the disk.

The cam lobe 164 is arranged to engage switch actuating members 166, 167 associated with switches 168, 169, respectively, these switches being mounted upon the end plate 26. The pin 165 is arranged to engage and depress arms 170, 171. The arm 170, when depressed, actuates switches 172, 173, and the arm 171, when depressed, actuates switches 174, 175. A stop member 180 mounted upon the base plate 24 is engaged by the pin 165 to limit rotation of the disk 163 in either direction. The arms 170, 171, are yieldingly maintained upwardly against stop pins 181 projecting from the end plate 26 by torsion springs 182, see Figure 2.

In addition to the switches 168, 169, 172—175, there are a pair of switches 182, 183, mounted on the plate 74, Figures 6 and 7. The switch 182 is mounted adjacent the upper end of the plate 74, and the switch 183 is mounted adjacent the plate 51. The switch 182 is actuated by a bar 186 carried by the member 47 for engaging the actuating element 187 of the switch when the member 47 has been elevated, see Figures 4, 7 and 10, with the work piece in printing position. The switch 183 is actuated by a rod 188 mounted at the opposite side of the member 47 for engaging the actuating element 189 of switch 183 when the member 47 has been moved to its down position.

After a work piece 46 has been positioned upon the work support 47, the machine is automatically operated through a cycle by the operator closing a push button switch 190 closing a circuit through coil 191. The fluid to the cylinder 49 is controlled by a solenoid valve 192, the coil 191, when energized, operating this valve to admit fluid in the lower end of the cylinder to effect upward movement of the work support. The valve also has a second coil 193 which, when energized, admits fluid to the upper end of the cylinder to move the work position to its lower position.

Referring to the wiring diagram Figure 11, the coil 191 is energized by closing the push button 190 connected in the secondary circuit from coil 194 of a transformer 195. The primary coil 196 of the transformer is connected across the line leads 200, 201. This effects upward movement of the work support 47, actuating the switch 182 to the on position. The switch 182 is a normally open switch, and the switch 183 is normally closed. Thus, with the switch 182 closed upon the work circuit being elevated, a circuit is completed through a control relay CR1 and a reversing relay R1, or through a control relay CR2 and a reversing relay R2. Which of these relays will be energized depends upon the position of the squeegee carriage at the start of the operation.

As previously explained above, a portion of the shaft 95 is threaded as at 97, and this threaded portion is engaged by the nut member 96 of the squeegee carriage whereby, upon rotation of the screw in one direction, the carriage is moved to the right, Figure 1, and rotation of the screw in the opposite direction effects movement of the squeegee carriage to the left. The cam actuated switches 168, 169 are normally closed switches and when actuated by the cam 165 serve to open the circuit to the driving motor 150. The gear ratio between the cam disk 163 and the shaft 95 is such that the shaft makes the necessary number of revolutions to traverse the squeegee carriage by the proper distance during substantially one revolution of the cam disk 163. That is, when the

squeegee carriage has been moved transversely of the work piece the required distance, the switch 168 or 169 will be opened momentarily. However, the coasting effect of the motor will continue to effect rotation of the screw 95 and the disk 163 until the pin 165 engages the stop 180, Figure 3, and accordingly, as the pin 165 engages the stop member either one of the arms 170, 171 will be depressed to effect actuation of the switches 172, 173, or the switches 174, 175. These four last mentioned switches have normally open contacts. The switch 173 is connected in circuit with the coil 204 of the reversing relay R1. The switch 174 is connected in circuit with the coil 205 of the reversing relay R2. Accordingly, one of the switches 173, 174 will be closed at the beginning of the operation depending upon whether the squeegee carriage has just finished its movement toward the right or toward the left.

Assuming that the switch 173 is closed and the switch 174 is opened, there is a circuit from the line lead 200 through the closed switches 183, 182, switch 173, wire 206, coil 204, switch 169, wire 207, to the line lead 201, closing the contacts of the reversing relay R1. A circuit is now established to the motor 150 to effect rotation of the screw 95 and rotation of the disk 163 in a clockwise direction, Figure 3, moving the pin 165 away from the stop 180 and permitting the switch actuating arm 170 to move upwardly about its pivot. This circuit extends from wire 208 connected between the switches 183, 182, through contacts 209, 210 and 211, wire 212, to the motor. A second circuit is established through wire 213 extending from wire 208 directly to the motor. The motor coils are connected to the opposite lead 201, through wire 214, contacts 215, 216, 217, wire 218, and through wire 220, contacts 221, 223 and 224, to wire 218, thence to the lead wire 201, causing the motor to rotate the cam disk 163 in a clockwise direction, as previously stated.

