

[54] ETCHING MACHINE

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[58] Field of Search **134/56 R, 57 R, 94, 95,**
134/97, 98, 133, 135, 140, 141, 143, 145,
146, 155, 200

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Primary Examiner—Robert L. Bleutge

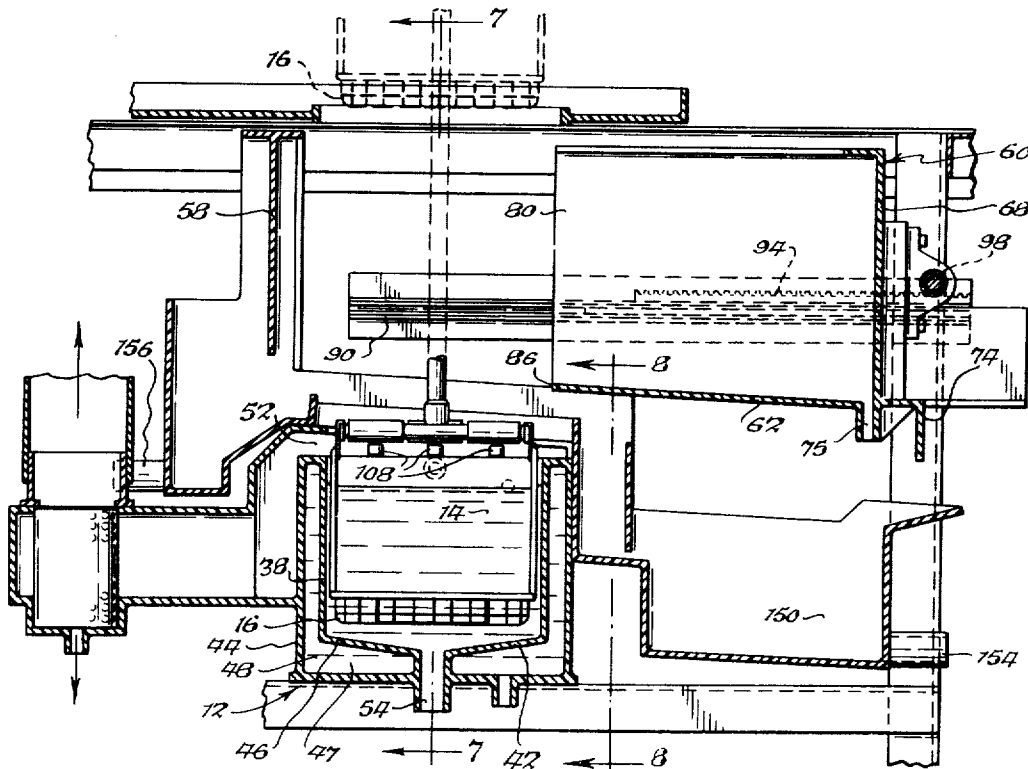
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[57]

ABSTRACT

An apparatus for processing an article comprising a movable spray chamber which can be positioned around the article to prevent spray liquids from contaminating other processing liquids. The movable spray chamber permits more rapid spraying of the article after the article is removed from another processing liquid.

