

June 25, 1968

R. S. LITTEREST ETAL

3,389,723

LIQUID INSERTION AND MACHINE

Filed Feb. 16, 1966

7 Sheets-Sheet 1

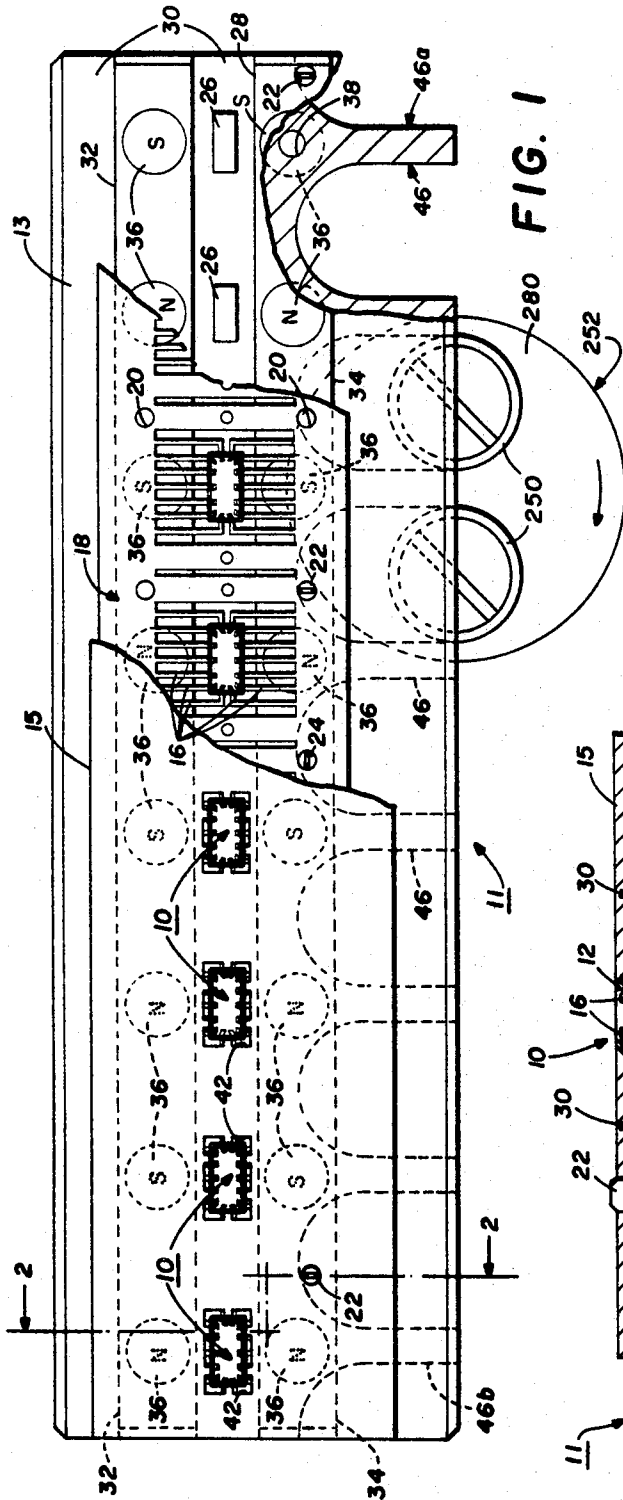


FIG. 1

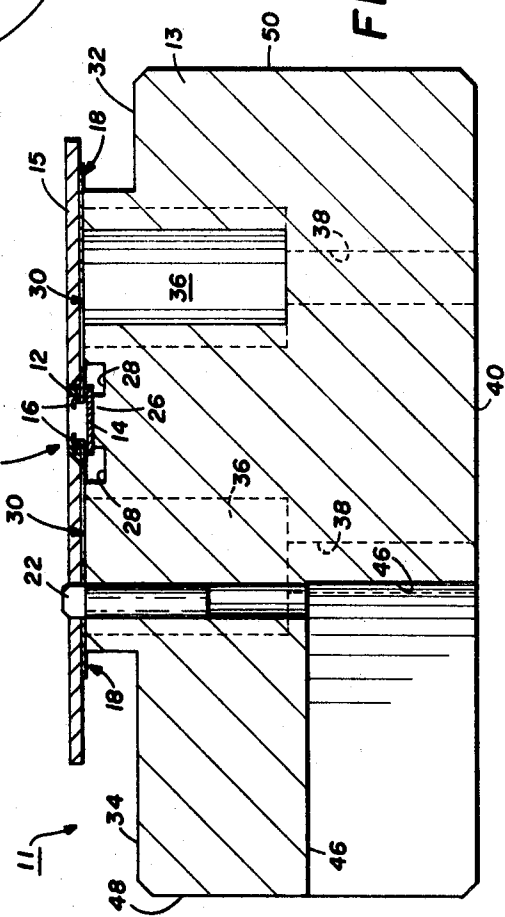


FIG. 2

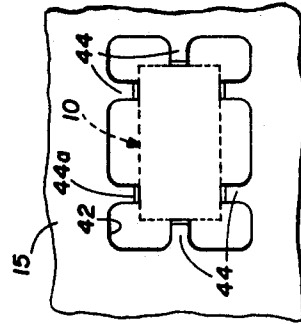


FIG. 3

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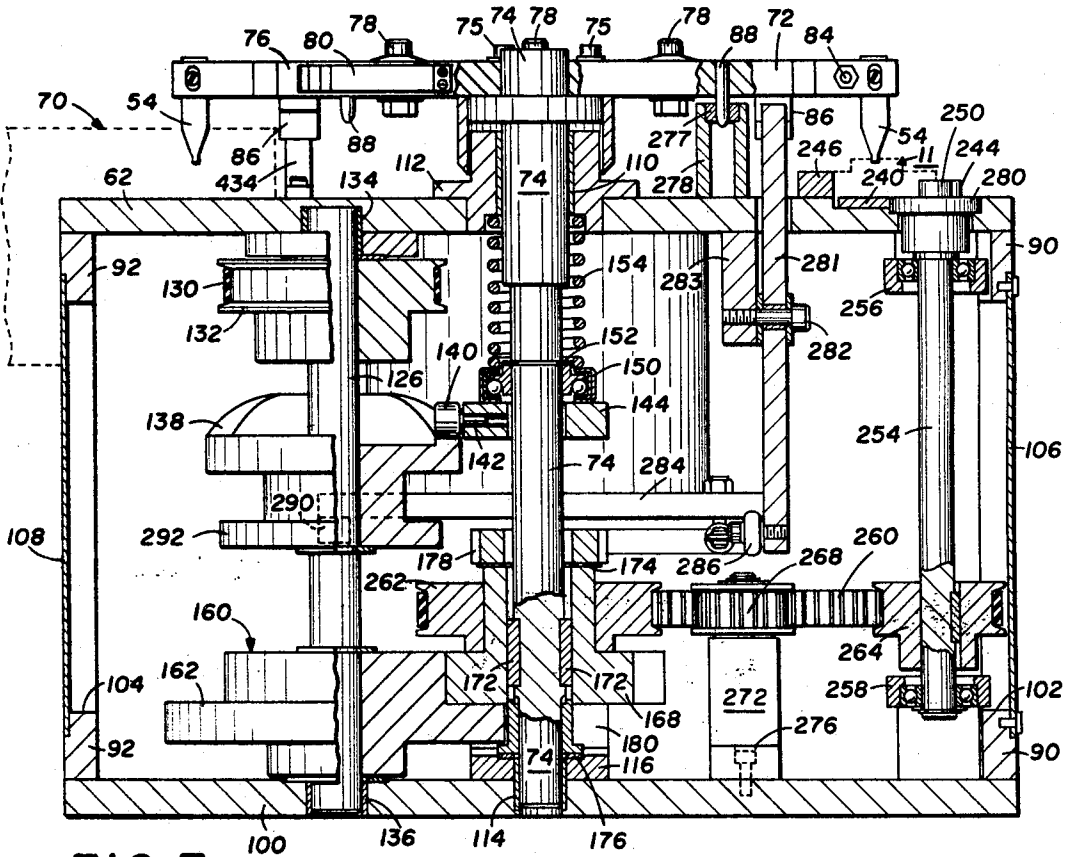


