Dec. 27, 1960 E. G. ARELT 2,966,115

SCREEN PRINTING APPARATUS

Filed May 4, 1959

14 Sheets-Sheet 1

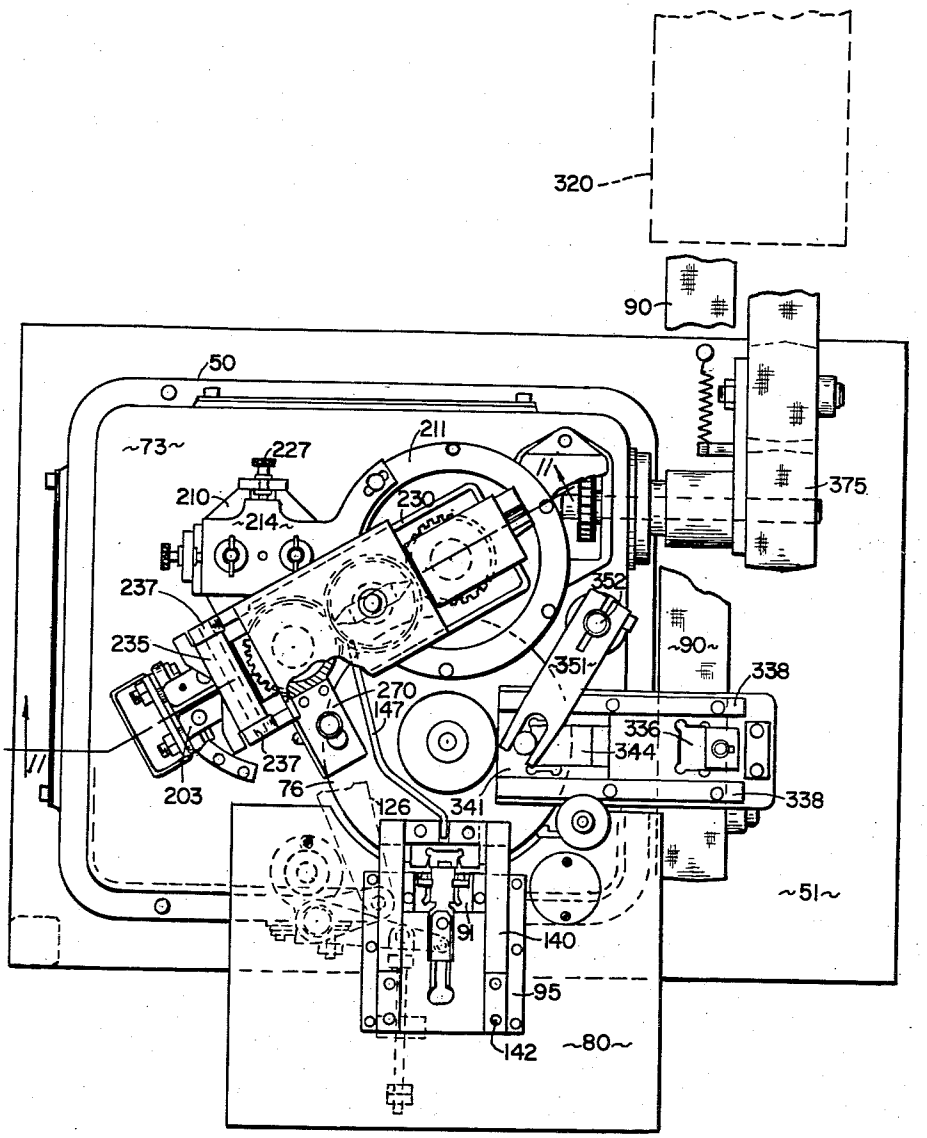


FIG-1

INVENTOR.
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D. Emmett Thompson

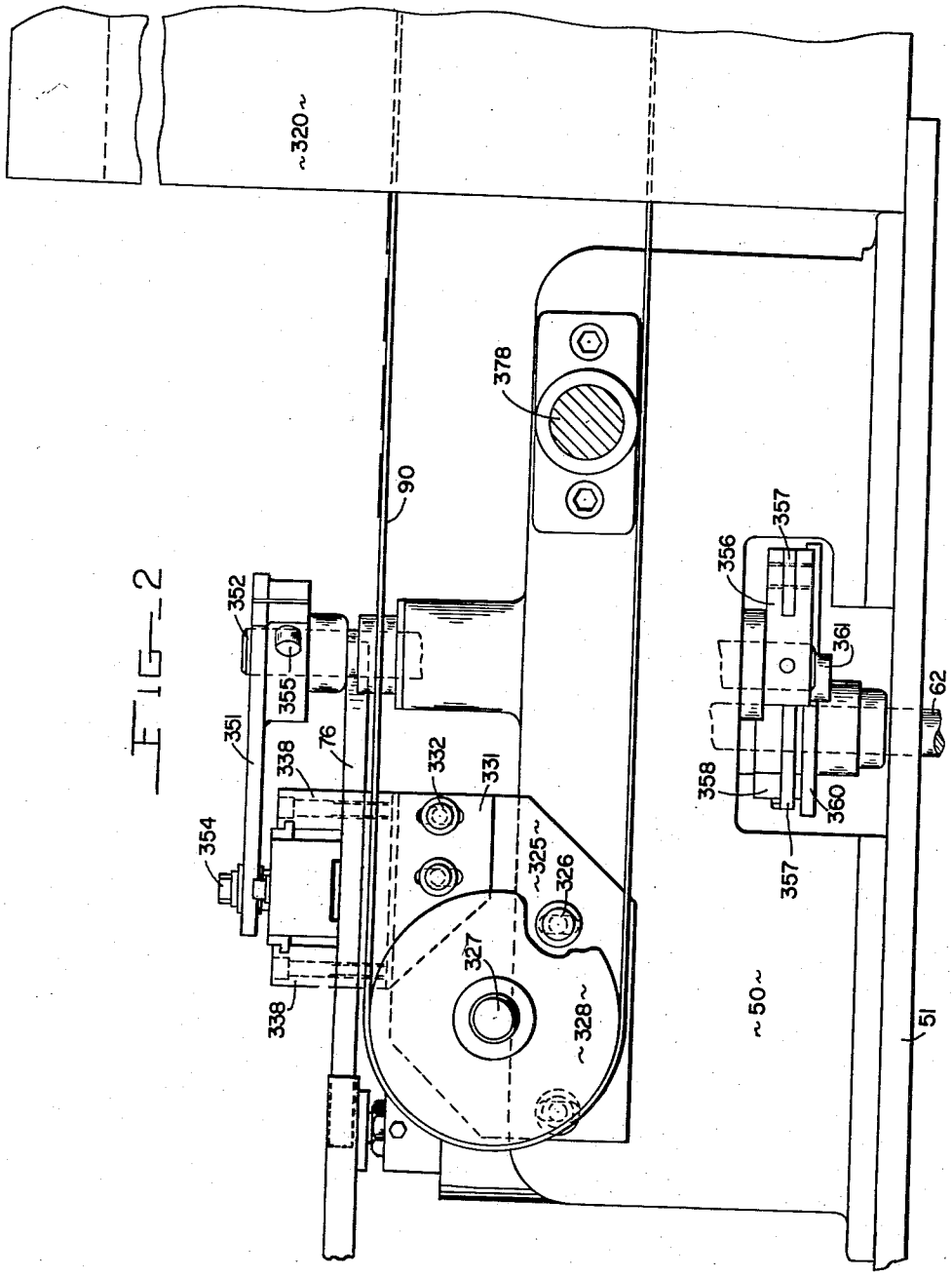
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SCREEN PRINTING APPARATUS

Filed May 4, 1959 14 Sheets-Sheet 2

FIG. 2



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SCREEN PRINTING APPARATUS

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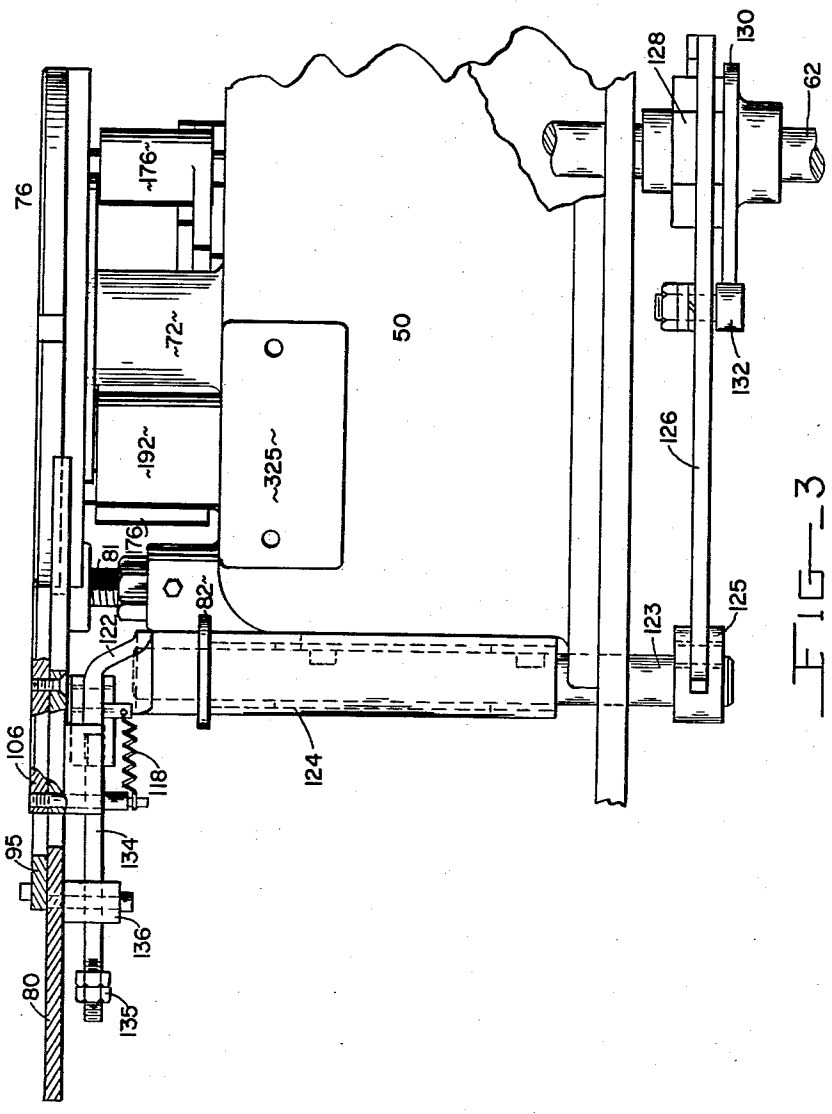


FIG. 3

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Dec. 27, 1960 E. G. ARELT 2,966,115