The control relay CR1 is provided with a movable contact 226 arranged to overlap pairs of contacts 227, 228 and 229, 230. A circuit is also provided to the coil 231 of the relay CR1 through wire 232, contacts 227, 226, 228, wire 234, relay coil 231, wire 235, to the lead 201. In the diagram Figure 11, the various contacts of the relays move upwardly when the respective relay coils are energized. Accordingly, when the overlapping contact 226 moves upwardly into engagement with the contacts 229, 230, a holding circuit for the coil 231 is provided through these contacts and wires 236, 237. There is also provided a holding circuit for the reversing relay R1 through wire 240, contacts 241, 242 and 243 and wires 244, 206. It will be observed that the wire 240 is connected intermediate the switches 182, 173. Upon the initial movement of the cam disk 163, the switch 173 is opened. However, the holding circuits for both of these relays R1 and CR1 is taken from the wire 240, whereby the relays will remain energized until the switch 182 is opened.

With the work circuit thus far described, the work support has been moved to its up position and the squeegee carriage is being moved transversely by the screw 97. The next step in the operation of the apparatus is to move one of the squeegees 85, 86, downwardly into engagement with the screen. If the carriage is being moved to the right, Figures 8 and 10, the squeegee 85 will be moved downwardly. As previously explained, the squeegees are operated by the fluid cylinder and piston structures 120, and the fluid to these cylinder structures is controlled by solenoid operated valves 250, 251, which are operated by coils 252, 253, respectively, and which are energized respectively by the control relays CR1, CR2. With the control relay CR1 energized, a circuit is completed to the coil 252 of valve 250, through wires 208, 256, contacts 257, 258, 259, wire 260, coil 252, wire 261, to wire 201. Thus the squeegee is moved downwardly into engagement with the printing screen prior to the time the squeegee is moved into registration with the work piece 46.

During the transverse movement of the squeegee carriage and rotation of the disk 163, the cam member 164 momentarily opened switch 168. However, this was of no moment because the coil 205 of the reversing relay R2 was not energized. When the squeegee has been moved transversely of the work piece and a distance therebeyond, the cam 164 opens switch 169. This deenergizes the reversing relay R1, opening the circuit to the motor 150. As previously stated, the coasting of the motor will continue to effect rotation of the disk 163 until the pin 165 engages the stop member 180. Just prior to this, the arm 171 has been depressed, closing the switches 175, 174. The closing of switch 175 establishes a circuit to the operating coil 193 of the valve 192, causing this valve to admit air to the upper end of the cylinder 49 and move the work support 47 downwardly, this circuit being established from the side 270 of the secondary circuit of transformer 195, through wire 271, switch 175, wire 272, contacts 273, 274, 275, of the control relay CR1, which is still energized, wire 276, coil 193, to the opposite side 277 of the transformer secondary circuit. This completes one cycle of operation with the switch 174 maintained in closed position and with the squeegee carriage having been moved transversely, say to the right, as shown in Figures 8 and 10.

Upon downward movement of the work support 47, the switch 182 is opened, thus breaking the holding circuit for the control relay CR1 through its holding contacts 226, 229, 230, and when the work support 47 reaches its bottom position, the switch 183 is opened, breaking the circuit through the coil 252 of valve 250, effecting upward movement of the squeegee 85. The operator then removes the printed work piece 46 and places a new work piece in the support 47. Upon actuating the push button 190, the cycle of operation will be repeated. However, in this instance, the reversing relay R2 is energized upon the work support 47 moving to its up position, this because the switch 174 is in closed position, this circuit being established from wire 240, switch 174, wire 280, coil 205 of relay R2, wire 281, switch 168, to the opposite lead 201 of the supply circuit. The arrangement of the relay R2 is the same as that of the reversing relay R1.

A holding circuit for R2 is provided through its contacts 284, 285, 286, wire 287. The operating reverse circuit to the motor 150 is established through wire 290 connected to the wire 208, and through wire 291 connected through the closed contacts 292, 293, 294, of the relay R2, wire 295, to the wire 208. The return circuit to the wire 201 is completed by wire 296, contacts 297, 298, 299, wire 300, and also through contacts 301, 302, 303 and wire 304.