FIG. 7

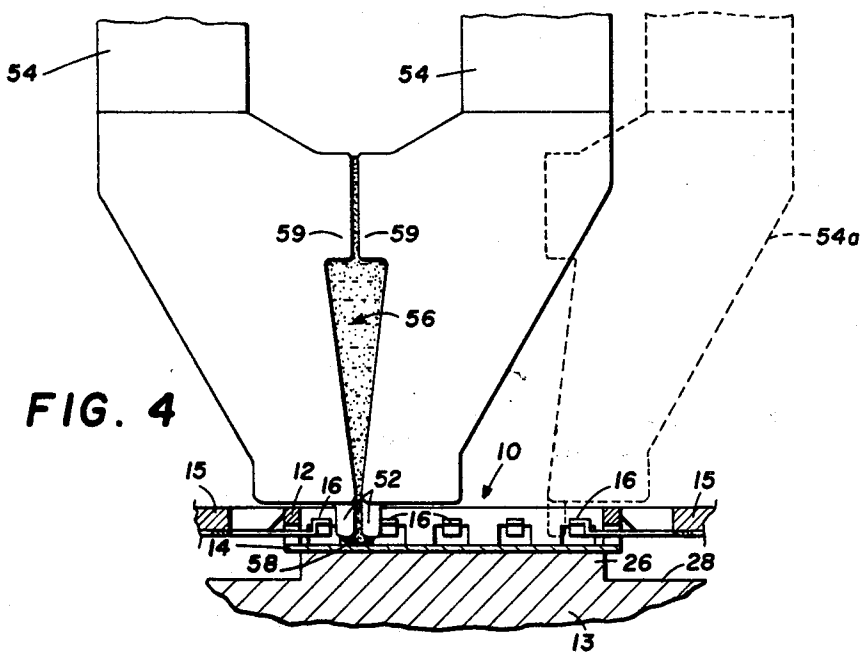


FIG. 4

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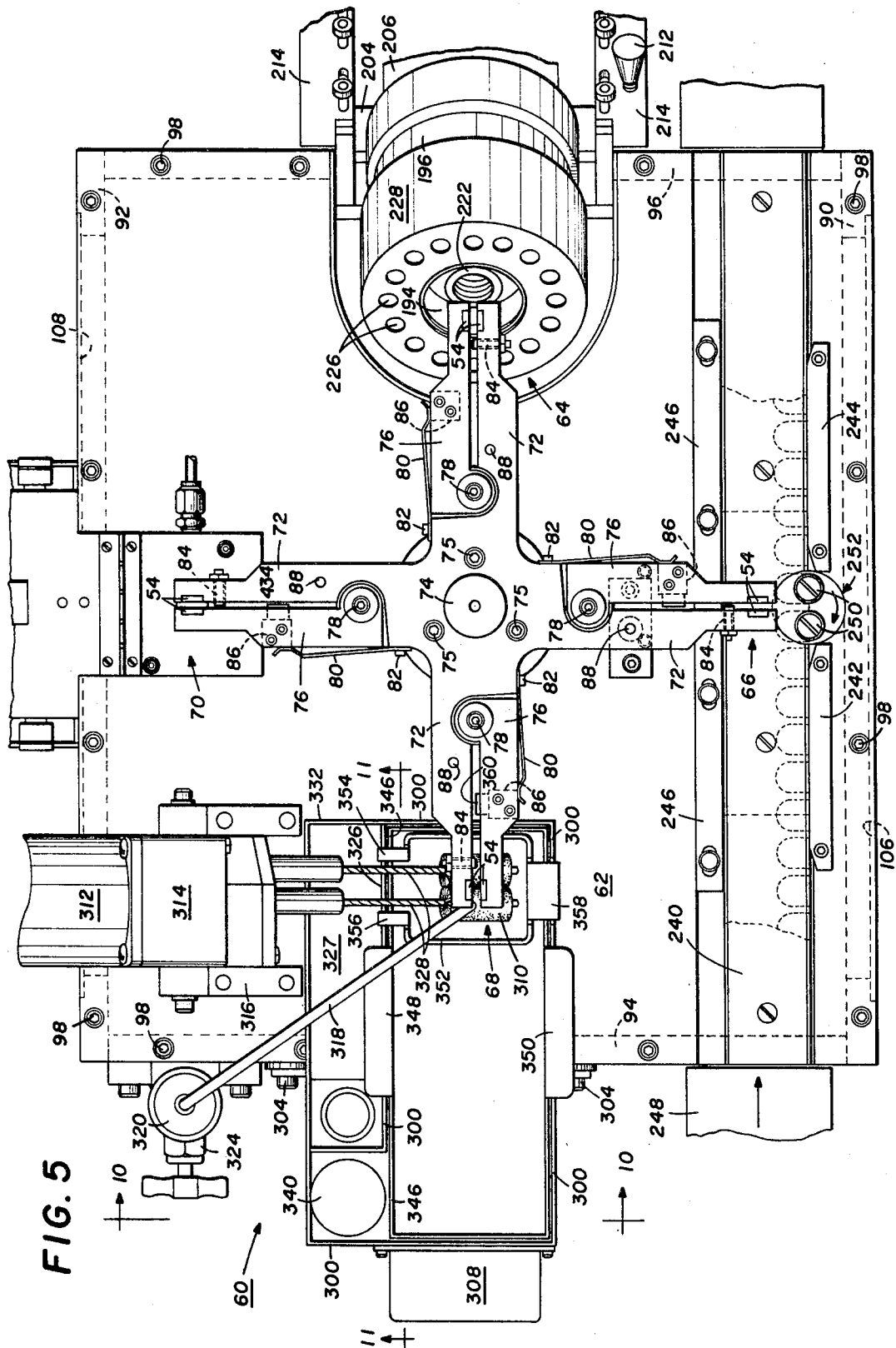
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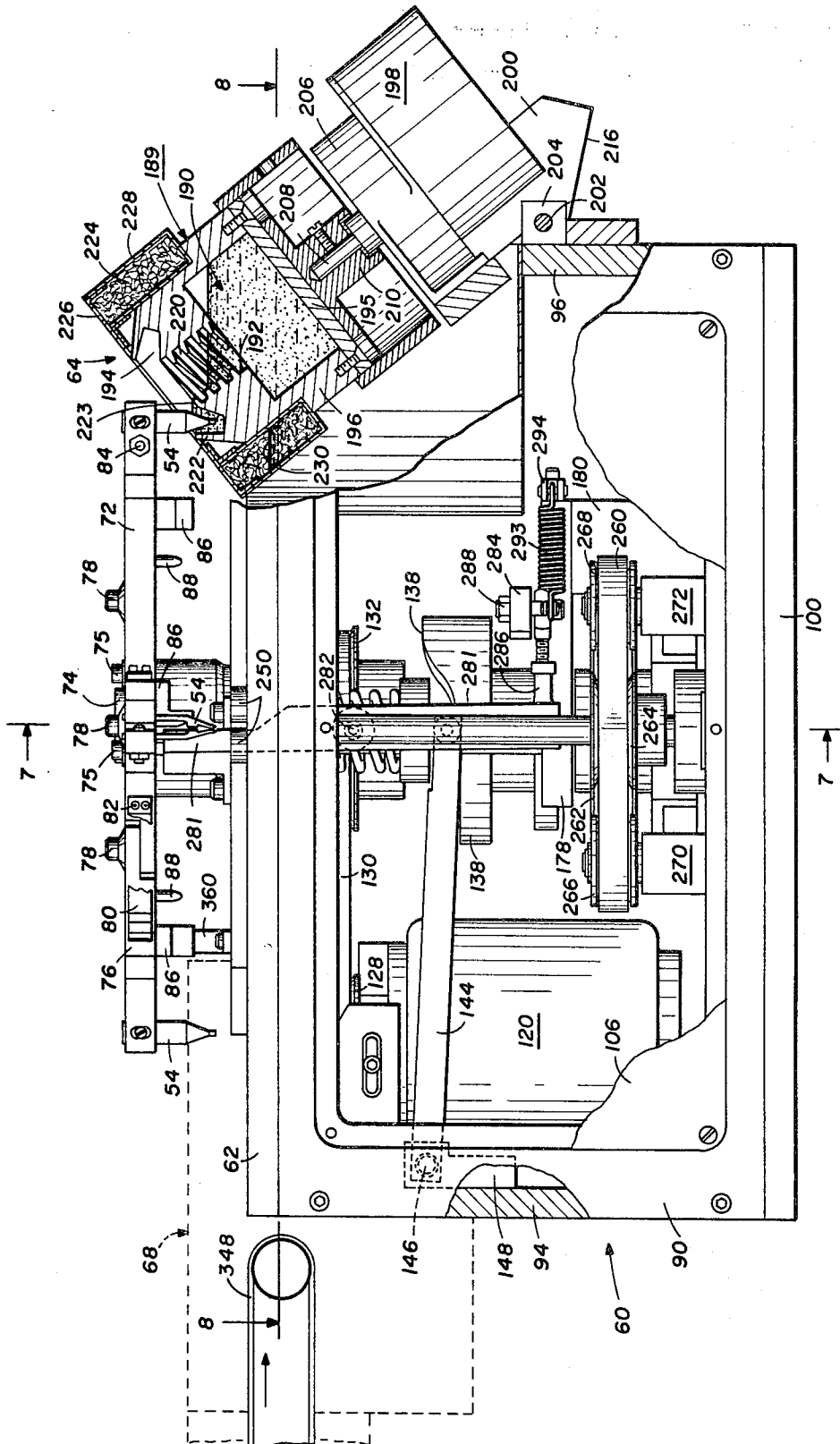