SCREEN PRINTING APPARATUS

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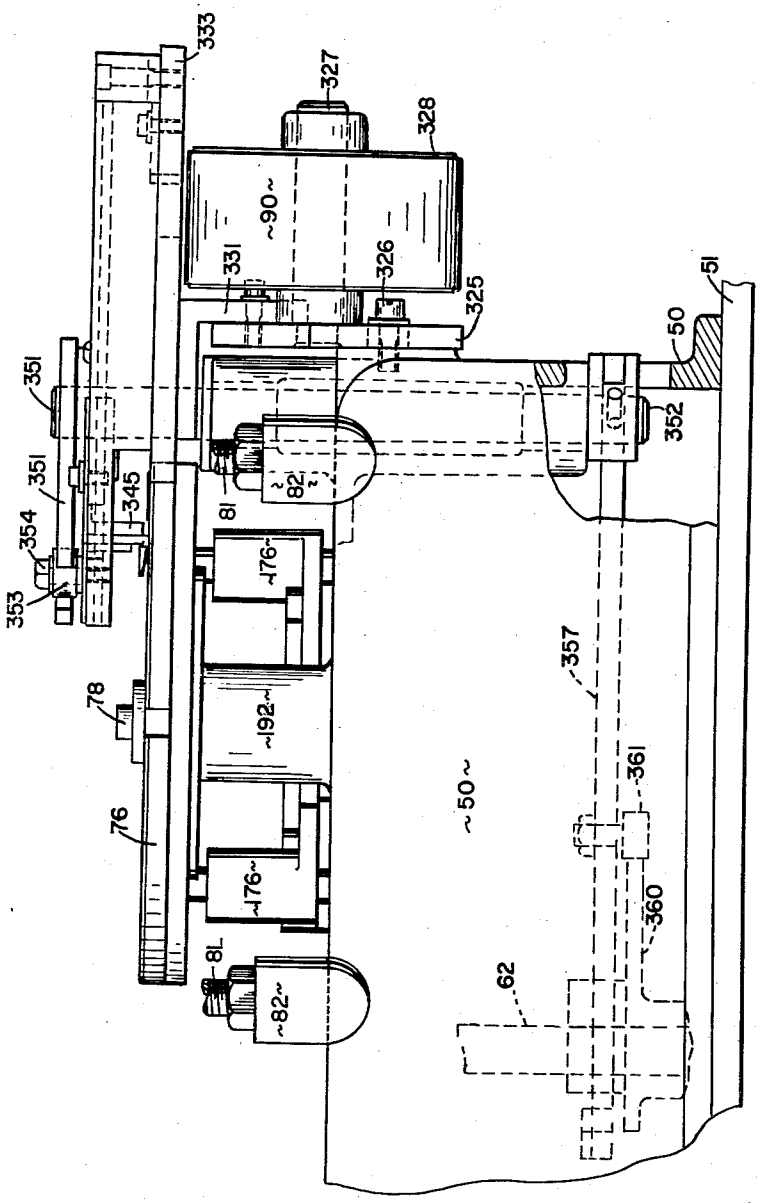


FIG-4

INVENTOR.
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Dec. 27, 1960 E. G. ARELT 2,966,115

SCREEN PRINTING APPARATUS

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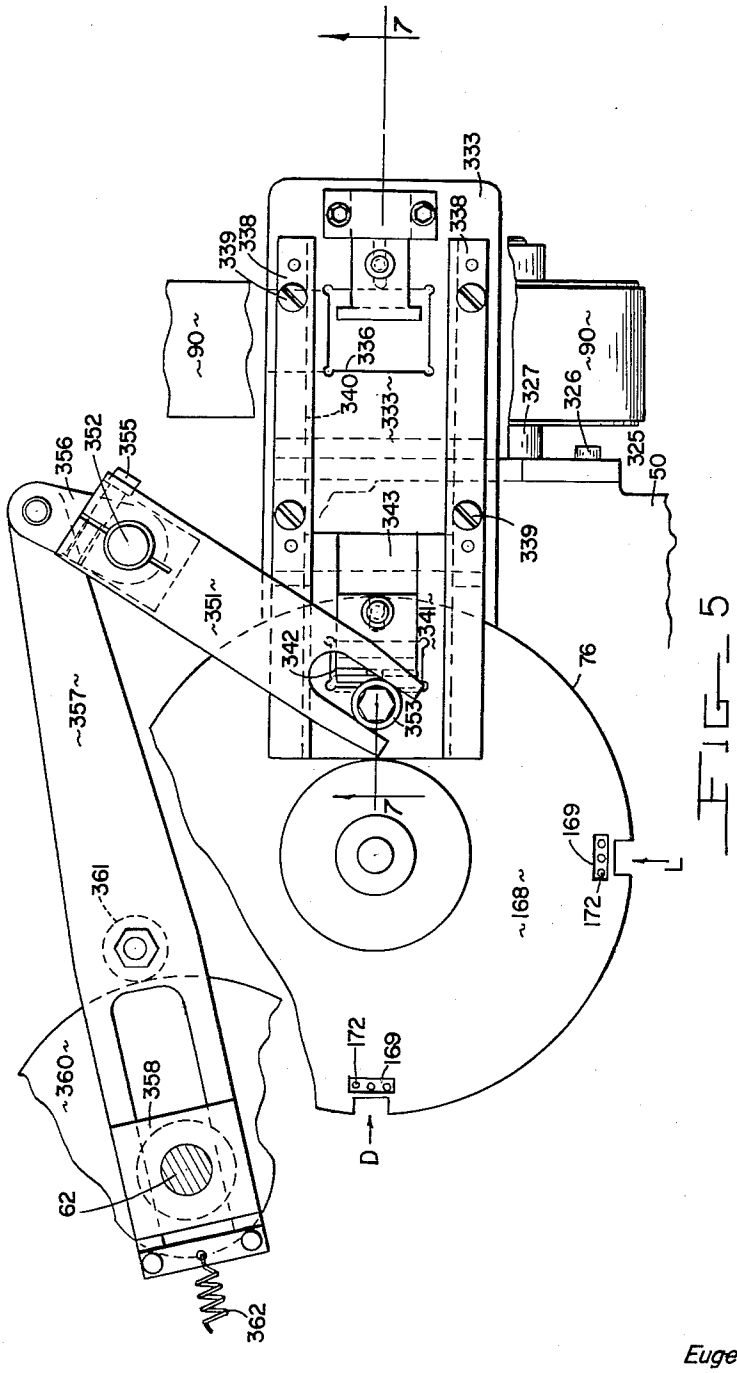


FIG. 5

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Dec. 27, 1960 E. G. ARELT 2,966,115

SCREEN PRINTING APPARATUS

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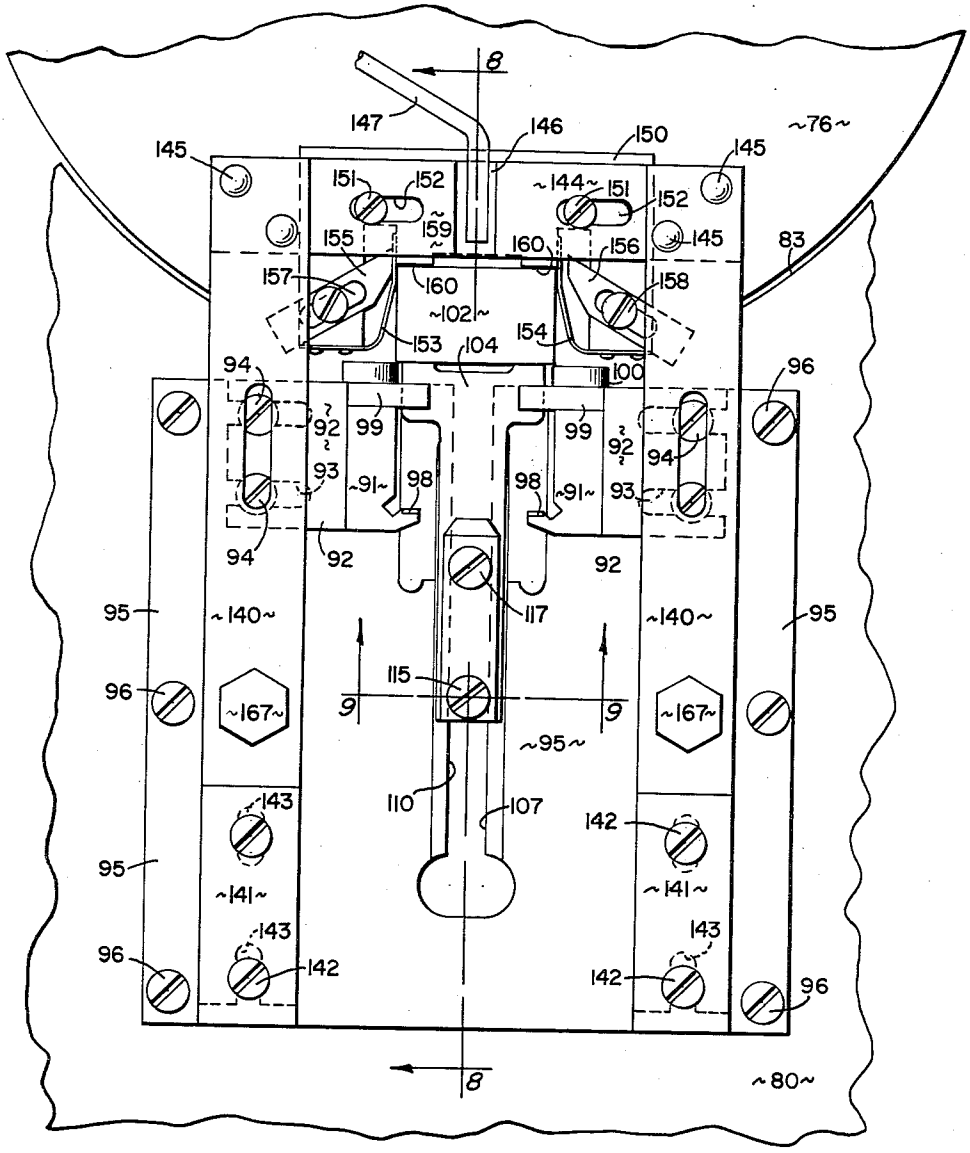


FIG. 6

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Dec. 27, 1960 E. G. ARELT 2,966,115