The control relay CR2 is in like manner energized from the wire 240 through the switch 174, wire 306, contacts 307, 308, bridged by the overlapping contact 309, wire 310, coil 311 of the relay, and wire 312, to the side 201 of the circuit. The control relay CR2 is of the same arrangement as the control relay CR1, the bridging contact 309 closing a holding circuit through wire 312, contacts 313, 309, 314, wire 310, to the coil. Also, the operating coil 253 for the squeegee control valve 251, associated with the cylinder structure 120 of the squeegee 86, is energized by a circuit extending from wire 208, wire 320, contacts 321, 322, 323, wire 324, coil 253, to the side 201, whereby the squeegee 86 is lowered into engagement with the print screen 28 and is moved transversely to the left, Figures 8 and 10, cross the work piece 46, this movement being terminated by the cam piece 164 opening the switch 168 which is connected in circuit for the coil 205 of the reversing relay R2 whereby, this relay is deenergized and subsequently the switches 172, 173, are closed, the switch 172 establishing a circuit from wire 270, through wire 330, switch 172, wire 331, contacts 332, 334, 335, wire 336, to the coil 193 to

effect downward movement of the work support 47, as previously described.

The apparatus operates automatically through a cycle to print the work piece with precision. The ink or print mix is forced uniformly through the porous or penetrable portion of the stencil or screen by the uniform speed of the movement of the squeegees transversely over the work piece and by the uniform predetermined pressure of the squeegees against the screen, this pressure being effected by the fluid operated cylinder and piston structures whereby the squeegees are yieldingly maintained against the screen with the desired pressure.

The squeegee assembly provides for the quick and convenient removal of the squeegees and their supporting plates, this being accomplished by swinging the bar 128 out of engagement with the piston rods 121 and lifting the assembly of plates 98, 100, off from the guide pins 102. The entire squeegee structure is movable about the axis of the screw 97 to permit convenient application of the ink mix to the screen, or to permit removal and replacement of the screen. The forward portion of the squeegee plate 87 is yieldingly maintained on the rail 88 by a latch member 350, see Figure 4, fixed to a stem 351 journaled in a block 352 secured to the under side of the plate 87. The upper end of the stem has a knob 353. The latch 350 is normally maintained against the under sides of the block and the rail 88 by a spring 354 encircling the upper portion of the stem and acting between or against the plate 87 and the knob 353. The latch is formed with a rib 355 engaging the side of the block 352 to prevent undesired rotation of the stem and latch out of engagement with the rail 88. When it is desired to swing the squeegee structure upwardly about the axis of the screw 97, the knob 353 is depressed and rotated to swing the latch out from under the rail 88.

The plate 87 is provided with screws 357 engaging the top surface of the rail and provide an adjustment to limit the amount of play or movement of the plate relative to the rail. This prevents excessive movement of the carriage about the axis of the screw when the rotation of the screw is reversed, all of which tends to a smoother operation of the squeegee structure.

It will also be observed that the squeegee assembly, consisting of the pair of squeegee supports and their fluid operating motors, can be conveniently removed from the plate 87 by simply removing the nuts 140. As previously explained, the squeegees are self-aligning with the screen because of the pivotal mounting of the plate 98 on screws 118. The work support can be adjusted into exact parallelism with the screen by the use of shims between the plate 51 and the washer 55, Figure 7.

The pulley 152 is part of a torque limiting clutch which may be adjusted by nut 360 and which functions to prevent undue strain on the gearing operating the cam disk 163 upon the pin 165 engaging the stop member 180 while the motor is still coasting.

What I claim is:

1. A screen printing apparatus comprising a frame, a print screen positioned horizontally in the frame under tension, a work support for positioning a work piece below and in proximity to the screen, a carriage mounted in the frame for horizontal reciprocation transversely of the screen, a pair of squeegees mounted on the carriage for independent vertical movement into and out of engagement with the screen, motion transmitting means operable to effect reciprocation of the carriage, a fluid operated motor connected to each of said squeegees, a supply of fluid under pressure, said motors being operable when connected to said fluid supply to move said squeegees downwardly into engagement with the screen and to press the screen against the work piece, valve means operable to connect one of said motors to the fluid supply upon movement of the carriage in one direction, and to connect the other motor to said supply upon movement of the carriage in the opposite direction.

2. A screen printing apparatus comprising a frame, a screen, a work support for positioning a work piece in close proximity to the under side of said screen, a carriage mounted in the frame above the screen for movement transversely thereof, a squeegee mounted on the carriage for vertical movement into and out of engagement with the screen, and a fluid operated cylinder and piston structure mounted on the carriage and operable to move said squeegee into engagement with the screen and yieldingly maintain said squeegee against the screen under uniform predetermined pressure.

3. A screen printing apparatus comprising a frame, a print screen, a work support for positioning a work piece in close proximity to the under side of the screen, a carriage slidably mounted in the frame above the screen for movement transversely of the work piece, a squeegee mounted on the carriage for vertical movement into and out of engagement with the screen, a fluid operated motor mounted on the carriage and operable to move the squeegee into engagement with the screen.