FIG. 6

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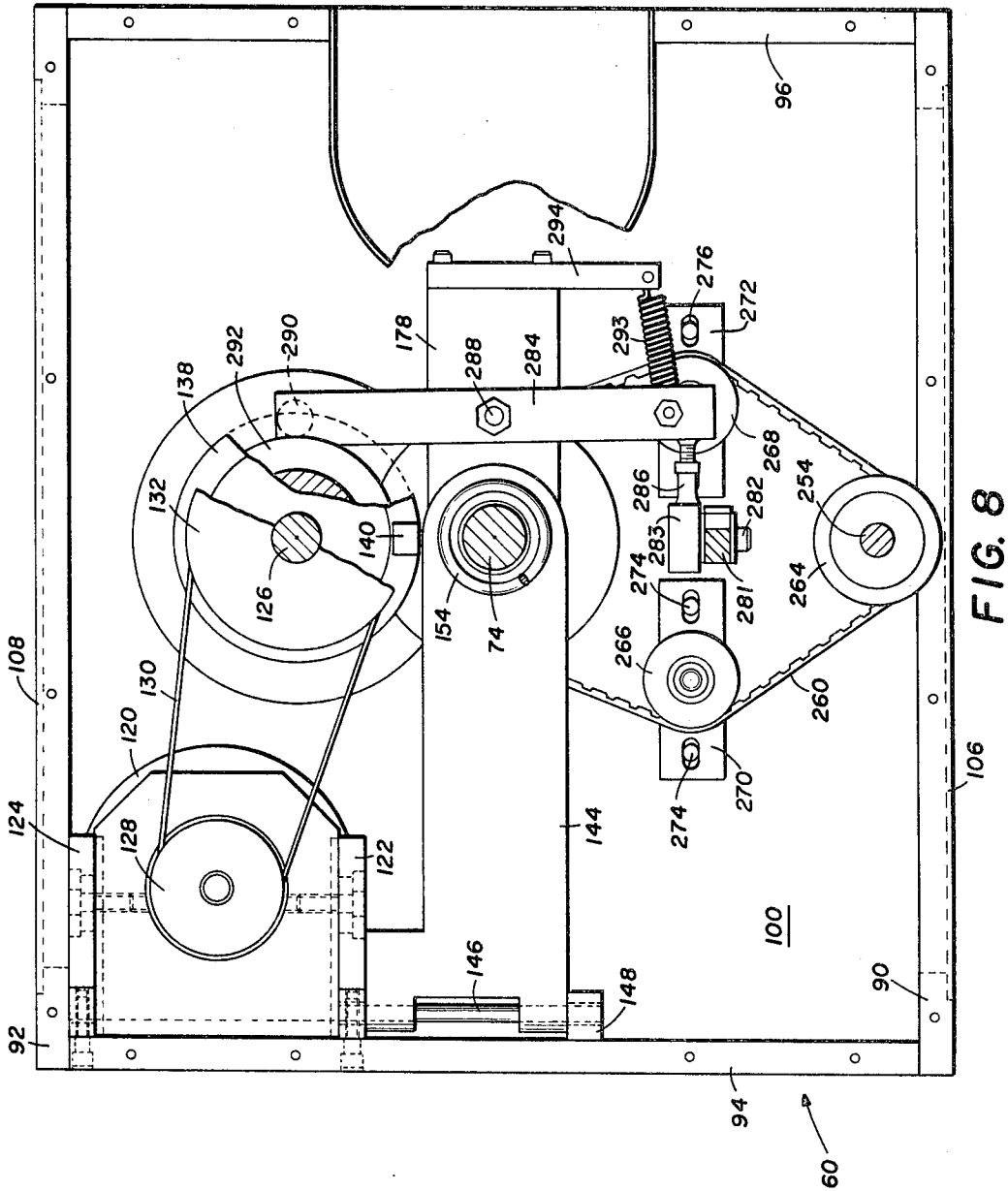


FIG. 8

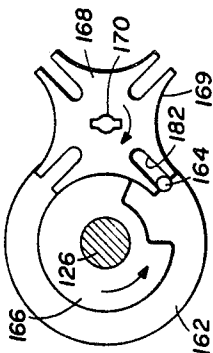


FIG. 9a

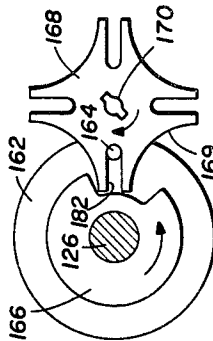


FIG. 9b

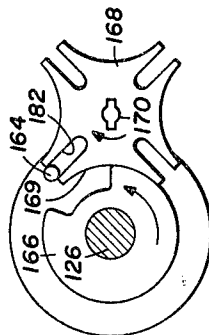


FIG. 9c

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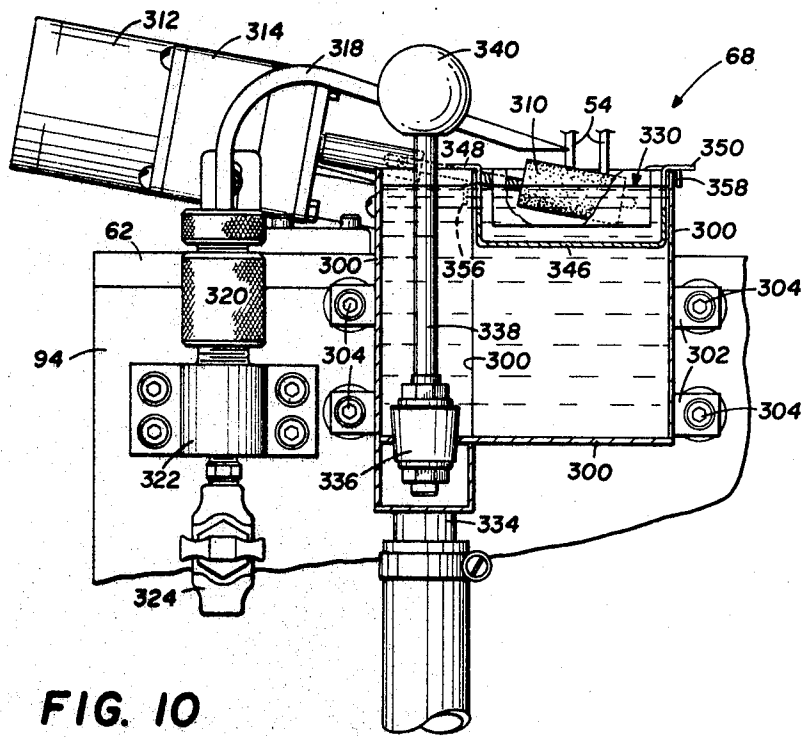