SCREEN PRINTING APPARATUS

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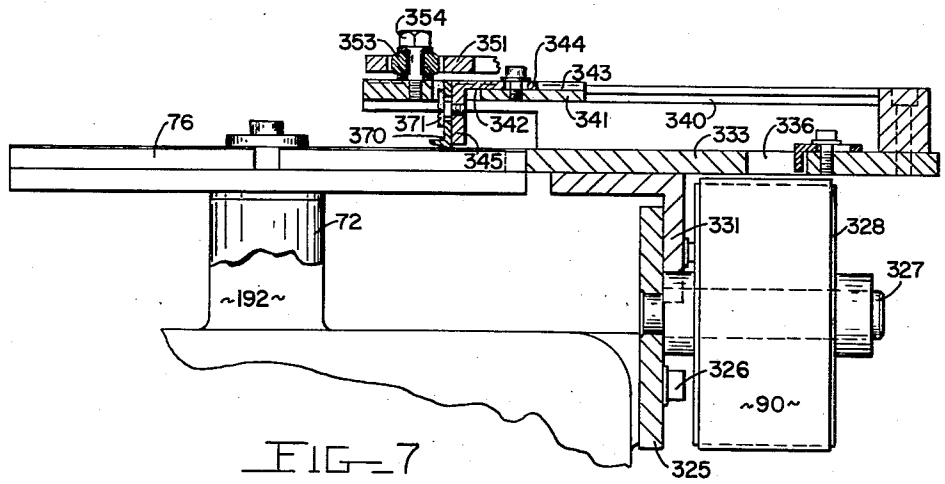
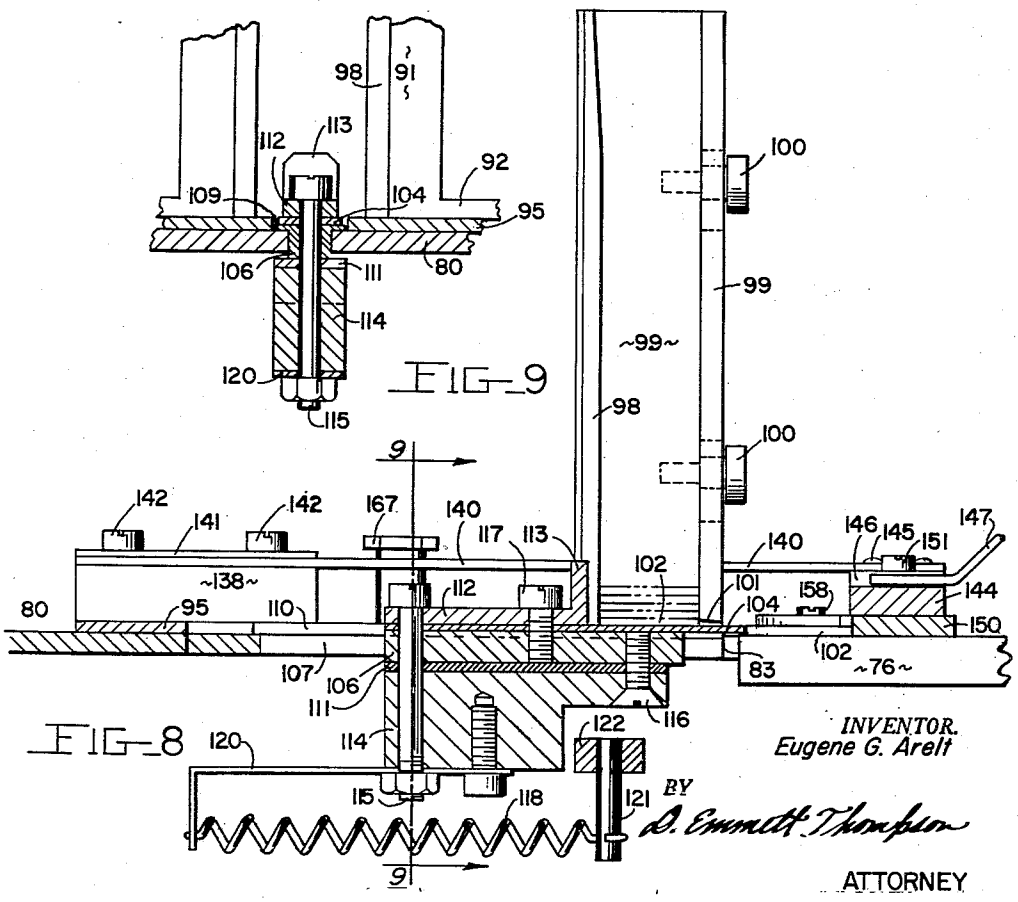


FIG-7



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Dec. 27, 1960 E. G. ARELT 2,966,115

SCREEN PRINTING APPARATUS

Filed May 4, 1959 14 Sheets-Sheet 8

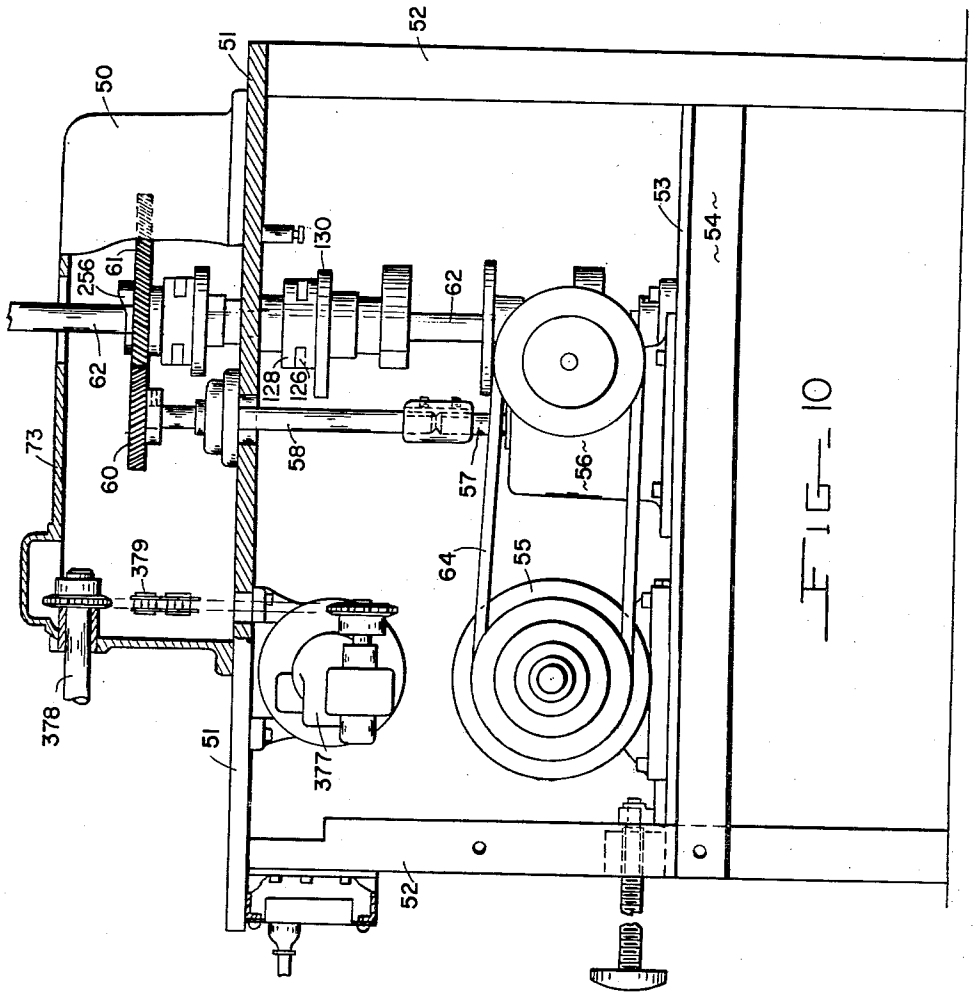


FIG. 10

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Dec. 27, 1960 E. G. ARELT 2,966,115

SCREEN PRINTING APPARATUS

Filed May 4, 1959 14 Sheets-Sheet 9

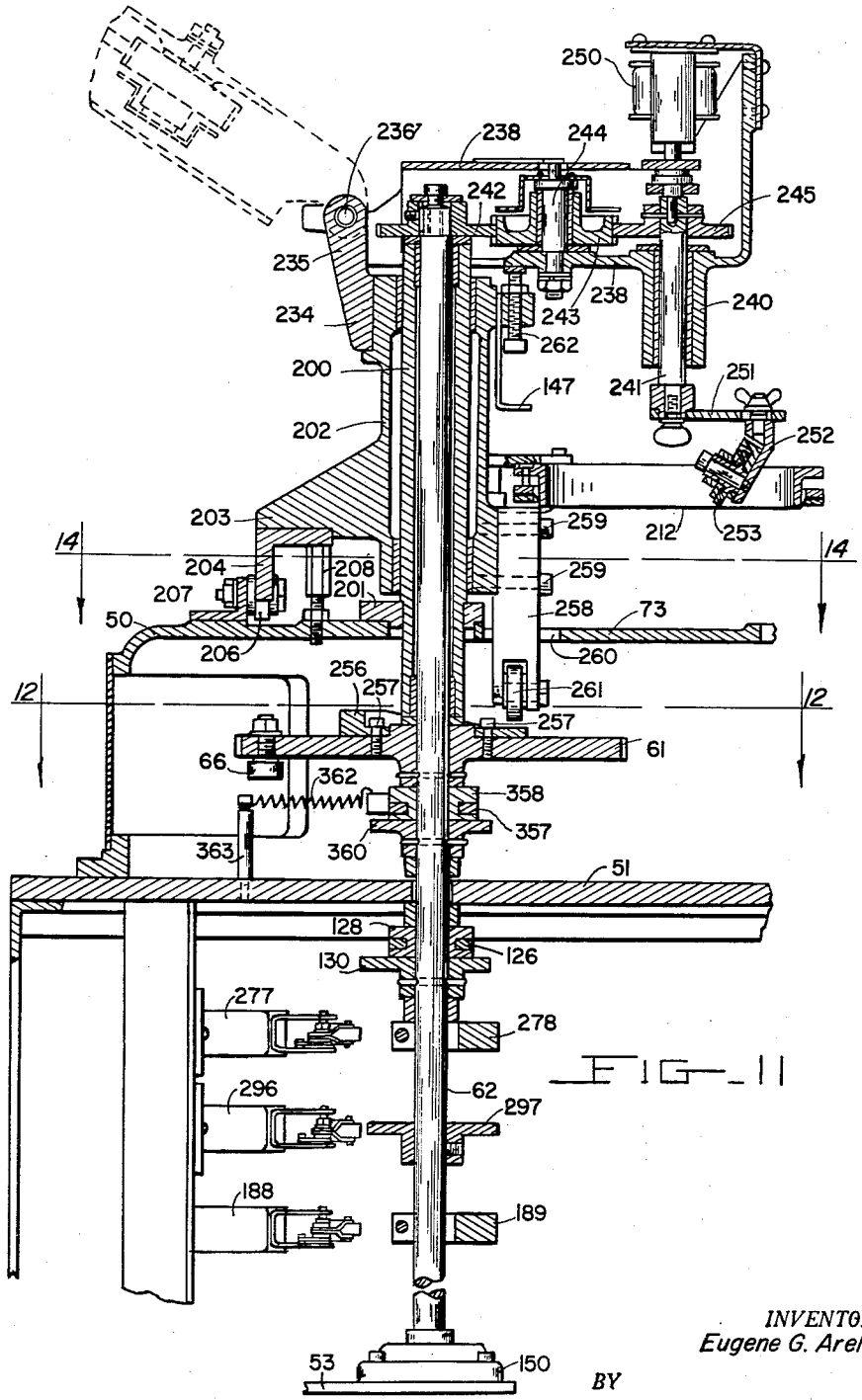


FIG. 11

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Dec. 27, 1960 E. G. ARELT 2,966,115