12 Claims, 10 Drawing Figures



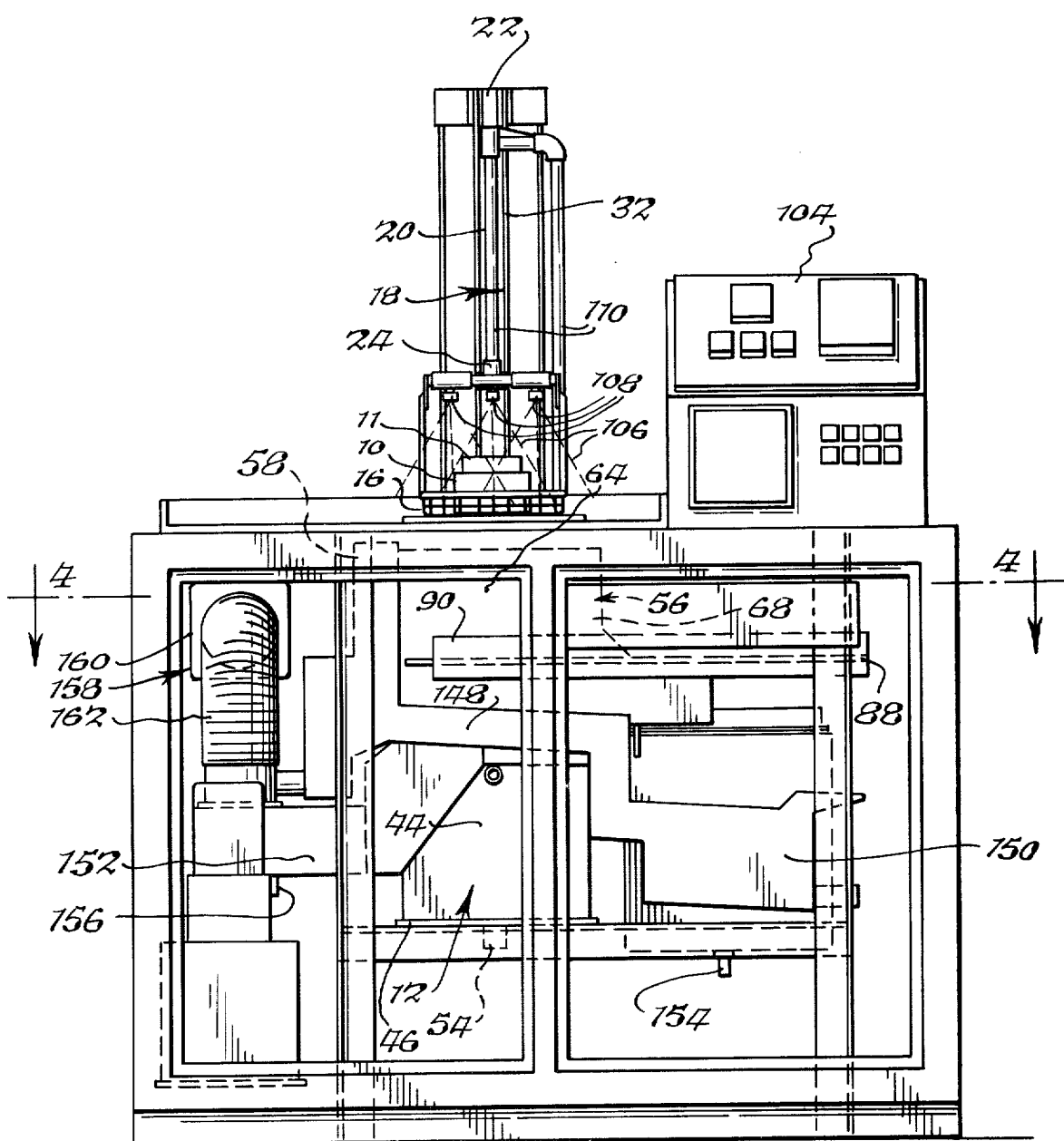


Fig. 1.