FIG. 10

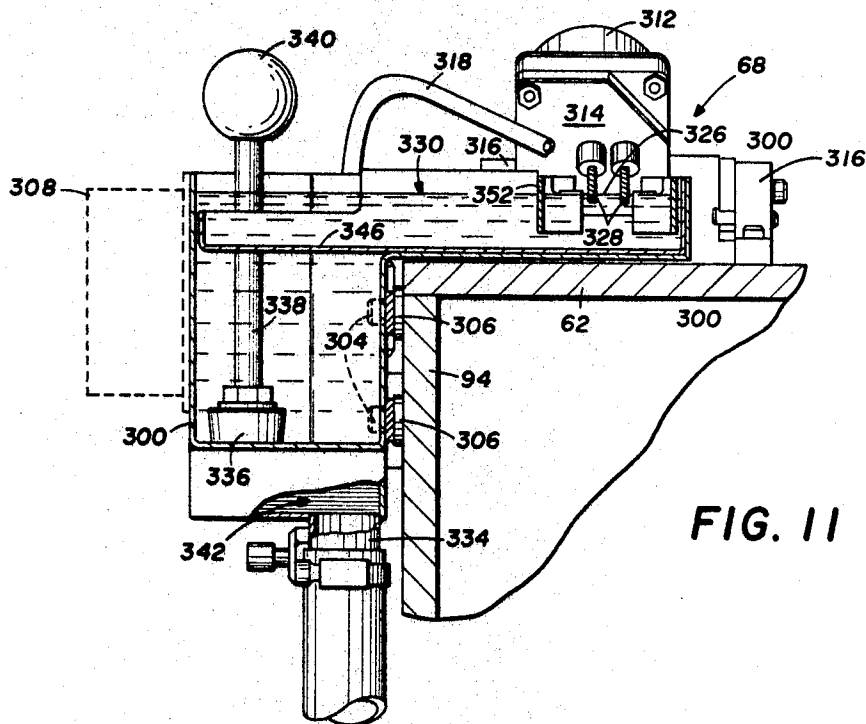


FIG. 11

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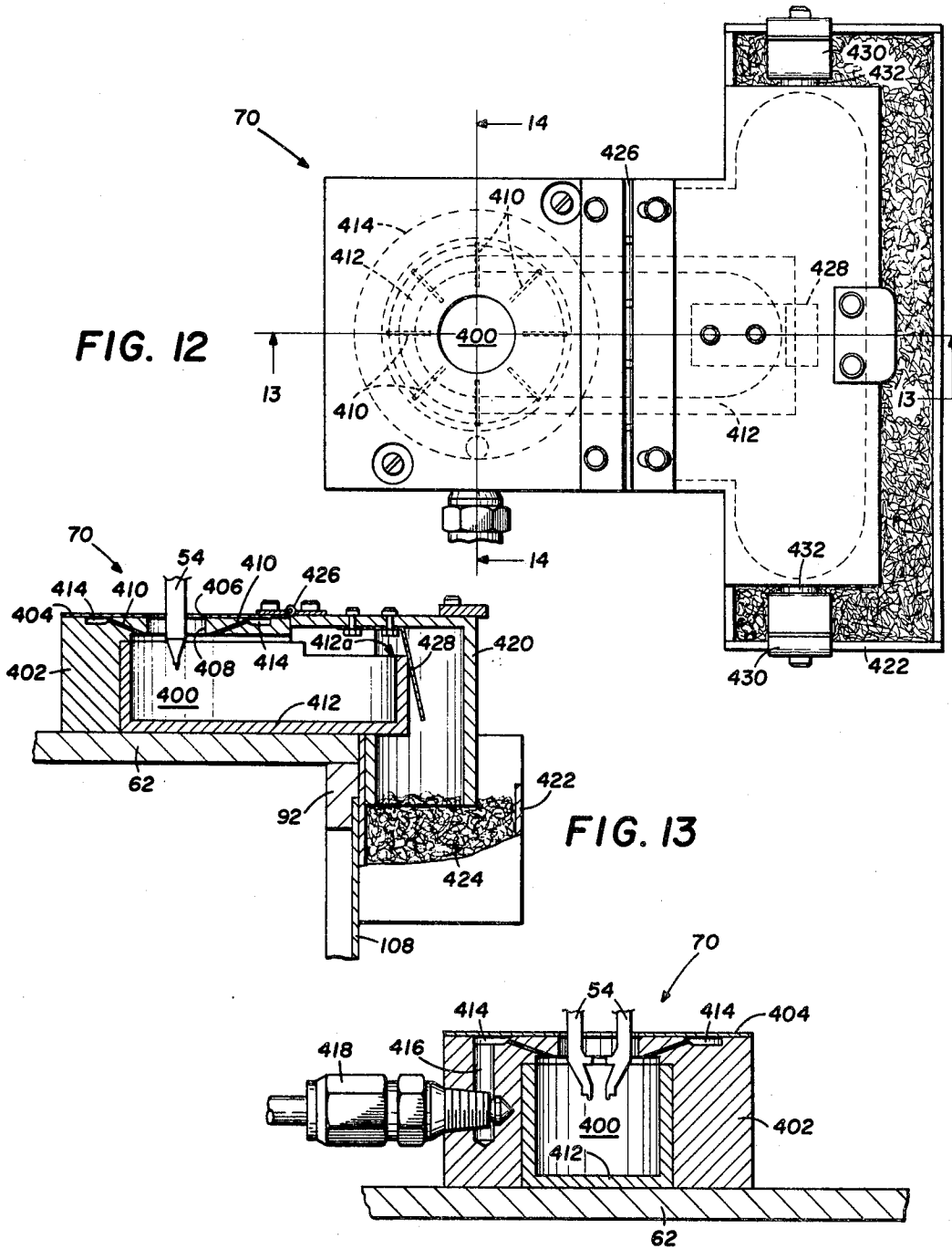


FIG. 12

FIG. 13

FIG. 14

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LIQUID INSERTION AND MACHINE

Ralph S. Litterst and Francis M. Brennan, Richardson, Tex., assignors to Texas Instruments Incorporated, Dallas, Tex., a corporation of Delaware
Filed Feb. 16, 1966, Ser. No. 527,838
14 Claims. (Cl. 141-90)

ABSTRACT OF THE DISCLOSURE

Disclosed is an apparatus for inserting a small predetermined volume of liquid into a small receptacle, the apparatus including a supply of liquid and a means for picking the liquid up by capillary action between fingers, and means for transporting the fingers to the receptacle in order to deposit the liquid therein.

This invention relates generally to method and apparatus for inserting a small predetermined volume of liquid into a small receptacle, and more particularly relates to a machine for automatically inserting a measured volume of glass slurry into a receptacle formed by the ring frame and base plate of a semiconductor network flat pack.

It is vitally important that all semiconductor devices be contained in a hermetically sealed package so that the environment around the device can be controlled. Since all semiconductor devices have at least two electrical leads, and most have three or more, at least one electrical lead must of necessity extend from the semiconductor device out through the package and be electrically insulated from the package. It is customary to fabricate semiconductor packages from an electrically conductive metal alloy. A glass seal is then formed between the lead and metal package to hermetically seal the package, insulate the lead from the package, and in most cases also mechanically support the lead.

In copending U.S. application Ser. No. 518,214, entitled, "Process for Fabricating Hermetic Seals," filed on Jan. 3, 1966, by Rogers et al. and assigned to the assignee of the present application, a process for fabricating a hermetically sealed semiconductor package was described wherein a glass slurry is used to transport the glass into the regions to be sealed. The process is particularly suited for fabricating a standard flat pack which may be on the order of 0.250 inch long, 0.125 inch wide and 0.03 inch deep and which has fourteen leads each of which must be electrically isolated from the package. In the fabrication of such a package, the leads are formed integral with a rectangular frame which supports the leads in the proper relative position by stamping this structure from a metal sheet. The ends of the leads are then extended through slots in the walls of a ring frame and a base plate is welded over the bottom of the ring frame to form an open-topped receptacle. The receptacle and lead wires are then supported so that the lead wires extend through the openings into the receptacle without touching the receptacle. A slurry comprised of finely ground glass particles and water is then placed within the receptacle. As the slurry wets the surface of the leads and the walls of the receptacle, the surface tension carries the glass particles into the openings around the leads. Then the water is evaporated, leaving a particulate glass solid around the leads which is subsequently fused to form a solid glass seal. The excess is then sandblasted away to expose the ends of the leads and the center portion of the base plate.

This invention is particularly concerned with method and apparatus for automatically inserting a predetermined quantity of the glass slurry into the receptacle formed by the ring frame and base plate. Apparatus heretofore em-

ployed for related purposes utilizes pressure or gravity flow of the liquid material from the tip of a nozzle and controls the flow of the liquid by seating a pin in the nozzle orifice. Apparatus using this method is not satisfactory for dispensing the glass slurry because the glass slurry quickly settles to the bottom of any vessel when not agitated, and dries very rapidly when exposed. The prior art techniques do not permit sufficient agitation at the nozzle tip and the flow through the nozzle tip could not be controlled with sufficient precision. Also use of a nozzle type dispenser does not provide a suitable means for spreading the slurry within the receptacle.

Therefore an important object of this invention is to provide method and apparatus for automatically and efficiently inserting a predetermined volume of glass slurry, or any other nontacky liquid, into the receptacle formed by the ring frame and base plate, or any other small receptacle.

Another object is to provide such an apparatus capable of inserting the slurry between the inwardly projecting ends of the leads without marring or bending the leads.

Another object is to provide a means for spreading the slurry to insure that it is distributed into the openings and crevices to be filled.

Another object is to provide an indexing mechanism for successively shifting a series of receptacles precisely to a predetermined position whereby each may be filled with a predetermined quantity of liquid.

A further object of the invention is to provide a means for continually supplying glass slurry or the like having a substantially constant concentration, which means needs a minimum of cleaning and attention.

Another object is to provide a means for cleaning a pair of fingers or the like using both brushing and ultrasonic waves.

Still another object is to provide a means for drying the pair of fingers after they have been cleaned.

Yet another object is to provide a simple, economically constructed mechanism for successively transporting a pair of fingers from a supply station to an insertion station, to a cleaning station, to a drying station, and back to the supply station while indexing a receptacle holder past the insertion station in synchronism with movement of the fingers.

These and other objects are accomplished by immersing a pair of spaced fingers forming a capillary cavity therebetween into a supply of liquid, transporting the fingers to an insertion station, inserting the fingers into a receptacle to be filled, and spreading the fingers to cause the liquid to flow into the receptacle. It is also preferred to transport the fingers to a cleaning station where the fingers are washed, then to a drying station where the fingers are dried prior to returning to the supply station.

The method is best carried out by apparatus comprised of a pair of fingers for forming a capillary cavity when disposed in adjacent relationship, an arm supporting each finger, the arms being rotatably supported on a vertically disposed shaft, means for raising and lowering the shaft when the fingers are over a supply station and over an insertion station, liquid supply means at the supply station into which the fingers are lowered, and means for supporting the receptacle to be filled at the insertion station such that the fingers are lowered into the receptacle. The apparatus also preferably includes a wash station having a wash tank into which the fingers are lowered after the capillary cavity is emptied. The wash station preferably includes brush means for scrubbing the fingers and for an ultrasonic wave generator for ultrasonically cleaning the fingers. When a wash station is employed, it is also desirable to provide a drying station into which the fingers are lowered and dried by air jets.

In accordance with a more specific aspect of the invention, four pairs of arms, and fingers, assuming four stations, are attached to the vertically disposed shaft. The shaft is periodically rotated one quarter turn for each revolution of a timing shaft by a Geneva drive and the shaft is lowered by a cam on the timing shaft during the period when the vertical shaft is not rotating. The fingers positioned at the insertion station are also spread apart while the shaft is lowered by a mechanism actuated by a cam on the timing shaft.

The invention also features a carrier assembly for a strip of lead frame and ring frame-base plate assemblies which precisely orient each ring frame-base plate in the desired relation to the leads of the lead frame so that the leads do not contact the ring frame or base plate. The carrier assembly includes a base member having a series of longitudinally spaced pedestals for supporting the ring frame-base plate receptacles which are disposed in a longitudinally extending groove. A series of locating pins project upwardly from the base member and pass through locating holes in the lead frame strip to properly locate the lead frame strip. The locating pins also project through locating holes in a top plate which presses the lead frame strip and the ends of the leads connected to the lead frame against the base member to thereby secure the leads in place. The top plate also surrounds each ring frame and properly locates the ring frame on the respective pedestals.

The invention also features a slurry supply tank having a large lower chamber, a restricted neck portion and an annular delivery trough around the outlet of the neck portion. The supply tank is rotated about the axis passing through the neck portion, which axis is disposed at an acute angle to the vertical. Suitable pump means, such as a helical groove, is located in the neck for transferring fluid from the lower chamber to the delivery trough into which the fingers are dipped to fill the capillary chamber with the slurry.