SCREEN PRINTING APPARATUS

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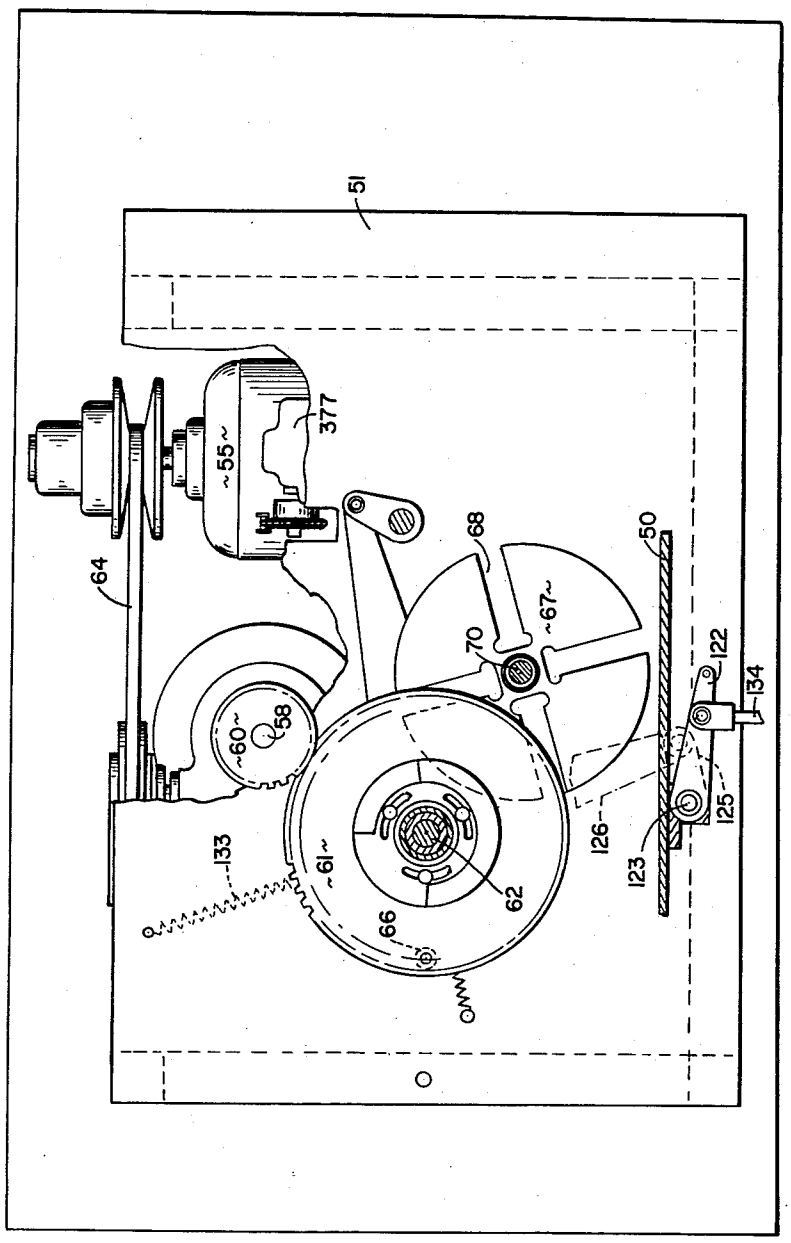


FIG. 12

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Dec. 27, 1960 E. G. ARELT 2,966,115

SCREEN PRINTING APPARATUS

Filed May 4, 1959 14 Sheets-Sheet 11

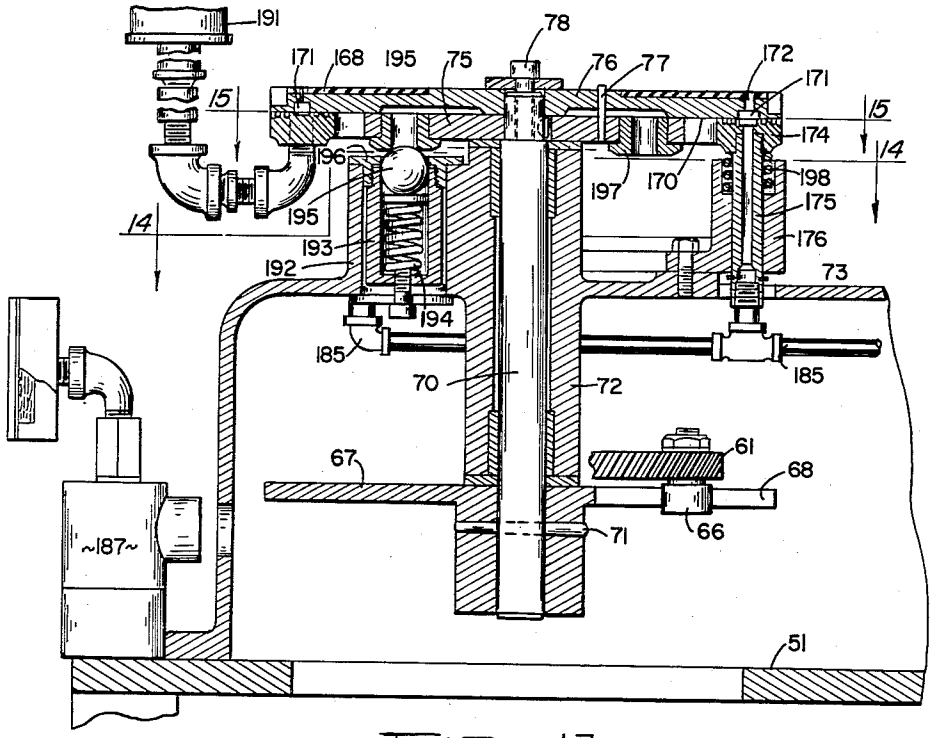


FIG_13

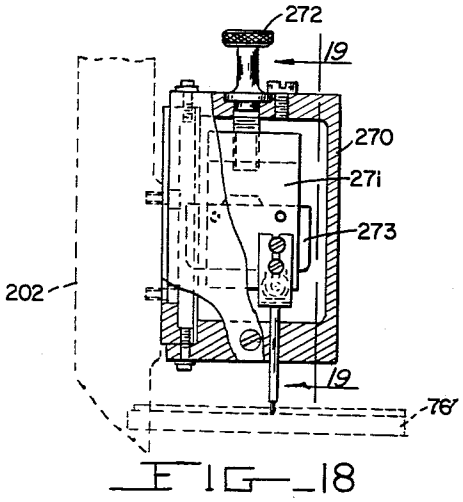


FIG_18

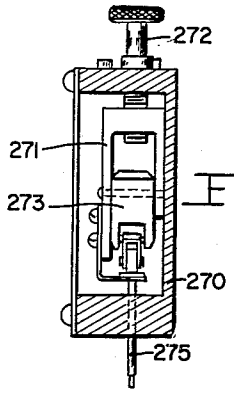


FIG_19

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Dec. 27, 1960 E. G. ARELT 2,966,115

SCREEN PRINTING APPARATUS

Filed May 4, 1959 14 Sheets-Sheet 12

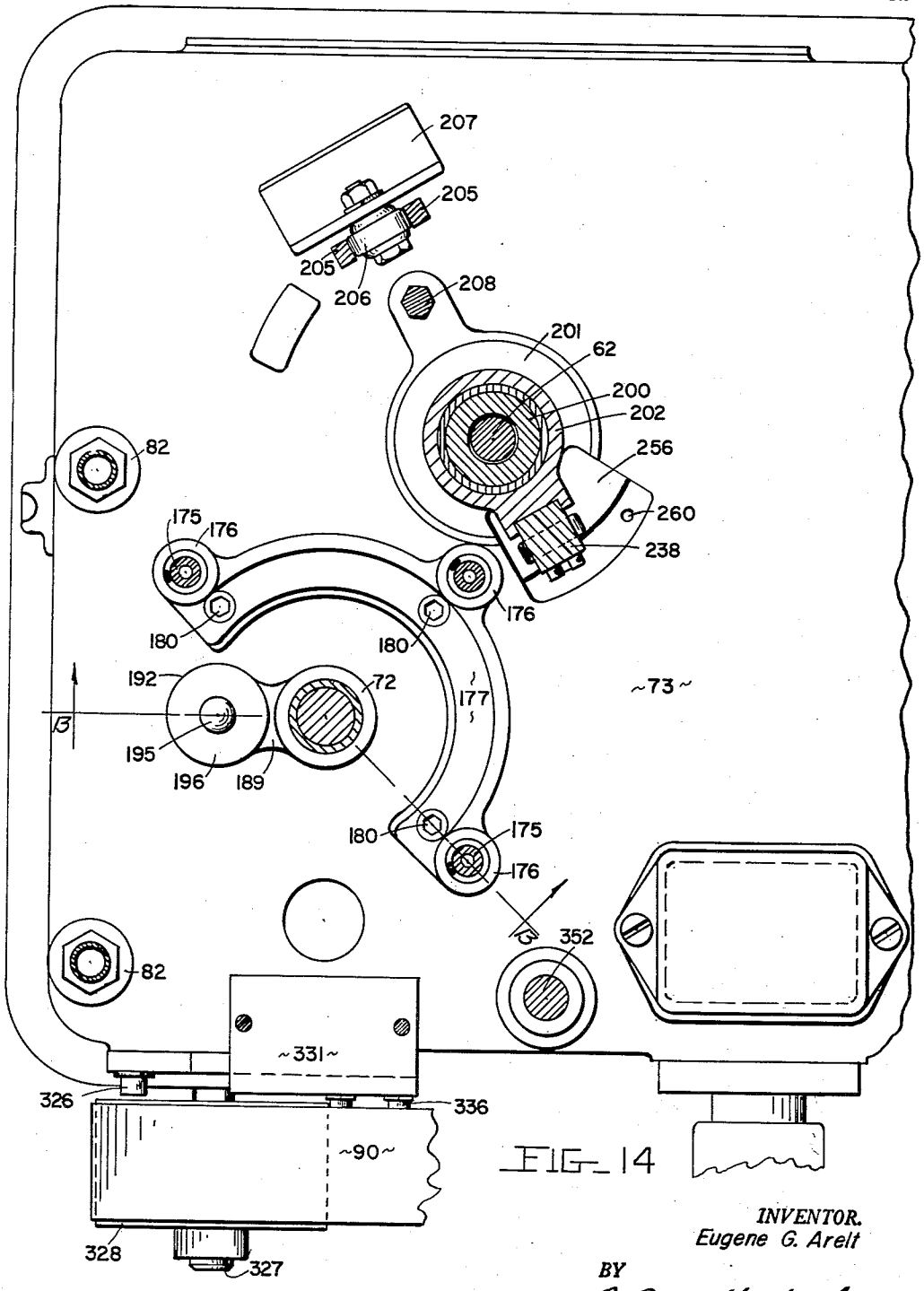


FIG. 14

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Dec. 27, 1960 E. G. ARELT 2,966,115