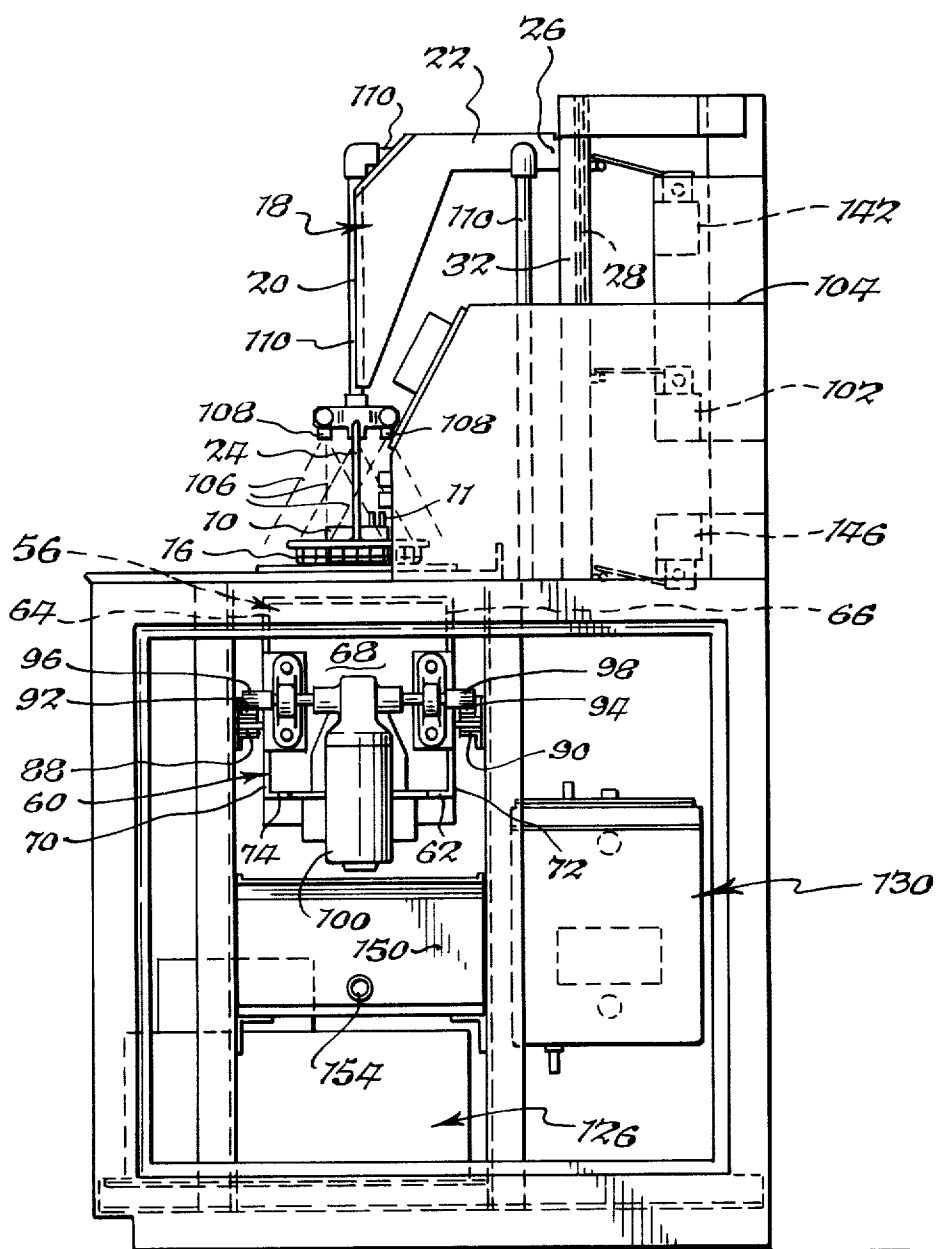


Fig. 2.