The novel features believed characteristic of the invention are set forth in the appended claims. The invention itself, however, as well as other objects and advantages thereof, may best be understood by reference to the following detailed description of illustrative embodiments, when read in conjunction with the accompanying drawings, wherein:

FIGURE 1 is a plan view, partially broken away, of a novel carrier assembly constructed in accordance with the present invention for transporting a strip of lead frame, ring frame and base plate assemblies past an insertion station;

FIGURE 2 is a sectional view taken substantially on lines 2—2 of FIGURE 1;

FIGURE 3 is an enlarged, partial plan view of a portion of the assembly of FIGURE 1;

FIGURE 4 is an enlarged side view of a pair of finger members in operative position in relation to the lead frame and ring frame assembly, showing the ring frame assembly and adjacent portions of the carrier in sectional view, and showing the open position of the fingers in dotted outline;

FIGURE 5 is a plan view of a glass insertion machine constructed in accordance with the present invention;

FIGURE 6 is a front elevational view of the machine of FIGURE 5, partially broken away to show details of construction;

FIGURE 7 is a sectional view taken substantially on lines 7—7 of FIGURE 6;

FIGURE 8 is a sectional view taken substantially on lines 8—8 of FIGURE 6;

FIGURES 9a-9c are somewhat schematic drawings illustrating the operation of the Geneva drive of the machine of FIGURE 5;

FIGURE 10 is a sectional view taken substantially on lines 10—10 of FIGURE 5, and shows details of the cleaning station;

FIGURE 11 is a sectional view taken substantially on lines 11—11 of FIGURE 5 and shows additional details of the wash station;

FIGURE 12 is an enlarged plan view showing details of construction of the drying station of the machine of FIGURE 5;

FIGURE 13 is a partial side view, partially broken away, of the drying station of FIGURE 12; and

FIGURE 14 is a rear view, partially in section, of the drying station of FIGURE 12.

Referring now to the drawings, and in particular to FIGURES 1, 2 and 4, the receptacle to be filled with glass slurry is a standard integrated circuit package indicated generally by the reference numeral 10 which is comprised of a ring frame 12 which is welded to a base plate 14. A set of fourteen leads 16 extend inwardly from a lead frame strip 18 through openings in the ring frame 12 and terminate within the receptacle 10. As illustrated in FIGURE 1, the lead frame strip 18 has eight sets of leads and eight associated receptacles 10. The lead frame strip 18 is provided with a number of locator holes 20, one on each side of the strip 18 for each receptacle 10.

A carrier assembly constructed in accordance with this invention is indicated generally by the reference numeral 11 and is comprised of a base member 13 and a top plate 15. Three locator pins 22 are provided at longitudinally spaced points on the base member 13. When the locator holes 20 are placed over the locator pins 22, the lead frame strip 18 is precisely located in the transverse direction on the base member 13. A single locator pin 24 is provided to pass through one of the locator holes 20 and accurately position the lead frame strip 18 longitudinally of the base member 13. As can be seen by referring to FIGURES 1 and 2, the locator pins 22 and 24 are wedge-shaped to facilitate easily placing the lead frame strip assembly on the base member. The locator pins contact both sides of the locator holes 20 in only one direction, and are therefore effective to precisely locate the lead frame strip 18 in only one direction. Thus it will be noted that the locator pins 22 are disposed with the widest dimension extending transversely of the base member 13, while the widest dimension of the wedge-shaped locator pin 24 is disposed longitudinally of the base member 13. The wedge-shaped locator pins facilitate placing and removing the lead frame strip. It will be also noted in FIGURE 2 that the upper corners of the widest dimension of the wedge-shaped locator pins 22 and 24 are beveled so as to further facilitate placement of the lead frame strip 18 over the locator pins.

Eight pedestals 26 are formed in a longitudinally extending groove 28 in the upper face 30 of the base member 13. The pedestals 26 are spaced to correspond to the spacing between the receptacles 10, and the upper surfaces of the pedestals are located below the upper surface 30 of the base plate so that each set of leads 16 laying flat on the surface 30 will project through the openings in the ring frame 12 without contacting either the ring frame or the base plate 14. This relationship can best be seen in FIGURES 2 and 4 wherein it will also be noted that the pedestals 26 are both narrower and shorter than the base plate 14 to prevent the slurry which enters into the opening around each of the leads from also wetting the edge of the pedestal and thus spreading into the groove 28 as a result of the surface tension of the liquid slurry. The outer edges of the base member 13 are also preferably provided with grooves 32 and 34 to facilitate manually placing the lead frame strip 18 in place. A cylindrical magnet, indicated by the reference character 36, is press fitted in a bore in the base member 13 on each side of each pedestal 26 and ground off flush with the upper face 30. Bores 38, as can be seen in FIGURE 2, may extend from the bottom face 40 of the base member 13 and intersect the bores in which the magnets 36 are disposed so that the magnets can be dislocated if desired. As will be noted in FIGURE 1, the pairs of magnets disposed on opposite

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sides of each of the pedestals 26 are oriented so that the same poles are at the surface 30, and successive pairs of magnets are of alternating polarity.

The top plate 15 is also provided with four locater holes which are appropriately spaced to receive the same four locater pins 22 and 24. It will be noted that the top plate 15 is wider than the lead frame strip 18 to facilitate separate application and removal. The top plate 15 has an opening 42 disposed over each pedestal 26 and six fingers 44 project inwardly and closely receive the ring frame 12 of the receptacle 10 to accurately locate the receptacle both transversely and longitudinally on the pedestal and base member. The corner between the end of each finger and the underside of the finger is preferably beveled, as illustrated at 44a in FIGURE 3, to facilitate placement of the top plate over the several ring frames 12, which it will be appreciated are free floating with respect to the leads 16. The magnets 36 hold both the lead frame strip 18 and the top plate 15 in place with a very substantial force so that the leads 16 are firmly pressed flat and held in place. A series of camways 46 shaped as illustrated in FIGURES 1 and 2 are formed in the bottom face 40 of the base member 13 adjacent one edge, it being noted that camways 46a and 46b at the leading and trailing ends of the base member correspond to one-half the camways intermediate the base member. Each of the camways 46 is centered between an adjacent pair of pedestals 26 for purposes which will hereafter be described in greater detail.

The lower face 40 of the base member 13 is skidded across a reference surface by an indexing mechanism operated in the camways 46 so as to successively position the receptacles 10 precisely at an insertion station. Accordingly, the upper surface 30 and the surface of the pedestals 26 must be precisely parallel to the bottom face 40 in order to orient each receptacle 10 and each set of leads 16 at precisely the right height. Precise transverse positioning of the carrier assembly 11 is achieved by edges 48 and 50 which are received between precisely aligned guide rails with a very close tolerance as will presently be described. The three locater pins 22 then precisely locate both the lead frame strip 18 and the top plate 15 in the transverse direction with respect to the base member 13 so as to properly locate the receptacle in the direction transverse to the carrier assembly. The receptacles 10 are precisely located in the longitudinal direction by the indexing mechanism which engages the camways 46 and the locater pin 24. Thus the leads 16 are precisely located with respect to the receptacles 10 and the leads and receptacles are precisely located at the insertion station in both the vertical, transverse and longitudinal directions so as to receive the nibs 52 of the pair of fingers 54 illustrated in FIGURE 4.

In accordance with an important aspect of the invention, a precisely predetermined quantity of liquid is inserted in each receptacle 10 by means of the pair of fingers 54 which form a capillary chamber 56 therebetween. The pair of nibs 52 at the lower end of the fingers 54 form the lower end of the capillary cavity and are sized to pass between the ends of the leads 16 into sufficiently close proximity to the base plate 14 that the meniscus 58 of the liquid in the capillary cavity 56 will contact the base plate 14. Then when the finger 54 is spread to the position 54a shown in dotted outline in FIGURE 4, the liquid in the cavity 56 will flow into and be spread across the bottom of the receptacle 10. It is also highly advantageous to oscillate the finger between the position indicated in dotted outline and the position indicated in solid outline a few times to assist in breaking the surface tension of the liquid and forcing the liquid slurry around the ends of the leads 16 and into the openings formed in the ring frame 12. The fingers are preferably withdrawn while held apart so that a minimum volume of the liquid will be withdrawn by the nibs 52. It is desirable to locate the nibs 52 in close proximity to better hold the liquid in the capillary cavity.

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The volume of the capillary cavity can be increased by forming the fingers so as to make a wedge-shaped cavity as illustrated. The wedge-shaped cavity also promotes flow of the liquid from the cavity and ease of cleaning. The upper end of the cavity is preferably sharply defined by the spur portions 59 so that the volume of liquid carried by the capillary cavity will not vary substantially as a result of errors in the depth to which the fingers are dipped into a supply of slurry as will presently be described. The volume of the capillary cavity can also be controlled by adjusting the space between the fingers 54 when the fingers are in the closed position. In accordance with the method of the present invention, the fingers 54 are disposed in closed relationship so as to form the capillary cavity 56 and dipped into a supply of the liquid to be inserted in the receptacle 10 so as to fill the capillary cavity. The fingers are then transported from the supply, lowered into the receptacle 10 and spread apart to insert the liquid into the receptacle. Since glass slurry dries very rapidly when exposed to the atmosphere, repeated use of the fingers 54 would result in a crusty deposit of glass particles on the walls of the fingers forming the capillary cavity. For this reason it is highly desirable to periodically wash or otherwise clean the fingers 54, preferably after each measured quantity of glass slurry is inserted into a receptacle. To prevent the water remaining on the fingers from diluting the glass slurry, the fingers are also preferably dried prior to refilling the capillary cavity.