SCREEN PRINTING APPARATUS

Filed May 4, 1959 14 Sheets-Sheet 13

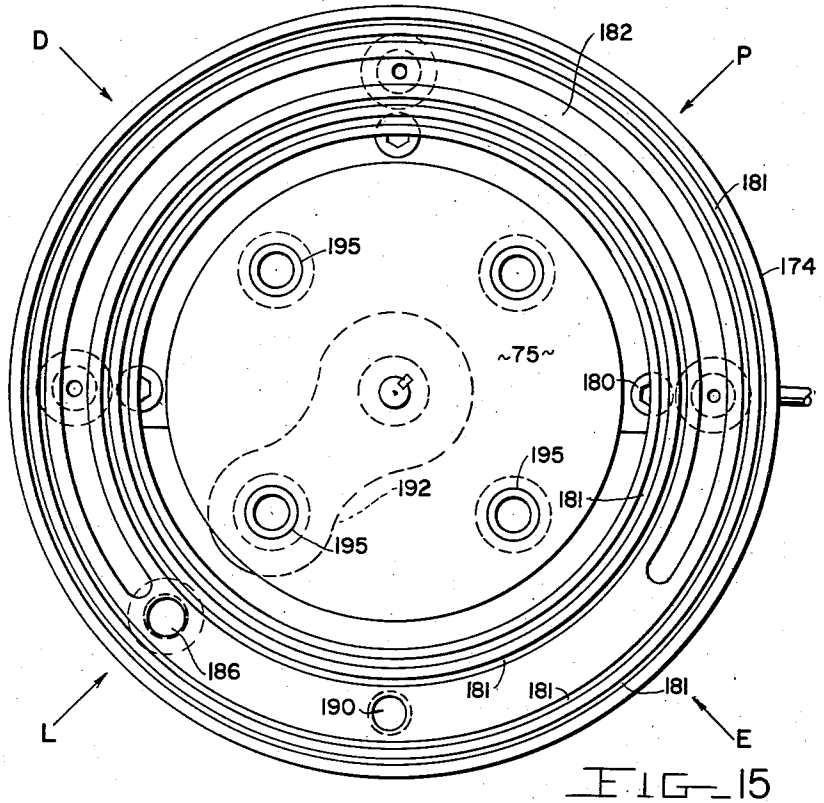


FIG. 15

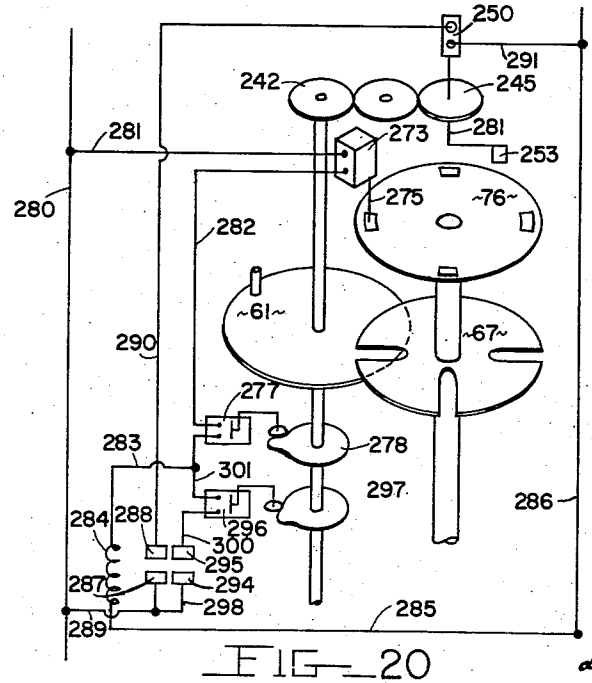


FIG. 20

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Dec. 27, 1960 E. G. ARELT 2,966,115

SCREEN PRINTING APPARATUS

Filed May 4, 1959 14 Sheets-Sheet 14

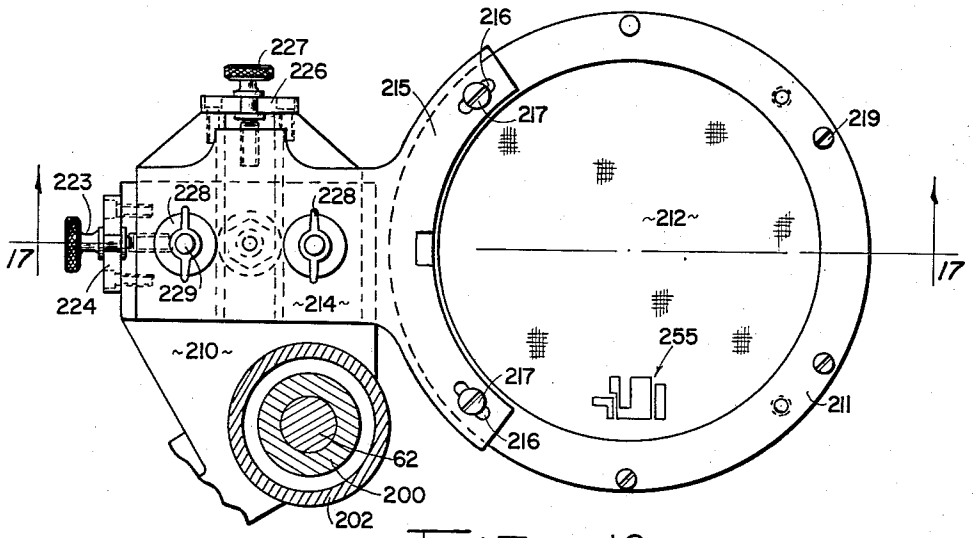


FIG. 16

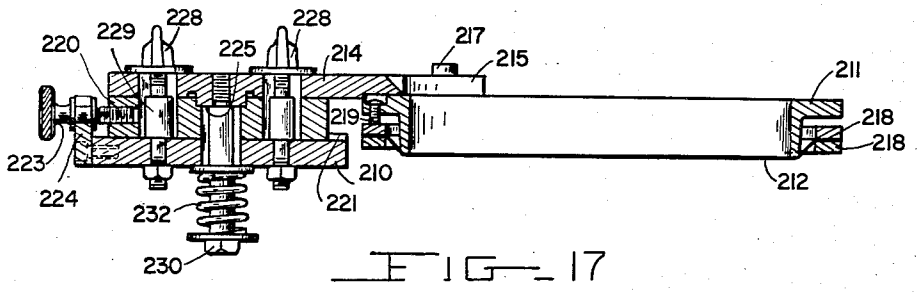


FIG. 17

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United States Patent Office

2,966,115

Patented Dec. 27, 1960

2,966,115

SCREEN PRINTING APPARATUS

Eugene G. Arelt, Baldwinsville, N.Y., assignor, by mesne assignments, to Speer Carbon Company, St. Marys, Pa., a corporation of New York

Filed May 4, 1959, Ser. No. 810,910

10 Claims. (Cl. 101—126)

This invention relates to screen printing apparatus, and has as an object apparatus for automatically applying a print design to work pieces at high speed. The machine is intended particularly for screen printing small plates formed of ceramic material in connection with the manufacture of components such as capacitors for electronic circuits. In this instance, the work pieces consist of fragile ceramic plates having a width and length measurement in the order of one inch or less, and a thickness in the neighborhood of .020 of an inch.

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.

In the drawings—

Figure 1 is a top plan view of a screen printing apparatus embodying my invention.

Figure 2 is a side elevational view looking to the left, Figure 1, of the base housing with the in-feed and printing mechanisms omitted.

Figure 3 is a partial side elevational view of the base housing with the work piece ejecting mechanism shown in Figure 2 omitted, and showing a portion of the in-feed mechanism in section.

Figure 4 is a front elevational view of the base housing and ejecting mechanism, the in-feed mechanism being removed.

Figure 5 is a top plan view of the work piece ejecting mechanism and the linkage for operating the same.

Figure 6 is an enlarged top plan view of the magazine and in-feed mechanism.

Figure 7 is a sectional view of the work piece ejecting mechanism taken on line 7—7, Figure 5.

Figure 8 is a sectional view of the work piece in-feed mechanism taken on line 8—8, Figure 6.

Figure 9 is a fragmentary sectional view taken on line 9—9, Figure 6.

Figure 10 is a rear elevational view of the frame and base housing with parts in section.

Figure 11 is a vertical sectional view taken on line 11—11, Figure 1.

Figure 12 is a view taken on a line corresponding to line 12—12, Figure 11.

Figure 13 is a sectional view taken on a line corresponding to line 13—13, Figure 14.

Figure 14 is a view taken on line 14—14, Figure 13.

Figure 15 is a view taken on line 15—15, Figure 13.

Figure 16 is a top plan view of the structure for supporting the print screen.

Figure 17 is a view taken on line 17—17, Figure 16.

Figure 18 is a view, partially in elevation and partially in section, of the work piece detecting mechanism.

Figure 19 is a view taken on line 19—19, Figure 18.

Figure 20 is a schematic wiring diagram of that portion of the circuity having to do with determining the presence or absence of a work piece on the turret.

The apparatus of my invention consists of a suitable framework in which there is journalled a turret for rotation about a vertical axis. A magazine is provided for containing a multiplicity of the work pieces, and a work piece feed mechanism is provided for successively feeding work pieces from the magazine to the turret. The turret is intermittently indexed to advance the work piece from the loading station to a detecting station to determine the presence or absence of a work piece on the turret and thence to a print station where the work pieces are screen printed. The next indexing movement of the turret advances the printed work piece to an ejection station where the printed work piece is removed from the turret.

More particularly, the machine includes various structural features directed particularly to the handling of the small fragile ceramic work pieces.