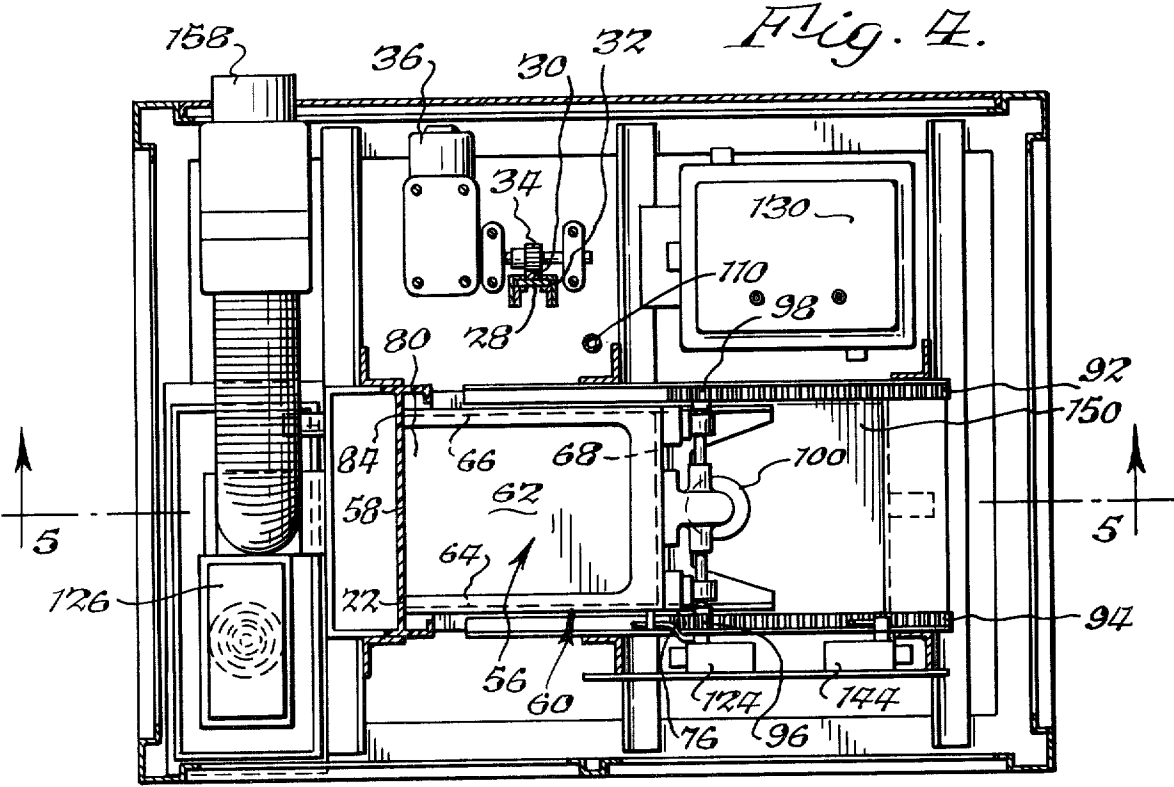
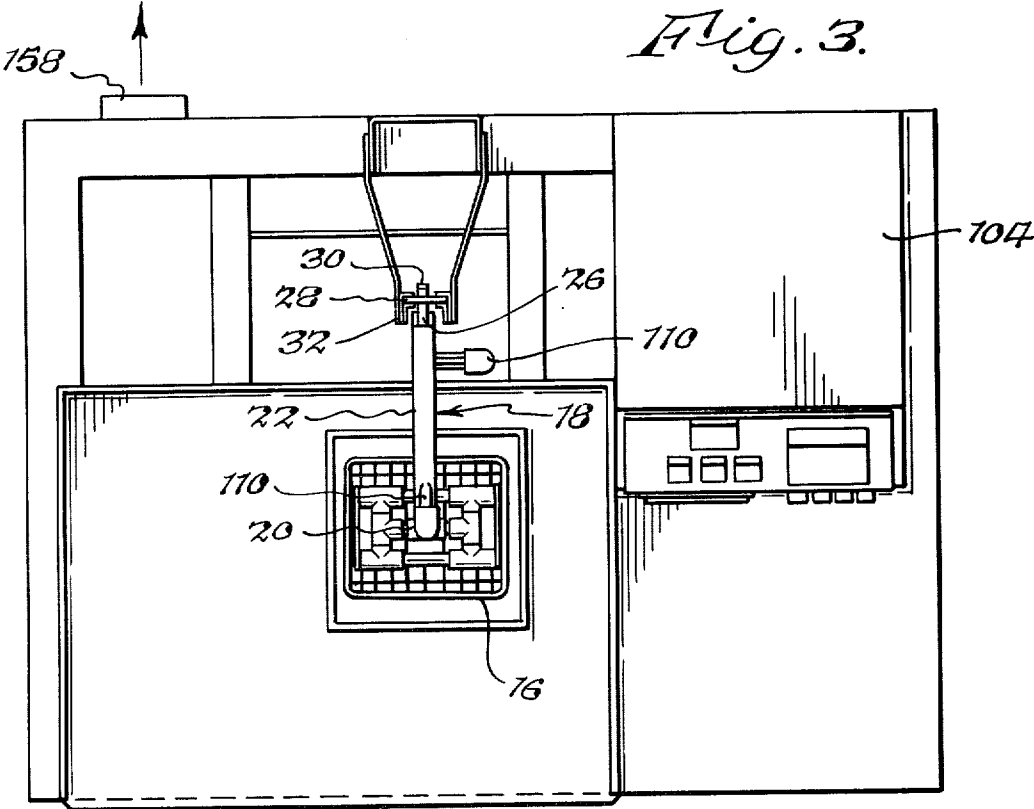


Fig. 5.