A machine for carrying out the method of the present invention is indicated generally by the reference numeral 60 in FIGURES 5-8. The machine 60 has a top plate 62 on which are located a slurry supply station 64, an insertion station 66, a washing station 68, and a drying station 70. Since there are four stations, four sets of fingers 54 are used. The fingers of each pair are disposed vertically in side-by-side relationship. One finger of each pair is rigidly fixed to a rigid arm 72. The four rigid arms 72 are rigidly connected to a vertically disposed shaft 74, which may be both raised and rotated, as will hereafter be described, by bolts 75. The other finger of each pair is rigidly fixed to a movable arm 76 which is pivotally connected to the corresponding rigid arm 72 by a pivot pin 78. Each of the movable arms 76 is biased into the closed position by a leaf spring 80 which is connected to the fixed arm 72 by a suitable screw fastener 82. The closed position of each of the movable arms 76 may be adjusted by a screw 84 which is threaded through the corresponding fixed arm 72. Thus by adjustment of the screws 84, the spacing between each pair of fingers 54 can be varied so as to vary the volume of the capillary cavity 56 formed between the fingers. Each of the movable arms 76 may be moved into the open position, as will hereafter be described in greater detail, by exerting a force on a cam lobe 86 which depends from each of the movable arms 76. A locater pin 88 is press fitted in each of the rigid arms 72 for precisely locating the fingers 54 at the insertion station as will presently be described.

The top plate 62 is supported by vertical front and rear plates 90 and 92, and left and right vertical side plates 94 and 96. The top plate 62 is connected to the four side plates by countersunk screws 98. The four vertical plates are supported by and connected to a bottom plate 100. The front and rear plates 90 and 92 may be provided with rectangular windows 102 and 104 which may be closed by relatively thin, removable cover plates 106 and 108 to facilitate assembly and servicing of the working parts which will presently be described.

The shaft 74 upon which the arms 72 are fixed extends vertically downwardly through a sleeve bearing 110 located in a journal 112 supported by the upper plate 62 and to a lower sleeve bearing 114 in a journal 116 supported by the lower plate 100. The shaft 74 is free to both rotate and reciprocate in the vertical direction in the sleeve bearings 110 and 114.

An electric motor 120 is supported by brackets 122 and

124 which are secured to the vertical side wall 94. The motor 120 drives a timing shaft 126 by means of a pulley 128 on the drive shaft of the motor 120, a belt 130, and a pulley 132 on the timing shaft 126. The timing shaft 126 is journaled in sleeve bearings 134 and 136 connected to the top and bottom plates 62 and 100.

The shaft 74, and therefore the four pairs of arms 72 and 76, and four pairs of fingers 54, are raised once each revolution of the timing shaft 126 by an upwardly facing cam 138 which is mounted on the timing shaft 126. A cam follower 140 rolls on the upwardly facing cam 138 and is journaled on a pin 142 connected to the free end of a lever arm 144. The other end of the lever arm 144 is pivotally connected to the side wall 94 by pivot pin 146 and brackets 148. The free end of the lever arm 144 is disposed around the shaft 74 and engages the outer race of a ball bearing 150. The inner race of the bearing 150 is disposed around the shaft 74 and engages a snap ring 152 when moved upwardly. As the cam follower 140 rides over the cam 138, the lever arm 144 is pivoted upwardly, raising the bearing 150 which engages the snap ring 152 and lifts the shaft 74. A coil spring 154 is disposed between the journal 112 and the bearing 150 to insure that the cam follower 140 follows the cam 138.

The shaft 74 is rotated one-quarter turn for each full revolution of the timing shaft 126 by a conventional Geneva drive having a driving member 160 and a driven member 168. The driving member 160 is splined on the timing shaft 126 and includes a flywheel portion 162, which carries a pin 164, and a locking cam portion 166. The driven member 168 has a keyway 170 which receives the shaft 74 and keys 172 which are fixed to the shaft 74. The keyway permits the shaft 74 to reciprocate vertically as the keys 172 slide in the keyway 170, yet rotates the shaft 74. The driven member has four radially extending slots 182. Each pair of slots is separated by a quartercircular concave edge 169 which mates with the circular locking cam 166 on the driving member 160. The driven member 168 is journaled between upper and lower thrust bearings 174 and 176. The upper bearing 174 is supported by a journal bracket 178 which is cantilevered out from a post 180 which in turn is connected to the bottom plate 100 by screws (not illustrated).

The operation of the Geneva drive is well known and is illustrated in the schematic drawings of FIGURES 9a-9c. As the timing shaft 126 rotates in the counter-clockwise direction, the pin 164 enters one of four slots 182 in the driven member 168. As the timing shaft 126 continues to rotate, the driven member 168 is rotated one-quarter turn at which time the pin 164 leaves the groove 182 and the locking cam 166 enters into the mating quartercircular slot 169 in the driven member 168. This locks the driven member 168 and therefore the shaft 74 in place until the pin enters the next slot 182. Thus the shaft 74 is rotated one-quarter turn for each full revolution of the timing shaft 126.

The raised portion of the cam 138 is located in a position on the timing shaft 126 with respect to the pin 164 so that the shaft 74 is fully raised during the entire period of time while the shaft 74 is being rotated, thus insuring that the pair of fingers 54 will clear the various stations as the arms 72 are rotated from station to station as will hereafter be described in greater detail.

The supply station 64 is comprised of a slurry supply tank 189 having a large lower chamber 190, a restricted neck chamber 192, and an annular delivery trough 194 formed around the outlet of the neck chamber 192, all of which are formed by a bottom plate 195 which is connected to a turned member 196. A reduction gear box 206 is mounted on a pair of brackets 200 which in turn are pivotally mounted on a shaft 202. The shaft 202 is supported by bracket 204 which is mounted on the vertical side plate 96. The reduction gear box 206 is driven by a motor 198 which is supported by the gear box. The slurry tank is mounted on the drive shaft 208

of the gear box 206 by a hub 210. Thus the slurry supply tank, gear box 206 and motor 198 are all pivotally mounted on the shaft 202. The axis of rotation of the slurry supply tank is disposed at approximately 45° and the position of the axis may be adjusted by a screw 212 which is threaded through a wing bracket 214 attached to the bracket 200. The end of the adjustment screw 212 engages the vertical side wall 96 to act as a stop. The shaft 202 permits the slurry tank assembly to be tilted away from the machine to facilitate servicing of the supply tank, in which case the lower edges 216 of the brackets 200 engage the vertical side wall 96 and act as a stop at the 45° angle.

The large lower chamber 190 is filled with slurry to a level at least high enough to enter into the neck portion 192, and usually will be completely filled. Then as the slurry tank is rotated by the motor 198, a helical groove 220 formed by screw threads pumps the slurry up the inclined lower surface of the neck portion 192 into the annular delivery trough 194. This pumping action is effective so long as the level of slurry in the lower chamber 190 extends into the lower end of the helical groove. The outer rim 222 of the annular trough 194 extends to a higher elevation than the inner rim 223 so that fluid pumped by the helical groove will not overflow the delivery trough 194. It is desirable for the helical groove to pump fluid to the delivery trough at a greater rate than it is withdrawn by the fingers 54. Then the fluid will continually overflow the inner rim 223 and the helical groove and thereby continually mix the slurry in the delivery groove with the slurry remaining in the neck portion 192 and enlarged lower chamber 190. Since the axis of the slurry supply tank is inclined at an angle of about 45° to the vertical, all walls are continually wet by the slurry as the tank is rotated about the axis. This prevents settling and caking of the glass particles on any surface.

The supply tank is also adapted to retard evaporation of water from the slurry and thereby tends to maintain a substantially constant water-to-glass particle ratio. The large lower chamber 190 provides a substantial volume of the slurry. The restricted neck portion 192 materially reduces the surface of the liquid that is exposed to the atmosphere so as to reduce the rate of evaporation. By both reducing the rate of evaporation and increasing the volume of the slurry, the concentration tends to remain substantially constant. The rate of evaporation may also be retarded by increasing the humidity of the air around the delivery trough 194. This is accomplished by a collar tank 224 disposed around the delivery trough 194. The collar tank 224 has opening 226 at the upper end thereof and is filled with a fibrous wick material 228, such as steel wool, and a supply of water 230 which wets the wick material 228 as the tank rotates. Moisture from the wetted wick then evaporates into the atmosphere to increase the humidity immediately adjacent the surface of the slurry and thereby to retard the rate of evaporation.

The insertion station 66 is comprised of a slide plate 240 which is inlaid in the top surface of the top plate 62 and very accurately formed and oriented to precisely support the carrier assemblies 11 at the height necessary to precisely locate each receptacle 10 at the insertion station. Guide rails 242 and 244 are positioned on one side of the slide plate 240, and a guide rail 246 is positioned on the other. The guide rails 242, 244 and 246 are very accurately located to closely receive the edges 48 and 50 of the carrier assembly 11 so as to precisely locate the receptacles 10 in the transverse direction. A conveyor belt 248 continually urges a series of carrier assemblies 11 from left to right over the slide plate 240 and between the guide rails 242 and 246 until the trailing edge of the leading camway 46a engages the left-hand cam roller 250 of an indexing mechanism indicated generally by the reference numeral 252.