The framework is in the form of a box-like housing 50, mounted upon a table top 51, supported by leg members 52. A shelf 53 is supported below the table top 51 by cross pieces 54. A drive motor 55 is mounted upon the shelf, as is also a reduction gear box 56. The gear box has an output shaft 57, connected to a driven shaft 58 journalled vertically in the framework and provided at its upper end with a gear 60 arranged in mesh with a gear 61 fixedly secured to a shaft 62, also journalled vertically in the frame and extending upwardly through the housing 50. The motor 55 is operatively connected to the gear box 56 by a belt 64. The gear 61 carries a roller 66 on its under side for cooperation with a Geneva disk 67, the roller moving into and out of four slots 68 formed in the disk 67 to effect an indexing movement of 90° of the disk for each revolution of the gear 61. The Geneva disk 67 is secured to the lower end of a shaft 70, as by a pin 71. The shaft is journalled vertically in a hub 72 formed in the top wall 73 of the housing 50. A disk 75 is keyed to the upper end of the shaft 70. A turret table 76 is positioned upon the disk 75 and is connected to the disk by a pin 77. The turret is held against the disk by a screw 78 threading into the end of the shaft 70, all whereby the disk 75 and the turret 76 are rotated in unison by the shaft 70.

A table 80 is supported by studs 81 extending into bosses 82 formed in the top wall 73 of the housing 50 at the forward edge thereof. The inner edge 83 of the table 80 is formed on a curvature complemental to the turret 76, the top surface of the table 80 being coplanar with the top surface of the turret. A magazine for supporting a stack of work pieces is mounted upon the table 80, and mechanism is provided for feeding the lowermost work piece in the stack onto the turret 76 during the dwell period thereof. The turret is indexed in a clockwise direction, Figure 1, to move the work piece positioned on the turret to a checking or detector station D, where the work piece is engaged by a probe 275, the purpose of which is to ascertain whether or not a work piece has been fed from the magazine onto the turret. Upon the next indexing of the turret, the work piece if present is moved to the print station P, in registration with a print screen which is then lowered into printing position, and printing of the work piece is effected by a movement of a squeegee over the screen. Upon the next indexing movement of the table, the printed work piece is moved to an ejecting station E, where the work piece is removed from the turret and deposited upon a conveyor belt 90.

The magazine consists of a pair of side members 91 extending vertically upwardly from the table 80. These members are formed at their lower ends with lateral extensions 92 formed with slots 93 to receive screws 94 threading into a plate 95 which is fixedly secured to the table 80, as by screws 96. With this arrangement,

the magazine sides **91** may be moved toward and from each other to accommodate work pieces of various lengths. The side members are formed with extensions **98** adjacent their outer edges, and guide members **99** are secured to the inner edges of the members **91**. These guide members are formed with vertically elongated slots to receive screws **100** threading into the members **91**. The lower ends **101** of the guide **99** are inclined downwardly toward the turret **76**, the arrangement being such that the lowermost work piece **102** in the magazine will enter under the lower ends of the guide members **99**, and because of the inclined surfaces **101**, the guide members will be urged upwardly as the lowermost work piece is advanced from the magazine onto the turret **76**. This arrangement prevents the work piece next to the lowermost work piece from being fed forwardly.

The lowermost work piece in the magazine is fed forwardly by a shuttle blade **104**, mounted upon a slide **106** positioned in a slot **107** formed in the table **80**, and having laterally extending portions **109** slidable on the table **80** and confined within a slot **110** formed in the plate **95**. A plate **111** is secured to the under side of the slide **106** and overlaps the marginal surface on the under side of the table about the slot **107**. A plate **112** is positioned upon the shuttle **104** and has an inner upwardly extending portion **113**. The assembly of the parts **104**, **106**, **111**, **112**, and a depending block **114**, are secured together by a bolt **115** and screws **116**, **117**, see Figure 8. This slide mechanism is yieldingly urged inwardly, toward the turret **76**, by a tension spring **118** secured at one end to a bracket **120** affixed to the block **114**, and at its other end to a pin **121** depending from an actuating lever **122**. The lever **122** is affixed to the upper end of a shaft **123**, journalled in a bearing bracket **124**, secured to the front side of the housing **50**. An arm **125** is affixed to the lower end of the shaft **123** and is pivotally connected to a link **126**. The opposite end of the link **126** is bifurcated for sliding movement in a block **128** mounted on the shaft **62**. A cam **130** is fixedly secured to the shaft **62** immediately below the block **128**. The link **126** carries a roller **132** engaging the periphery of the cam **130**. The link **126** is yieldingly urged inwardly to maintain the roller **132** against the cam by a tension spring **133**. The arrangement is such that during the dwell of the turret **76**, the slide mechanism is urged inwardly to transfer the lowermost work piece **102** from the magazine onto the turret **76**. When no work piece is being fed by the slide, inward movement thereof is limited by a rod **134** pivotally connected at its inner end to the lever **122**. Jam nuts **135** are threaded on the outer end of the rod which is slidably mounted in a block **136** depending from the plate **80**. Inward movement of the slide **106** is limited by nuts **135** engaging block **136**.

In order that the printing may be accurately impressed upon the work piece, the lowermost work piece in the magazine, when transferred from the magazine to the turret, is accurately positioned on the turret. Blocks **138** are positioned on the plate **95**.

A leaf spring **140**, see Figures 6 and 8, is mounted on each of the blocks **138** and these springs extend inwardly over the turret **76**. A plate **141** is mounted on the outer end of each of the leaf springs **140** and this assembly is fixedly secured to the plate **95** and the table **80** by screws **142**. The leaf springs **140** are formed with elongated apertures **143** for receiving the screws **142** to provide for adjustment of the springs toward and from the turret **76**. A cross piece **144** is fixed to the inner ends of the springs **140**, as by rivets **145**. This cross member is formed with a slot **146** centrally in its upper surface to receive the end of a rod **147**. A U-shaped plate **150** is fixed to the under side of the member **144** by screws **151** extending through elongated apertures **152** formed in the member **144** and threading into the plate **150**, whereby the plate may be adjusted transversely of the spring members **140**.

Referring again to Figures 6 and 8, leaf springs **153**, **154**, are affixed to the ends of the leg of the plate **150**, the free portion of these springs extending inwardly toward the turret **76**. The leg portions of the plate **150** are formed in their upper surfaces with slots to slidably receive backing members **155**, **156**. Each of these members being formed with a lengthwise extending slot **157** to receive screws **158** threading into the legs of the plate **150**. These backing members are adjusted to bring their inner ends into engagement with the inner ends of the springs **153** to limit lateral movement of the springs in a direction away from the center line of the magazine.

The plate **150** is formed with notches **159** to permit lateral movement of the free ends of the springs. One of the backing members, as **155**, is adjusted against the contiguous spring **153**, so as to limit outward lateral movement of the spring. In this instance, the right-hand backing member **156** is adjusted in inwardly lateral spaced relation to the contiguous spring **154**. With this arrangement, when the shuttle **104** advances a work piece **102** from the magazine, the forward edge of the work piece is positioned against the shoulders **160** formed on the plate **150**. The side edges of the work piece are engaged by the springs **153**, **154**. Inasmuch as the movement of the spring **153** is limited by the backing member **155**, the left-hand forward corner of the work piece is positioned against the spring **153** and against the contiguous shoulder **160** of plate **150**, the work piece being held in this position by the spring **154**.

The work piece feeding slide is actuated inwardly by inward movement of the free end of the arm **122** and the tension spring **118**, this arrangement functioning to precisely position the work piece against the turret **76**.

During the advancement of the work piece **102** from the magazine to the turret, the plate **150** is depressed against the top surface of the turret by a rod **147** which is connected to the printing mechanism hereinafter described. During the indexing movement of the turret, the rod **147** is elevated, permitting the plate **150** to be elevated by the leaf springs **140** a distance above the turret so as not to interfere with the movement of the work piece by the turret. Upward movement of the springs **140** is limited by screws **167**.

The upper surface of the turret **76** is provided with an annular rubber covering **168**, see Figure 13. This covering **168** is formed with small rectangular apertures **169** spaced apart equally in a circumferential direction, whereby these recesses are positioned during the dwell of the turret at the stations L, D, P and E. The under surface **170** of the turret **76** is machined flat and formed adjacent the periphery of the turret with a circular groove **171**. The turret is also formed with small apertures **172** communicating with the recesses **169** and the circular groove **171**.

A vacuum ring **174**, shown in plan in Figure 15 and in section in Figure 13, is mounted below the turret and is supported by three tubular members **175**, each of which is slidably mounted in a cylindrical boss **176**. The vertically disposed bosses **176** are formed integral with an arcuate casting **177**, see Figure 14, which is affixed to the top wall **73** of the housing **50**, as by screws **180**. The vacuum ring **174** is positioned concentric with the axis of the turret. The upper surface of the ring is formed with a plurality of circumferentially extending grooves **181** which are relatively narrow and shallow. The upper surface of the ring is also formed with a centrally located groove **182**, this groove extending from a point spaced slightly from the loading station and extending through the detector station, the printing station and terminating short of the discharge station. This groove is arranged in registration with the groove **171** formed on the under surface of the turret. A source of vacuum is connected

to the hollow supporting studs 175, such connection being illustrated at 185, Figure 13. The vacuum ring 174 is formed with an aperture 186 at the loading station L. This aperture is connected to a source of vacuum through a solenoid operated valve 187 which is opened momentarily by a switch 188 operated by a cam 189 on the shaft 62. This valve 187 is opened after the work piece has been fed from the magazine to the turret at the loading station and just prior to the indexing movement of the turret, whereby the work piece is held on the turret by vacuum until connection is made to the vacuum groove 182 in the vacuum ring.

The vacuum ring 174 is also formed with an aperture 190 intermediate the loading and ejecting stations. This aperture is connected to an oiler 191. With this arrangement, the work pieces are held securely on the top surface 168 of the turret during indexing movement thereof until the work pieces approach the ejection station E.

The tubular boss 72, in which the turret shaft 70 is journalled, is formed with a radial extension 192 which is apertured to receive a cylindrical member 193 closed at its lower end and containing a spring 194 acting against a detent ball 195 which has a portion extending through an apertured cap 196. The turret mounting disk 75 is provided with four bushings 197, each positioned in line with one of the stations, and the detent ball 195 is positioned in registration with the loading station, whereby upon completion of each indexing movement of the turret it is held in proper registration to the various stations.

The bosses 176 are counter-bored at their upper ends to receive a helical compression spring 198 surrounding each of the supporting members 175 to yieldingly urge the vacuum ring 174 upwardly to make good vacuum-tight engagement with the under surface of the turret. The vacuum-tight fit is assisted by a film of oil between the ring and the turret supplied by the oiler 191. With this arrangement, the work pieces are fixedly held on the upper turret covering 168.

The cam shaft 62 extends upwardly through the housing 50, see Figures 11 and 14, and the upper portion of the shaft is journalled in a vertically disposed sleeve 200 carried by a plate 201 fixedly mounted in the top wall 73 of the housing 50. There is mounted on the sleeve 200 for axial and rotatable movement, a supporting casting 202 formed with a radially extending flange 203, to the under side of which there is secured an angle bracket, the vertical portion 204 of which is bifurcated to form leg members 205 which straddle a roller 206 carried by an angle bracket 207 secured to the top wall 73 of the housing 50. An adjustable stop member 208 is mounted in the top wall 73 to limit the downward movement of the casting 202. The angle bracket 204 and the roller 206 permit vertical movement of the support casting but retain the same against rotation about the shaft 62.