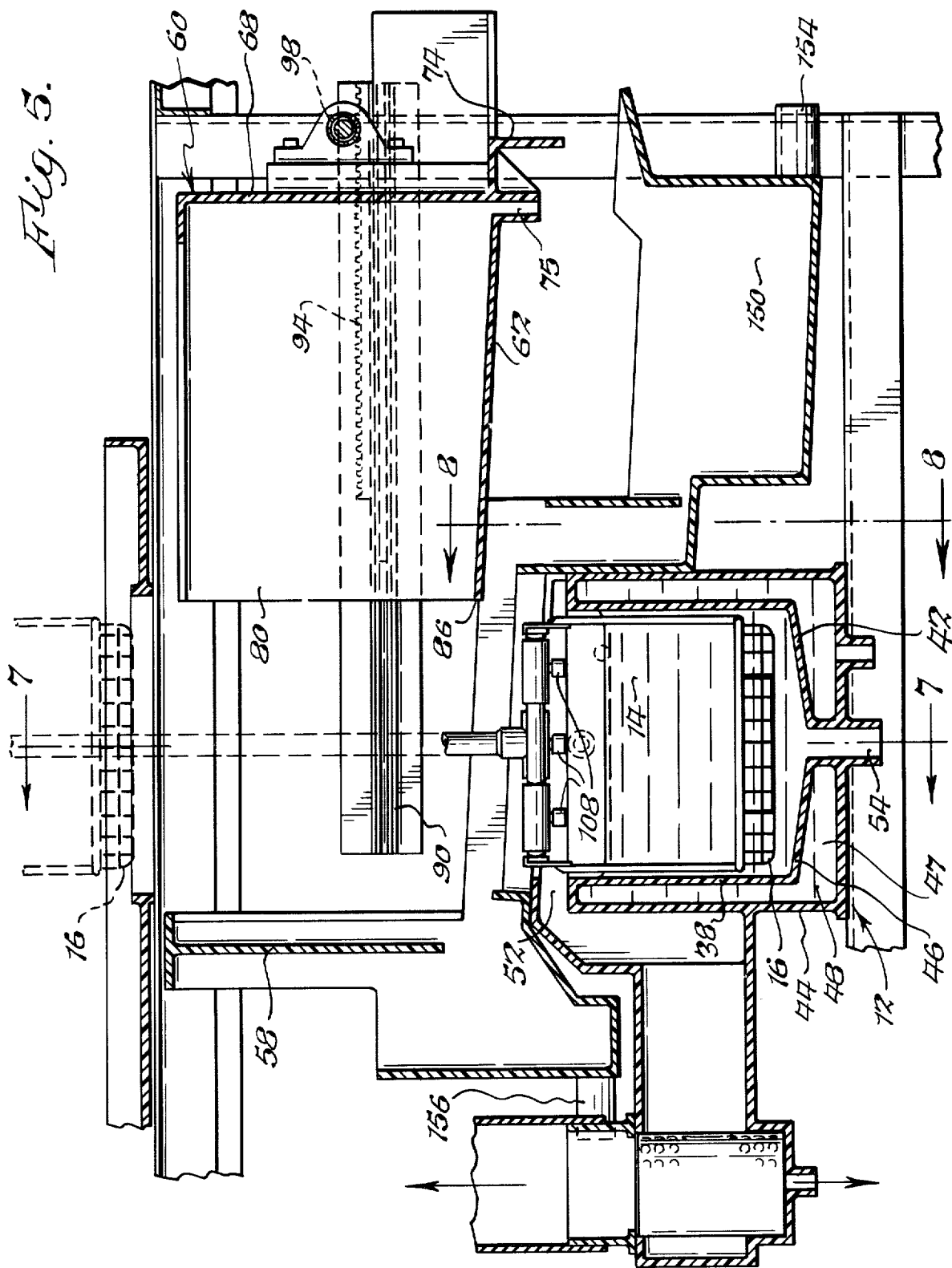