The indexing mechanism 252 is comprised of an indexing shaft 254 which is journaled in upper and lower ball bearings 256 and 258 which are in turn supported by suitable journal blocks secured to the upper and lower plates 62 and 100 as illustrated. The indexing shaft 254 is driven from the shaft 74 by a timing belt 260 which passes around a pulley 262 connected to the driven member 168 of the Geneva drive and a pulley 264 splined to the indexing shaft 254. The timing belt 260 also passes around a pair of idler pulleys 266 and 268 which are journaled on posts 270 and 272, respectively. The posts 270 and 272 are adjustably connected to the bottom plate 100 by screws 274 and 276. The pulley 264 is one-half the diameter of the pulley 262 so that the shaft 254 will rotate 180° each time that the shaft 74 rotates 90°. After the idlers 266 and 268 have been moved outwardly to tension the timing belt 260, the rotational position of the indexing shaft 254 may be adjusted by moving the idlers 266 and 268 in unison in the same direction. The two rollers 250 are journaled on a plate 280 which is affixed to the upper end of the indexing shaft 254 and is flush with the slide plate 240. The rollers 250 are located on opposite sides of the axis of the indexing shaft 254 and are spaced apart a distance corresponding to the spacing between the camways 46 on the carrier assemblies 11. The axis of the shaft 254 is spaced from the edge of the guide rails 242 and 244 only a sufficient distance to avoid an interference with the carrier assemblies. The rotational position of the shaft 254, when not in motion, is adjusted so that the left-hand cam roller 250 just enters the corresponding camway 46. This positions the carrier assembly with great precision because any error in the rotational position of the indexing shaft has no effect on the position of the carrier assembly. In order to start a carrier assembly through the indexing mechanism, the carrier assembly is urged forward, usually by the conveyor belt 248 acting on the following carrier assembly 11, until the trailing edge of the camway 46a engages the left-hand roller 250. Then as the driven member 168 of the Geneva drive is rotated 90° so as to rotate a pair of fingers 54 from the supply station 64 to the insertion station 66, the indexing shaft 254 rotates 180° and the left-hand roller 250 moves up into the half camway 46a and the right-hand roller 250 moves into the first complete camway 46 to precisely position the first receptacle 10 at the insertion station. It is important to note that since only two rollers 250 are used, the acceleration and deceleration of the carrier assembly is sinusoidal, beginning and ending at zero, and thus movement of the carrier assembly is very smooth. Then when the shaft 74 is lowered, the nibs 52 on the fingers 54 enter the receptacle.

The fingers 54 are very precisely located at the insertion station by the locater pin 88 on the fixed arm 72 which drops into a female locater 277 as the shaft 74 is lowered. The female locater is mounted on a bracket 278 which in turn is adjustably secured to the top plate 62 so as to precisely locate the nibs 52.

After the nibs 52 on the fingers 54 have been lowered into the receptacle 10 positioned at the insertion station 66, the fingers are spread apart several times to deposit the glass slurry in the receptacle and spread the slurry to insure that all leads are fully wet and all cavities filled. This is accomplished by a lever arm 281 which is pivotally mounted on a pin 282 extending from a bracket 283 which depends from the top plate 62. The lever arm 281 extends through an opening in the top plate 62 and engages the depending cam lobe 86 secured to the movable arm 76. The lower end of the lever arm 281 is connected to a horizontally extending lever arm 284 by an adjustable length push rod 286. The lever arm 284 is pivotally mounted on the bracket 178 by pivot pin 288. A cam follower 290 is journaled on the bottom side of the lever arm 284 and rides on a circular cam 292 on the timing shaft 126. Lobes are provided on the cam wheel 292 to pivot the lever arm 284 and hence the lever arm 281 so

that the upper end of lever arm 281 will engage the cam 86 and open the fingers during the time while the shaft 74 is lowered and inactive. It is also desirable for the fingers 54 to be spread apart as the fingers are raised by operation of the cam 138 for reasons heretofore discussed. It will be appreciated that since the distance the finger 54 moves is extremely small, the lobes on the cam wheel 292 are extremely small and therefore no attempt has been made to show the lobes in the drawings. A tension spring 293 interconnects the lever arm 284 and the end of a bracket 294 which is cantilevered from the bracket 178 to continually bias the cam follower 290 against the cam wheel 292 and bias the upper end of the lever arm 281 away from the cam lobe 86.

The wash station 68 includes a primary tank 300 which is mounted on the vertical side wall 94 by brackets 302. The brackets 302 are welded or otherwise connected to the tank 300 and are connected to the side wall 94 by vibration isolation means comprised of bolts 304 which pass through shock absorber washers 306 and are threaded into the side wall 94. An ultrasonic transducer 308 of conventional design is secured to the tank 300 and induces ultrasonic waves in the water filling the primary tank 300. The ends of the fingers 54 are lowered between a pair of counterrotating, meshing brushes 310. The axes of the brushes are disposed at an angle to the horizontal, as best seen in FIGURE 10, so as to insure that all portions of the fingers 54 are contacted by the bristles of the brushes. The brushes 310 are driven by an electric motor 312 and gear box 314 which are mounted on the top plate 62 by a bracket 316.

Clean water is continually applied to the brushes 310 by a spout 318 which is conveniently mounted in a swivel connector 320 which in turn is mounted on the side plate 94 by bracket 322. Flow of water through the spout 318 is controlled by a valve 324. An overflow weir 326 in the side wall of the tank 300, which also serves to pass the shafts 328 of the brushes 310 into the tank, maintains water in the primary tank 300 at the level 330 so as to keep the brushes 310 substantially immersed. Water overflowing the weir 326 passes into an upper drain chamber 327, which is formed by the side wall 332 and the wall of the tank 300, then into a lower drain chamber 342 and out through a drain hose 334. The primary tank 300 may be completely drained by pulling stopper 336, which is conveniently connected to a shaft 338 and spherical handle 340, so that the water will pass into the lower drain chamber 342 and out the drain hose 334.

A settling tray 346 is disposed almost entirely beneath the water level 330, except for tabs 348 and 350 which rest on the upper edges of opposite side walls of the tank 300 to support the tray. The settling tray 346 provides a basin in which the glass particles washed from the fingers 54 will settle out rather than pass into the plant sewage system. A vertical baffle 352 is disposed around the brushes 310 for segregating the water in the remainder of the settling tray 346 from the fresh water around brushes 310. The baffle 352 has tabs 354, 356 and 358 which rest on the upper edge of the side walls of the tank 300 to support the baffle. The water being added to the interior of the baffle 352 from the spout 318 flows outwardly under the bottom of the baffle into the settling tray 346 so as to prevent the reentry of the glass particles in the settling tray 346 to the washing area, and also overflows the weir 326. A cam post 360 (see FIGURES 5 and 6) is mounted on the top plate 62 and positioned to engage the cam lobe 86 on the movable arm 76 positioned at the wash station as the arm is lowered to spread the arms and fingers 54 and facilitate cleaning the fingers 54.

The drying station 70 is comprised of a drying chamber 400 formed by a manifold block 402 and a top plate 404. The fingers 54 are introduced to the drying chamber 400 through an opening 406 in the top plate 404 and an opening 408 in the block 402. Eight air jets 410 are directed radially inwardly and downwardly toward the cen-

ter of the drying chamber 400. The jets 410 extend from an annular manifold 414 formed by an angular groove in the block 402 and the top plate 404. The annular manifold 414 is in fluid communication with a source of compressed air through a bore 416 and fitting 418. In addition to impinging directly upon the fingers 54, the air from the downwardly directed jets 410 induces a down draft through the opening 406 which prevents any glass particles from being blown out into the room atmosphere. The combined stream of air then passes down a tray 412 and spills over the top of the tray 412 at the end 412a opposite the drying chamber. A bonnet 420 directs the air downwardly into a suitable filter box 422. The filter 422 is filled with any suitable fibrous material 424 and is affixed to the rear wall 92 by a suitable means (not illustrated). The bonnet 420 is connected to the top plate 404 and block 402 by a hinge 426 and can be pivoted upwardly to permit the tray 412 to be easily emptied. A leaf spring 428 is secured within the bonnet 420 and engages the end of the tray 412 to hold the tray in place. The bonnet 420 is held in place by a pair of leaf springs 430 which are connected to the ends of the filter box 422 and snap over bars 432 on the ends of the bonnet 420. A cam post 434 is also provided on the top plate 62 at the drying station to engage the cam lobe 86 as the arm 76 is lowered and spread the fingers 54 while inserted in the drying chamber.

While operating the machine, the air jets may be continually in operation, or may be operated only when the fingers 54 are lowered. In the latter case a suitable solenoid controlled air valve may be opened at the proper time by a limit switch (not illustrated) closed by the lever arm 144 as it lowers, for example. As mentioned, the downwardly directed air jets establish a flow of air in through the opening 406 so that any glass particles do not escape to the atmosphere through the opening 406. Any glass particles remaining in the liquid wetting the fingers are almost instantly dried and blown off into the tray 412 where the glass particles are collected. The air then passes through the tray 412, up over the end of the tray, and is directed downwardly by the bonnet 420 through the fibrous material 424 of the filter 422 and then passes out into the atmosphere. Of course, the fibrous material 424 traps any remaining glass particles so as to prevent contamination of the atmosphere. The tray 412 may be emptied from time to time and the fibrous material 424 replaced merely by pivoting the bonnet 420 upwardly about the hinge 426.