The support 202 is also formed with a radially extending portion 210 in the form of a flat bracket which serves to support an annular member 211 carrying a print screen 212, see Figures 1, 16 and 17. The ring member 211 is secured to a bracket 214 having an arcuate portion 215 formed with circumferentially extending slots 216 to receive screws 217 threading into the annular member 211, to permit rotary adjustment of the ring 211 on bracket 215.

The peripheral portion of the print screen 212 is clamped between a pair of rings 218, the rings being secured to the member 211, as by screws 219, whereby the screen may be drawn taut across the lower end of the member 211. The bracket 214 is positioned on a plate 220, the under surface of the plate being formed with a groove to receive a key 221 formed on the mounting plate 210. An adjusting screw 223 is mounted in a bracket 224 fixed to the plate 210, the screw being threaded into the plate 220, whereby the plate 220 is adjusted in a direction radial of the screen 212. The bracket 214 is formed with a rib 225 slidable in a groove formed in the plate 220 and extending perpendicular to the key 221. The plate 220 is provided with a bracket 226 in which an adjusting screw 227 is mounted and which threads into the bracket 214. Thus, by manipulation of the screws 223, 227, the bracket 215, carrying the screen ring 211, may be adjusted in two directions normal to each other. When the screen is properly adjusted, the assembly is clamped in adjusted position by wing nuts 228 threaded on studs 229 fixedly mounted in the plate 210, the plate 220 and the bracket 214 being formed with oversize apertures in which the studs 229 are mounted to provide for such universal adjustment. To aid in making this adjustment, a bolt 230 extending through enlarged apertures formed centrally in the plates 210, 220, is threaded into the bracket 214. A helical compression spring 232 is mounted on the bolt between the head thereof and the under side of the plate 210. This arrangement maintains tension on the assembly to render the making of the adjustment more easy.

The upper end of the support 202 is machined circular to receive a bracket 234, formed with an upstanding portion 235, see Figure 11, apertured to receive a pin 236 which also extends through apertured ears 237 formed on one end of a housing 238. This housing extends radially from the axis of the shaft 62 and is formed with a depending boss 240 in which is journalled a shaft 241. Rotation is imparted to the shaft 241 through a gear train including a driving gear 242 secured to the upper end of the shaft 62, an intermediate gear 243 journalled on a stud 244 mounted in the bottom wall of the housing 238, and a driven gear 245 fixedly secured to the upper end of the spindle 241. Due to the fact that the supporting casting 202 is periodically elevated on the sleeve 200 and likewise, the housing 238, the intermediate gear 243 has a face of substantial width. Also, the spindle 241 may be reciprocated in the boss 240 by means of a solenoid 250, as will be hereinafter explained.

An arm 251 is secured to the lower end of the spindle and carries at its outer free end an angle bracket 252 to which is secured a squeegee 253. The arrangement is such that upon rotation of the spindle 241, the squeegee is moved over the printing portion 255 of the screen 212, causing the ink on the screen to be forced through the open print areas of the screen at 255 to print a work piece supported under that area of the screen by the turret 76.

During indexing movement of the turret 76, the support casting and the print screen 212 carried thereby are elevated above the plane of the turret, and a work piece carried thereon, this elevation being effected by a cam 256 secured to the gear 61, as by screws 257. A follower 258 is secured to the casting 202, as by screws 259 and extends downwardly through a hole 260 in the top wall 73 of the housing 50. A cam engaging roller 261 is journalled in the lower end of the follower 258, the arrangement being such that during the dwell of the turret the low portion of the cam 256 is below the follower roller 261, permitting the casting 202 to rest upon the stop member 208. With the assembly in this position, the print screen 212 is in printing relation to a work piece positioned at the printing station and while the screen 212 is in printing position, one revolution is imparted to the spindle 241 by the gear train in the housing 238 to effect the printing of the work piece.

It will be understood that the taut print screen is positioned just slightly above the work piece at the print station, and the print portion 255 of the screen is pressed downwardly by the passage of the squeegee 253 over this portion of the screen so that there is printing contact between the screen and the work piece. In the event that no work piece is present at the printing station, the solenoid 250 is energized, moving the spindle 241 upwardly so that the squeegee does not contact the print screen during rotation of the spindle 241 and accordingly, no ink is forced through the print area 255 of the screen. This arrangement prevents the discharge of

ink on the turret when no work piece is present at the printing station.

As previously stated, the housing 238 is pivotally mounted on the pin 236. It is maintained in operative adjusted position by a stop screw 262. To provide for the convenient application of ink to the print screen and/or the cleaning of the screen, the housing 238 may be tilted about the pivot pin 236 to the dotted line position shown in Figure 11.

A box 270 is fixed to the support casting 202, see Figures 1, 18 and 19. A bracket 271 is mounted in the box and is adjustable vertically by means of the adjusting screw 272. A switch 273 is carried by the bracket 271. A probe 275 is carried by the bracket 271 and extends through an aperture in the bottom wall of the box 270 and serves as an actuator for the switch 273. The probe 275 is positioned to contact a work piece positioned at the detector station D.

When the supporting casting 202 is permitted to descend by the cam 256 during the dwell of the turret, the lower end of the probe 275 will engage the work piece on the turret at station D, effecting upward movement of the probe 275 relative to the switch 273 to cause the contacts of the switch to open. However, if no work piece is present, the contacts of switch 273 close. The switch 273 is connected in series with a switch 277 having normally open contacts which are closed by a cam 278 mounted on the shaft 62. Referring to the diagram Figure 20, a circuit can be traced from the hot side 280 of the power supply, wire 281, switch 273, wire 282, switch 277, wire 283, to relay coil 284, wire 285, to the common side 286 of the supply. With switches 273, 277 closed, relay 284 is energized, closing its contacts 287, 288. Contact 287 is connected by a wire 289 to the hot side 280, and contact 288 is connected by wire 290 to the solenoid 250, and by wire 291 to the common side 286, and with this circuit established the squeegee spindle 21 is elevated to move the squeegee 253 upwardly out of print relation to the screen 212.

It will be recalled, the shaft 62 rotates continuously and during one-quarter of each revolution of the shaft 62, the turret 76 is indexed 90°. The squeegee 253 is rotated in unison with the shaft 62 through the gear train in the housing 238, the squeegee being moved over the print area 255 of the screen during the dwell period of the turret.

The arrangement of the cam 278 is such as to close the contacts of the switch 277 toward the end of the dwell period of the turret—that is, after the squeegee has passed over the print area 255 of the screen.

A stick circuit is provided for the relay 284 including contacts 294, 295, of relay 284 and switch 296, the contacts of which are normally closed and opened momentarily by a cam 297 also mounted on shaft 62. Contact 294 is connected to the hot side of the supply 280 by wires 298, 289. The contact 295 is connected by wire 300 to switch 296, and the holding circuit for the relay is completed by wire 301 connected to wire 283. Cam 297 is arranged to open the contacts of switch 296 momentarily just before cam 278 closes the contacts of switch 277.

If a work piece is present on the turret at station D upon descent of the probe 275, the contacts of switch 273 will not be closed and the solenoid 250 will not be energized, and the squeegee 253 will move over the screen 212 in printing engagement therewith.

If, on the other hand, there is no work piece present at station D, the contacts of switch 273 will close and the circuit to relay 284 will be completed by the closure of contacts of switch 277 by cam 278, the relay establishing its own stick circuit through its contacts 294, 295, and this circuit will prevail until the contacts of switch 296 are opened by cam 297, which will not occur until the shaft 62 has completed the major portion of a revolution which will be subsequent to the next indexing of the turret and movement of the squeegee over the printing area of the screen, whereby that work piece becomes printed at the printing station. Subsequent to this printing operation, cam 297 will open switch 296, breaking the stick circuit, causing relay 284 to drop out, breaking the circuit to the solenoid 250 to permit the squeegee to descend into printing engagement with the screen in the event that a work piece has been moved to the detector station D. With this arrangement, the squeegee does not force ink through the printing area 255 of the screen unless there is a work piece positioned on the turret at the printing station.

When the turret has been indexed to position the printed work piece at ejecting station E, the work piece is automatically removed from the turret and deposited on the conveyor belt 90 which conveys the printed work piece through an elongated drying oven 320. A plate 325 is affixed to the side of the housing 50 as by cap screws 326, and carries a stud 327 on which there is journalled a pulley 328 over which there is trained the conveyor belt 90. An angle bracket 331 is affixed to the plate 325, as by screws 332, and a plate 333 is affixed to the angle bracket 331. The top surface of the plate 333 is arranged coplanar with the top of the turret 76. The plate 333 is formed with an aperture 336 dimensioned to permit a printed work piece to drop therethrough onto the conveyor belt. The plate 333 is disposed radially of the turret 76 and guide members 338 are fixed to the plate 333, as by screws 339, and extend lengthwise of the plate in spaced apart parallel relation. The guide members 338 are formed with grooves 340 on their confronting surfaces, adjacent their top edges, to provide guideways for slidably receiving a plate 341 formed with an aperture 342, and being recessed in its top surface from the aperture outwardly, as at 343. A plate 344 is positioned in the recess 343 and has a depending portion 345 extending downwardly through the aperture 342 and terminating in close adjacency to the top surface of the turret 76.

The slide 341 is reciprocated in the guides 338 by an arm 351 fixed at one end to a shaft 352 journalled vertically in the housing 50. The arm 351 is bifurcated at its opposite end for engagement with a roller 353 attached to the slide 341 by a shouldered screw 354. The arm 351 is split and adjustably clamped to the upper end of the shaft 352 by screw 355. An arm 356 is secured to the lower end of the shaft 352 and is pivotally connected to a link 357. The link 357 is bifurcated at its opposite end for sliding engagement with a block 358 journalled on the shaft 62 immediately above the cam 360. A roller 361 is journalled on the under side of the link 357, and is maintained in contact with the periphery of the cam 360 by a tension spring 362 attached to the inner bifurcated end of the link 357 and to a pin 363 carried by the table top 51.

The arrangement is such that during the dwell period of the turret 76, the slide is moved outwardly to transfer the printed work piece from the turret through the aperture 336 to the conveyor belt 90.

The work piece is moved off from the turret by a work engaging member 370, see Figure 7, which is attached to the downwardly extending leg 345 of the plate 344 by means of a shouldered screw 371, the member 370 being formed with an elongated vertical slot for receiving the shoulder portion of the screw, whereby the member 370 falls by gravity to the upper surface of the turret 76 and rides on that surface during reciprocation of the slide. The member 370 engages the rear, or inner edge, of the wafer work piece, sliding it along the plate 333, through the aperture 336, to the conveyor belt 90.