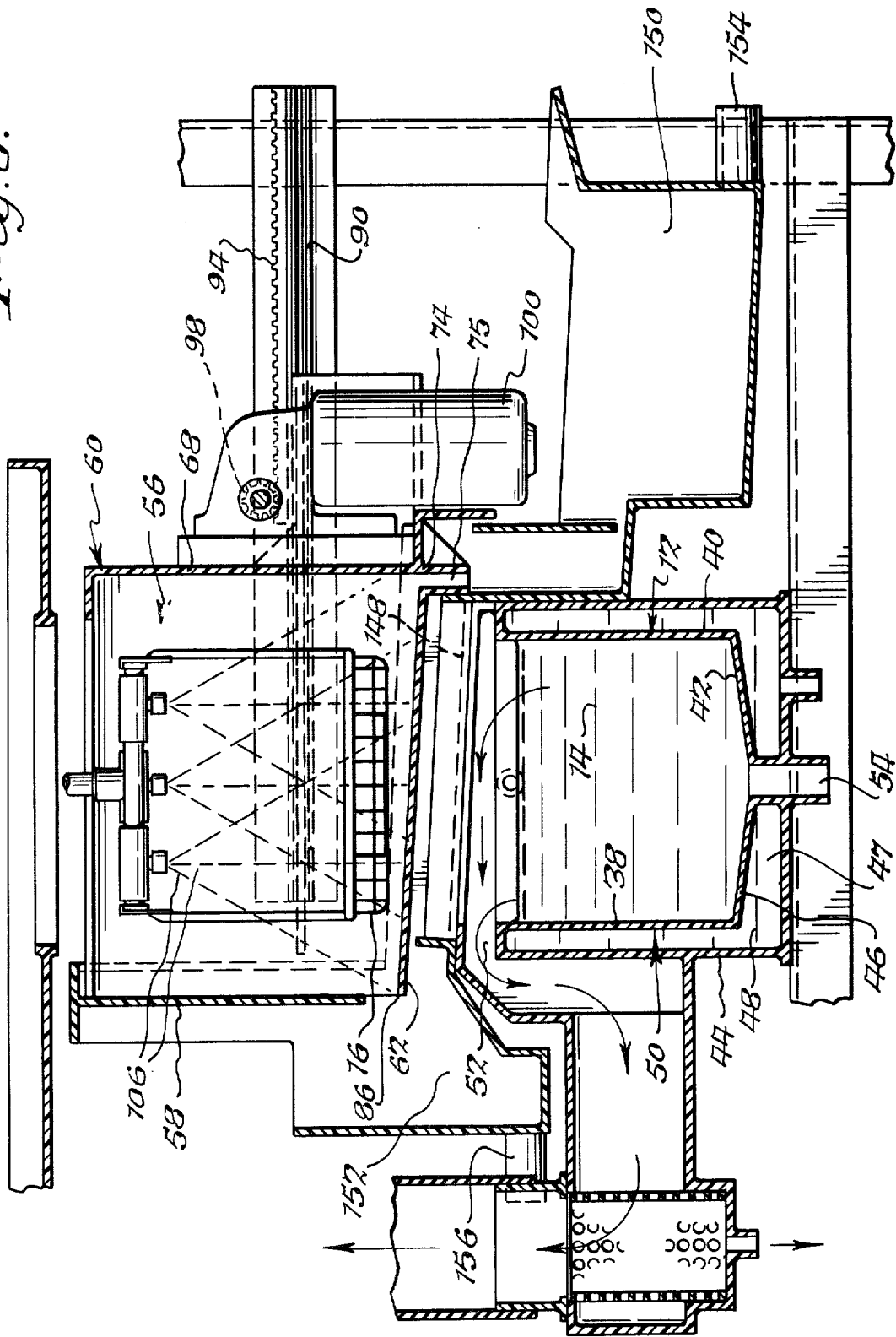