4. A screen printing apparatus comprising a frame, a screen positioned horizontally and under tension in the frame, a work support for positioning a work piece in close proximity to the under side of the screen, a carriage slidably mounted in the frame above the screen for movement transversely of the work piece, a squeegee support detachably mounted on the carriage for movement toward and from the screen, a squeegee mounted on said support, a fluid operated motor mounted on said carriage and operable to move said support toward the screen and the squeegee carried by the support into engagement with the screen.

5. A screen printing apparatus as defined in claim 4 wherein the fluid operated motor is detachably connected to the squeegee support.

6. A screen printing apparatus comprising a frame, a print screen mounted horizontally in the frame and being under tension, means for positioning a work support in close proximity to the under side of the screen, a carriage mounted in the frame for movement transversely of the work piece and parallel to the screen, said carriage having guideways extending perpendicular to said screen, a squeegee support mounted on said guideways for vertical movement toward and from the screen, a fluid operated motor mounted on the carriage, means detachably connecting said support to said motor, said motor being operable to effect vertical movement of said support and a squeegee carried by the support.

7. A screen printing apparatus comprising a frame, a print screen mounted under tension in the frame and extending horizontally, a work support for positioning a work piece below and in proximity to the screen, a carriage, a squeegee assembly mounted in the carriage, said assembly comprising a pair of squeegee supports, a squeegee carried by each support, said supports being individually movable vertically to effect movement of the squeegees carried thereby into and out of engagement with the screen, a fluid operated motor connected to each of said squeegee supports for effecting vertical movement thereof, and means detachably securing said assembly to the carriage.

8. A screen printing apparatus comprising a frame, a print screen mounted horizontally in the frame, a work support for positioning a work piece below and in proximity to the screen, a pair of guide members fixedly mounted in the frame above the screen and extending transversely thereof, a squeegee carriage slidably mounted on said guide members, a squeegee mounted on the carriage intermediate said guideways for movement into and out of engagement with the screen, means operable to move said carriage along said guide members and move the squeegee into engagement with the screen, said carriage being movable about one of said guide members

toward and from the screen, and means mounted on the carriage for disconnecting the same from said other guide member.

9. A screen printing apparatus comprising a frame, a print screen mounted horizontally under tension, a work support for positioning a work piece below and in proximity to the screen, a pair of elongated guide members mounted in the frame and extending above and parallel to the screen, a carriage slidably mounted on said guide members and a squeegee mounted on the carriage for vertical movement into and out of engagement with the screen, power means mounted on the carriage and operable to effect vertical movement of the squeegee, power means operable to effect reciprocation of the carriage along said guide members, said carriage being movable about the axis of one of said guide members, and means carried by the carriage for detachably engaging said other guide member.

10. A screen printing apparatus as defined in claim 9 wherein the guide member about which said carriage is movable consists of a screw operable to effect movement of the carriage along said guide members.

11. A screen printing apparatus comprising a frame, a print screen mounted horizontally in the frame, a work support mounted for vertical movement below the screen for positioning a work piece below and in close proximity to the screen, a screw and a guide rail extending in parallel spaced apart relation above the screen and parallel thereto, a carriage journaled on said screw and slidably engaging said guide rail, said carriage having a nut portion threadedly engaging the screw whereby, upon rotation of the screw, movement is imparted to the carriage, a squeegee assembly mounted on the carriage, said assembly including a squeegee support movable vertically toward and from the screen, a squeegee carried by said support and power operated means operable to move said squeegee support toward and from the screen, and releasable means on said carriage cooperable with said guide rail to restrain movement of the carriage about the axis of the screw.

12. A screen printing apparatus comprising a frame, a screen positioned horizontally and under tension in the frame, a work support for positioning a work piece in close proximity to the under side of the screen, a screw journaled in the frame and extending parallel to the screen above the same, a guide member mounted in the frame in spaced horizontal relation to said screw and extending parallel therewith, a carriage slidably mounted on said screw and having a portion slidably engaging said guide rail, a nut member fixed to the carriage and engaging said screw whereby, upon rotation of said screw, said carriage is moved horizontally in parallel spaced relation to said screen, a squeegee unit detachably mounted on the carriage intermediate said screw and guide rail, said unit including a pair of squeegees and a pair of fluid operated motors for effecting independent vertical movement of said squeegees into and out of engagement with said screen.

13. A screen printing apparatus as defined in claim 12 wherein said fluid operated motors are detachably connected to said squeegees respectively, and said squeegees are independently removable from said unit.

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