The printed work pieces are conveyed by the conveyor belt through the elongated drying oven 320. The conveyor belt 90 operates continuously, the upper run of the belt moving in a direction toward the oven 320. Any suitable drive mechanism may be employed to operate

the conveyor belt. In instances where the work pieces consist of the thin ceramic wafers referred to for the manufacture of electrical capacitors, the wafers are also printed on the reverse side. In order to effect maximum production, a machine identical to the one described above is located on the opposite side of the oven and is employed to print the reverse side of the wafers. The printed pieces from that machine are discharged onto a conveyor belt **375**, see Figure 1, similar to the belt **90** for conveyance through the oven, whereby the work pieces are returned for access by the operator of the machine herein described, which includes drive mechanism for the belt **375**, which is operatively connected to the belt **90** at the second machine. The drive herein shown consists of a motor **377**, see Figures 10 and 12, mounted on the under side of the table top **51** and being operatively connected to a shaft **378** by a chain **379**. The shaft **378** is journalled horizontally in the housing **50** and carries at its outer end a pulley over which the conveyor belt **375** is trained.

The machine described functions efficiently to screen print the work pieces at high speed and to effect the printing in a particularly precise manner.

What I claim is:

1. Apparatus for screen printing flat ceramic work pieces comprising a frame, a turret disk journalled in the frame for rotation about a vertical axis, motion transmitting mechanism operable to intermittently index said turret to advance work pieces from a loading station successively to a printing station and a discharge station, a magazine for containing a plurality of work pieces, feeding means at said loading station operable during the dwell of said turret to feed a work piece from said magazine to said turret, said feeding means including positioning means for precisely positioning a work piece over the turret, means for moving the positioning means downwardly in proximity to the turret, means to transfer the positioned work piece to the turret, means operable after the work piece has been transferred to the turret and prior to indexing movement of the turret to hold the work piece in position on the turret, a print screen having a print area positioned in registration with a work piece at said printing station, said screen being normally positioned in a plane above the path traveled by work pieces on said turret, means operable during the dwell of the turret for moving said screen downwardly into printing relation with the work piece on the turret, means operable to move a squeegee over the print area of said screen to effect printing of the work piece, and a work piece ejector mechanism located at said discharge station for ejecting the printed work piece from said turret.

2. A screen printing apparatus as defined in claim 1, wherein means is provided for adjusting the movement of the screen toward the turret.

3. Apparatus for screen printing flat ceramic work pieces comprising a frame, a turret disk journalled in the frame for rotation about a vertical axis, motion transmitting mechanism operable to intermittently index said turret to advance work pieces from a loading station successively to a printing station and a discharge station, a magazine for containing a plurality of work pieces, a work piece positioning member at said loading station and being normally positioned above a work piece position on the turret for precisely positioning a work piece over the work piece position on the turret, means operable during the dwell of said turret to move said work piece positioning member downwardly in proximity to said turret, work piece in-feed mechanism operable during the dwell of said turret to move a work piece from said magazine onto said turret against said positioning member, means operable prior to indexing movement of the turret to hold such work piece in position on the turret, a print screen normally positioned in the plane above the path traveled by the work pieces on said turret, said screen having a print area positioned in registration with a work piece at said print station, means operable during the dwell of said turret for moving said screen downwardly into printing relation with a work piece on the turret, means operable to move a squeegee over the print area of said screen to effect printing of the work piece, and a work piece ejector mechanism located at said discharge station for ejecting the printed work piece from the turret.

4. Apparatus for screen printing flat ceramic work pieces comprising a frame, a turret disk journalled in the frame for rotation about a vertical axis, motion transmitting mechanism operable to intermittently index said turret to advance work pieces from a loading station successively to a printing station and a discharge station, a magazine for containing a plurality of work pieces, infeed mechanism operable during the dwell of said turret to transfer a work piece from said magazine to the turret, said in-feed mechanism including positioning means for precisely positioning a work piece over the turret, means for moving the positioning means downwardly in proximity to the turret, means to transfer the positioned work piece to the turret, vacuum means operable to fixedly hold the work piece on the turret at said loading station and during movement of the work piece to said printing station, a printing screen having a print area in registration with a work piece positioned on the turret at said print station, said screen being positioned above the path traveled by said work pieces during indexing movement of the turret, and means operable during the dwell of the turret to move said print screen downwardly into printing relation with the work piece, a squeegee movable over said screen while the same is positioned in printing relation to the work piece to effect the printing thereof, and work piece ejector mechanism located at said discharge station for ejecting the printed work piece from the turret.

5. Apparatus for screen printing flat, thin, ceramic work pieces comprising a frame, a turret disk journalled in said frame on a vertical axis, motion transmitting mechanism operable to intermittently index said turret to advance work pieces from a loading station successively to a checking station, a printing station and a discharge station, a magazine at said loading station containing a stack of work pieces, feeding means at said station operable, during the dwell of said turret, to feed a work piece from said magazine to said turret, said feeding means including positioning means for precisely positioning a work piece over the turret, means for moving the positioning means downwardly in proximity to the turret, means to transfer the positioned work piece to the turret, means to hold the work piece accurately in position on the turret, checking means at said checking station for determining the presence or absence of a work piece positioned on said turret, a print screen having a print portion positioned in registration with a work piece at said printing station, said screen being normally positioned in a plane above the path traveled by work pieces on said turret, and means operable, during the dwell of the turret, for moving said screen downwardly into printing relation to a work piece on the turret, a squeegee movable continuously over a path including the printing portion of said screen, said squeegee being normally positioned above said screen and out of contact with the ink supply thereon, motion transmitting mechanism controlled by said checking means, and operable upon presentation of a work piece at said printing station, to move said squeegee downwardly in engagement with said screen to effect printing of the work piece, and a work piece ejector mechanism located at said discharge station for ejecting the printed work piece from said turret.

6. Screen printing apparatus comprising a frame, a work piece supporting turret disk journalled in the frame, motion transmitting mechanism operable to effect intermittent rotation of said turret to successively move a work piece from a loading station to a checking station,

a printing station and a discharge station, means at said loading station for supporting a supply of work pieces and feeding means operable during the dwell of said turret for moving a work piece from said supply to said turret, said feeding means including positioning means for precisely positioning a work piece over the turret, means for moving the positioning means downwardly in proximity to the turret, means to transfer the positioned work piece to the turret, means operable after the work piece has been transferred to the turret and prior to indexing movement of the turret to hold the work piece in position on the turret, checking means at said checking station operable during the dwell of the turret to determine the presence or absence of a work piece at said station, a print screen at said printing station normally spaced above said turret, means operable, during the dwell of said turret, to move said screen toward the turret into printing relation with a work piece, a squeegee movable into engagement with and over said screen to effect printing of the work piece, means operable upon said checking means determining the presence of a work piece to effect movement of said squeegee into engagement with the screen, and means at said discharge station for ejecting the printed work piece from the turret.

7. Apparatus for screen printing flat ceramic work pieces comprising a frame, a turret disk journalled in the frame for rotation about a vertical axis, motion transmitting mechanism operable to intermittently index said turret to advance work pieces from a loading station successively to a printing station and a discharge station, a magazine for containing a plurality of work pieces, a U-shaped work piece positioning member arranged at said loading station and being positioned in parallel spaced relation to the upper surface of said turret and with the legs of said member extending toward said magazine, a fixed work piece stop member carried by one leg of said positioning member, a work piece stop carried by the other leg of said member and being yieldingly urged towards said fixed stop, means operable during the dwell of the turret to move said positioning member downwardly in proximity to the turret, an in-feed mechanism operable during the dwell of the turret to transfer a work piece from said magazine on said turret between said stop members, a printing screen having a print area in registration with a work piece positioned on the turret at said print station, said screen being normally positioned above the path traveled by said work pieces during indexing movement of the turret, and means operable during the dwell of the turret to move said print screen downwardly into printing relation with the work piece, a squeegee movable over the screen while the same is positioned in printing relation to the work piece to effect the printing thereof, and a work piece ejector mechanism located at said discharge station for ejecting the printed work piece from the turret.

8. Apparatus for screen printing flat ceramic work pieces comprising a frame, a turret disk journalled in the frame for rotation about a vertical axis, motion transmitting mechanism operable to intermittently index said turret to advance work pieces from a loading station successively to a detecting station, a print station, and a discharge station, a magazine at said loading station containing a stack of work pieces, feeding means at said loading station operable during the dwell of said turret to feed a work piece from said magazine to said turret, said feeding means including positioning means for precisely positioning a work piece over the turret, means for moving the positioning means downwardly in proximity to the turret, means to transfer the positioned work piece to the turret, means operable after the work piece has been transferred to the turret and prior to indexing movement of the turret to hold the work piece in position on the turret, work piece detecting means at said detecting station for determining the presence or absence of a work piece positioned on the turret at said detecting station, a shaft journalled vertically in the frame and operable in timed relation to the indexing of said turret, a print screen assembly, a print screen carried thereby and having a print area arranged in registration with a work piece positioned on the turret at said printing station, cam means mounted on said shaft and cooperable upon rotation thereof to maintain said print assembly in elevated position with said screen positioned in a plane above the path traveled by work pieces on said turret and to move said assembly downwardly to move said screen into printing relation to a work piece on the turret, a squeegee carried by said assembly and being moved in a circular path over said print area upon rotation of said shaft, motion transmitting mechanism controlled by said detecting means and operable upon the absence of a work piece at said detecting station to effect movement of said squeegee upwardly from said screen during its next succeeding cycle of rotation, whereby no ink will be forced through the print area of the screen, and a work piece ejector mechanism located at said discharge station for ejecting printed work pieces from said turret.

9. Apparatus for screen printing flat ceramic work pieces comprising a frame, a turret disk journalled in the frame for rotation about a vertical axis, motion transmitting mechanism operable to intermittently index said turret to advance work pieces from a loading station successively to a printing station and a discharge station, a magazine for containing a plurality of work pieces, feeding means at said loading station operable during the dwell of said turret to feed a work piece from said magazine to said turret, a print screen having a print area positioned in registration with a work piece at said printing station, said screen being normally positioned in a plane above the path traveled by work pieces on said turret, means operable during the dwell of the turret for moving said screen downwardly into printing relation with the work piece on the turret, means operable to move a squeegee over the print area of said screen to effect printing of the work piece, a guideway extending radially above the turret at said discharge station, a slide mounted for reciprocation in said guideway, a work piece engaging member depending from said slide and terminating at its lower end in close proximity to the upper surface of said turret for engaging the inner edge of a work piece thereon, said slide being normally positioned with said work piece engaging member positioned inwardly of the path traveled by work pieces on said turret, and motion transmitting means operable during the dwell period of the turret to move said slide outwardly in said guideway for the ejection of a printed work piece from the turret.

10. Apparatus for screen printing flat, thin, ceramic work pieces as defined in claim 9, wherein said work piece engaging member is mounted for free upward movement upon said slide.

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