Fig. 6.



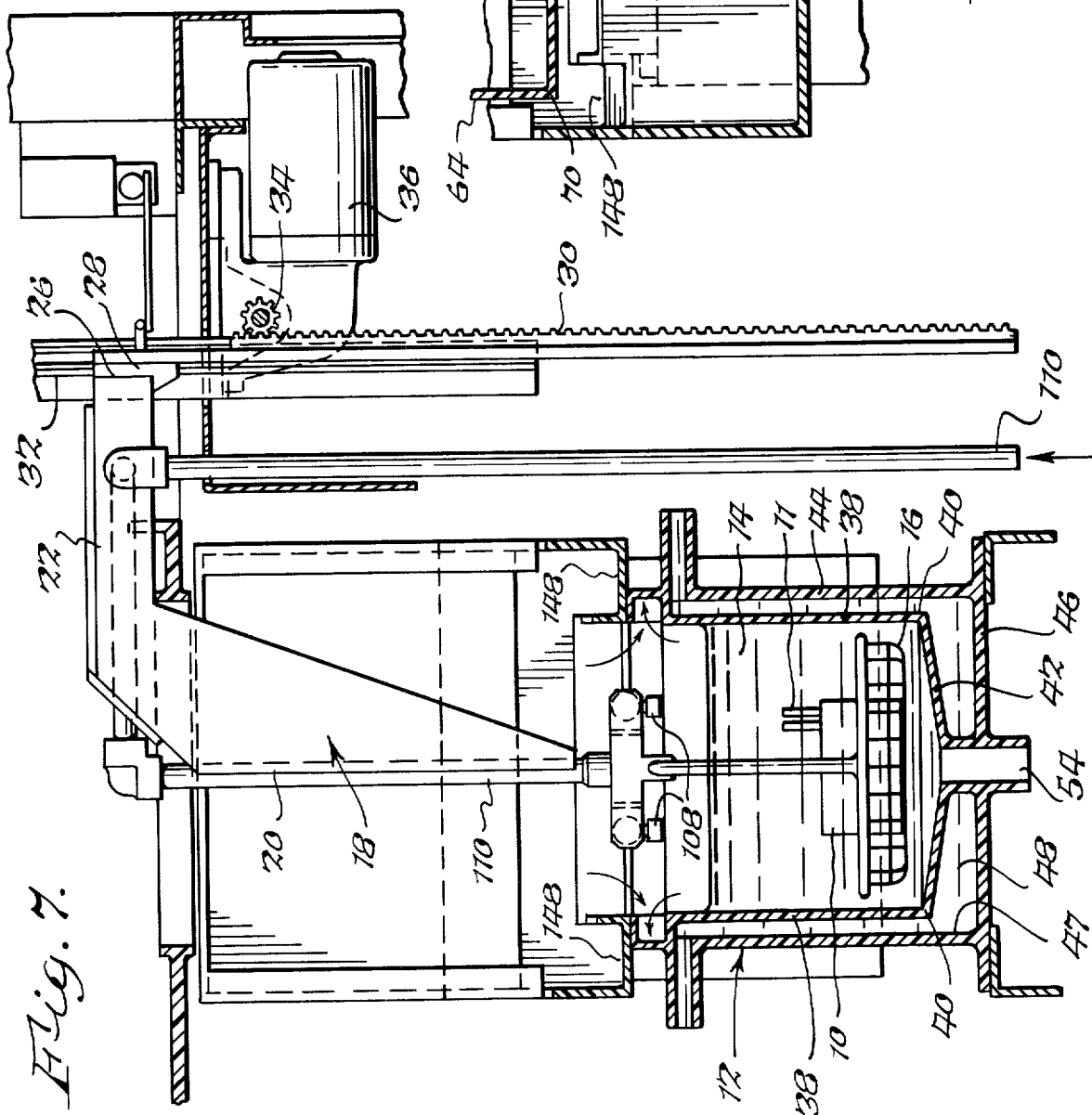


Fig. 7.

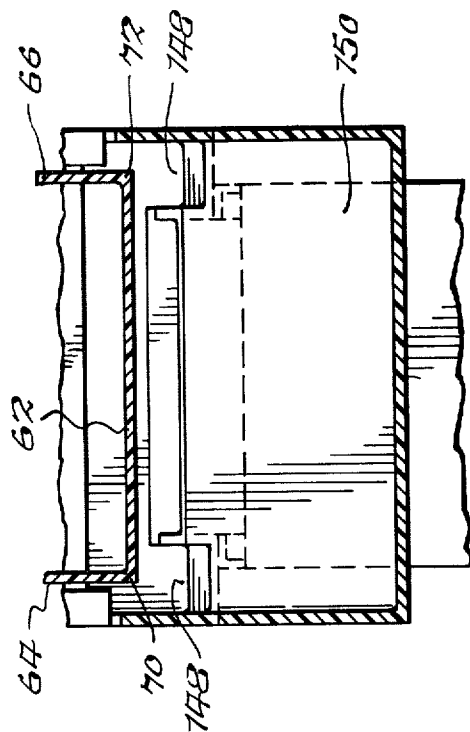


Fig. 8.