In the operation of the machine 60, the slurry supply tank 189 is filled with slurry and is set in motion. The brushes 310 are rotated and fresh water is continually introduced from the spout 318. At least one carrier, and usually a large number of carriers, is loaded with the lead frame strip assemblies and fed by the conveyor 248 to the machine. Each assembly must be moved either by the conveyor 248 or manually until one of the cam rollers 250 enters a complete camway 46. After the machine 60 is set in operation, the timing shaft 126 rotates continuously. Just prior to the time that the Geneva drive rotates the shaft 74 one-quarter turn and the indexing shaft 254 one-half turn, the shaft 74 and thus four sets of fingers 54 are raised as the cam follower 140 rolls over the cam 138. Then each pair of fingers 54 is rotated 90° to the next station. At the same time, the indexing mechanism 252 indexes the carrier assembly forward and aligns the next successive receptacle 10 at the insertion station. As soon as the Geneva drive has moved the shaft 74 one-quarter turn and locked the shaft in position, the cam 138 lowers the shaft 74 so as to insert each pair of fingers 54 into the station at which it is positioned. The pair of fingers 54 which are immersed in the delivery trough of the supply station remain closed by the spring 80. The pair of fingers 54 inserted in the receptacle at the insertion station 66 are opened and closed a plurality of times by operation of the cam 292, lever arm 284, linkage 286 and lever arm 281

acting on the cam lobe 86. As the fixed arm 72 is lowered, the locator pin 88 enters the female locator 277 to precisely position the nibs on the fingers 54 in the receptacle. Also as the arms are lowered, the movable arms 76 located at the wash station 68 and drying station 70 are pivoted outwardly as the cam lobes 86 on the arms are lowered past the cam posts 360 and 434, respectively, so as to spread the fingers 54 and facilitate washing and drying. Thus each pair of fingers 54 is successively moved between the supply station 64, insertion station 66, wash station 68 and drying station 70 prior to returning to the supply station.

Although particular embodiments of the method and apparatus of the present invention have been described in detail, it is to be understood that various changes, substitutions and alterations can be made therein without departing from the spirit and scope of the invention as defined by the appended claims.

What is claimed is:

1. In a machine for inserting a predetermined quantity of liquid in a receptacle, the combination of:

a supply station having liquid supply means for containing a supply of the liquid,

an insertion station having receptacle support means for supporting the receptacle which is to receive the predetermined quantity of liquid,

a pair of fingers adapted to form a capillary cavity between the fingers, and

actuation means for holding the fingers in predetermined relationship to form a capillary cavity of predetermined volume, for contacting the fingers with the liquid contained by the liquid supply means to fill the capillary cavity with the liquid, for transporting the fingers to a receptacle supported by the receptacle support means and for spreading the fingers to deposit the liquid carried in the capillary cavity in the receptacle.

2. The combination defined in claim 1 wherein the liquid supply means and the receptacle receive the fingers through openings in the tops thereof, and wherein the actuating means comprises:

a shaft disposed generally vertically and mounted for both rotational movement and reciprocal movement between upper and lower positions,

a pair of horizontally disposed arms connected to the shaft and extending generally horizontally therefrom, at least one of the arms being pivotally movable with respect to the other arm to permit spreading the arms, each arm supporting one of the fingers at the end thereof remote from the shaft, the shaft being positioned relative to the liquid supply means and the receptacle support means such that when the shaft is in the lower position the fingers will be inserted in either the liquid supply means or a receptacle on the receptacle support means and when the shaft is in the upper position the fingers will be withdrawn from the liquid supply means and the receptacle on the receptacle support means, and such that rotation of the shaft will transport the fingers from one of said liquid supply means and receptacle support means to the other,

means for periodically reciprocating the shaft to withdraw and insert the fingers,

means for rotating the shaft to transport the fingers between said liquid supply means and receptacle support means while the fingers are withdrawn, and means for spreading the arms while the shaft is in the lower position and the fingers are inserted in the receptacle at the insertion station.

3. The combination defined in claim 2 further characterized by:

a continuously rotating timing shaft, and wherein the means for reciprocating the shaft between the lowered and raised positions comprises curved cam means on the timing shaft and cam follower means

engaging the cam means and connected to said shaft for positioning said shaft in response to the curvature of the cam means, and wherein

the means for rotating said shaft comprises a driving member on the timing shaft and a driven member on said vertical shaft, said driving member being operative to drive the driven member during the portion of the revolution of the timing shaft that the cam means raises the shaft to the upper position.

4. The combination defined in claim 3 wherein the means for rotating the shaft comprises:

lost motion drive means having a driving member which is continually rotated by the timing shaft and a driven member which is keyed to the shaft for rotating the shaft, yet permitting reciprocation of the shaft.

5. The combination defined in claim 4 further characterized by:

indexing means located at the insertion station for successively indexing a series of receptacles past the insertion station, the indexing means being driven from the driven member of the lost motion drive means whereby the indexing means will be operative while the shaft is being rotated.

6. The combination defined in claim 5 wherein the indexing means comprises:

an elongated slide plate,

an elongated carrier assembly slidably resting on the slide plate for supporting a plurality of receptacles spaced longitudinally of the carrier assembly at uniformly spaced intervals,

a plurality of camways extending transversely of the carrier assembly having open aligned ends and spaced longitudinally of the carrier assembly at corresponding intervals,

an indexing shaft having an axis of rotation,

a plurality of cam means mounted on the shaft and equally spaced around a circle about the axis of rotation for successively entering the camways and moving the carrier assembly along the slide plate as the shaft is rotated, and

drive means interconnecting the driven member of the lost motion drive means and the indexing shaft for rotating the indexing shaft through an angle equal to that required to move the next receptacle into position at the insertion station each time that the shaft is rotated.

7. The combination defined in claim 6 wherein the carrier assembly is further characterized by:

an elongated base member having an upper surface for supporting a lead frame strip assembly,

a plurality of locator pins extending upwardly from the base member for passing through locator holes in a lead frame strip assembly and precisely locating the strip assembly on the base member,

a pedestal projecting upwardly from a recess formed in the upper surface for supporting each of the receptacles of the lead frame strip assembly, the upper surface of each pedestal being positioned with respect to the upper surface so as to properly position the receptacle in the vertical direction with respect to the leads of the lead frame strip, and

a top plate for disposition over the lead frame strip having locator holes therein for receiving the locator pins and precisely locating the top plate with respect to the base member and having an aperture therein for receiving and locating each receptacle transversely and longitudinally of the base member.

8. The combination defined in claim 1 wherein the liquid supply means comprises:

a receptacle having a longitudinally extending axis and an open end around the axis, and

means for supporting the receptacle with the axis disposed at an acute angle to the vertical and for rotating the receptacle about the axis

whereby the fingers may be inserted through the open end into the liquid in the receptacle and whereby the liquid will be continually mixed and all interior walls of the receptacle continually wet by rotation of the receptacle to prevent settling and coagulation of constituents in the liquid.

9. The combination defined in claim 8 wherein the receptacle is further characterized by:

a relatively large lower chamber,

a restrictive neck portion concentric to the axis at the upper end of the lower chamber,

an annular delivery trough concentric with the axis and disposed around the open end of the restrictive neck portion, and

pump means in the neck portion for continually pumping liquid from the lower chamber and neck portion into the delivery trough as a result of rotation of the receptacle.

10. The combination defined in claim 9 wherein the pump means comprises:

a helical groove formed in the interior surface forming the neck portion.

11. The combination defined in claim 1 further characterized by:

at least one additional station having means for cleaning the fingers, the stations being disposed about the circumference of a circle at equally spaced positions,

a number of pairs of fingers corresponding to the number of stations, each pair of fingers adapted to form a capillary cavity between the fingers,

rotary means for supporting a pair of the fingers at each of the stations, the rotary means having an axis of rotation disposed at the center of the circle on which the stations are disposed, and wherein

the actuation means comprises means for raising the rotary means to a height such that each of the pairs of fingers will clear the respective stations, for rotating the rotary means so as to move each pair of fingers to the next adjacent station, and for lowering the rotary means to place each pair of fingers in operative position at the respective stations, and

means for spreading the pair of fingers at the insertion station.

12. The combination defined in claim 11 wherein the additional stations consist of a washing station and a drying station.

13. The combination defined in claim 12 wherein the wash station comprises:

a pair of counterrotating, meshing brushes disposed at an acute angle to the horizontal in a position to receive the portion of the pair of fingers forming the capillary cavity between the brushes as the fingers are lowered at the station,

a tank disposed around the brushes for maintaining liquid to a level to continually wet the brushes,

a settling tray disposed under the brushes and forming a settling basin for solid particles washed from the fingers,

baffle means disposed around the brushes and spaced from the bottom of the settling tray,

means for continually directing a stream of clean water into the baffled area, and

an ultrasonic transducer operatively connected to the tank for inducing ultrasonic waves in the water in the tank to facilitate cleaning the fingers immersed therein.

14. The combination defined in claim 12 wherein the drying station comprises:

manifold means forming a drying chamber having an open top for receiving a pair of fingers lowered at the drying station,

a tray disposed in the bottom of the drying chamber having an exhaust opening remote from the top opening,

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a plurality of air jets for connection to a supply of compressed air disposed around the drying chamber and directed toward the center thereof and away from the top opening to impinge on and dry the fingers inserted in the drying chamber and to induce a flow of air down through the top opening and out the exhaust opening, and

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filter means over the exhaust opening through which the exhaust air must pass.

No references cited.

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