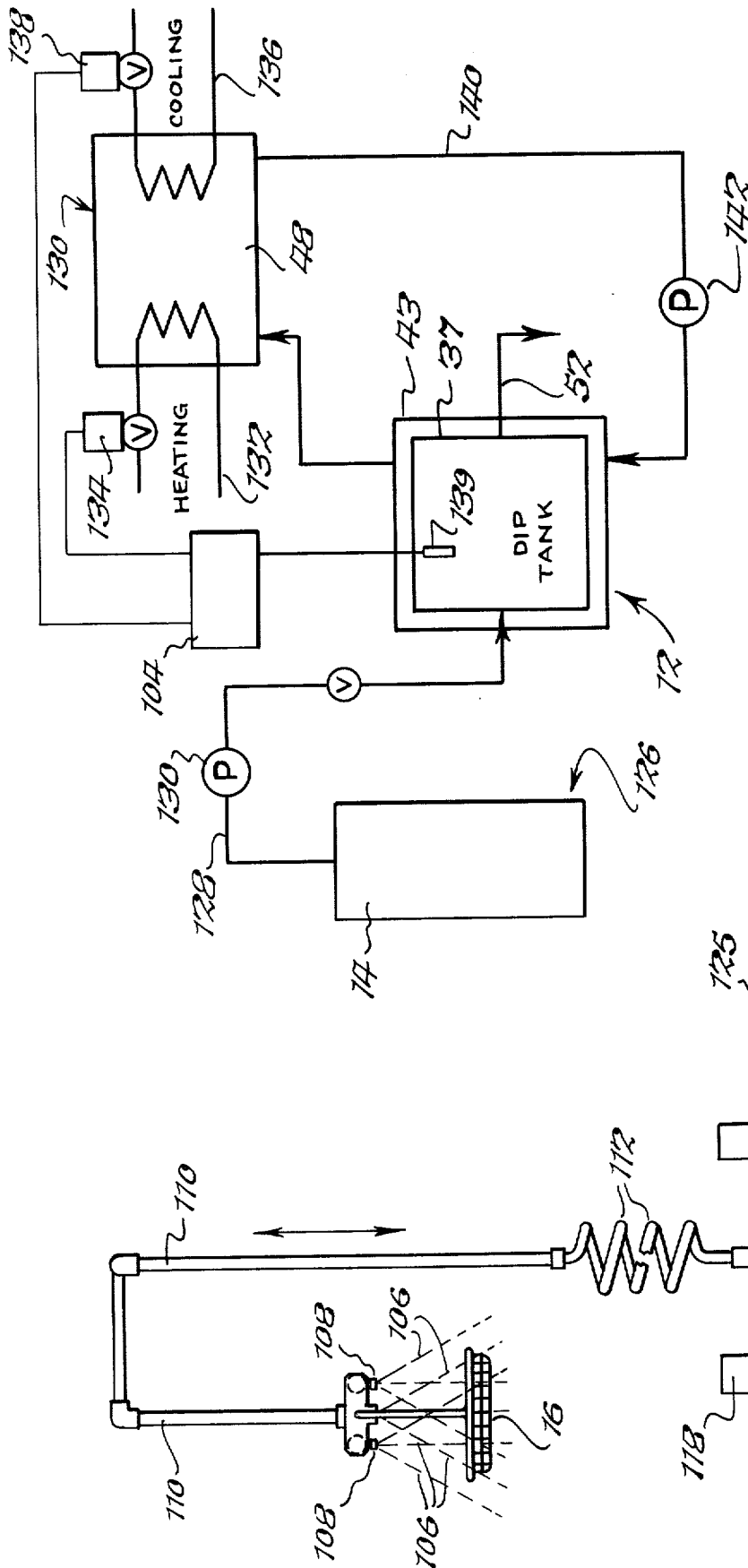


Fig. 10.

Fig. 9.

ETCHING MACHINE

BACKGROUND OF THE INVENTION

Many of the distinct steps involved in manufacturing electronic semi-conductor devices involve the use of liquid chemicals. Prior art workers have attempted to provide continuous type machines for conducting the various steps involved in the manufacture of electronic semi-conductor devices, for example, U.S. Pat. Nos. 3,219,509; 3,388,023; 3,630,804; 3,657,049; 3,663,724 and 3,727,620.

Apparently, for reasons of complexity, economics, reliability, lack of uniform results or other reasons, these devices have not met with wide acceptance in the semi-conductor manufacturing industry since the practice of conducting these liquid chemical treatment steps by means of small individual batches is still widespread in the industry. These batch-wise processes are conducted in small vessels, usually less than 5 gallons of liquid and typically about 1 gallon. The workpieces or articles are transported manually through the individual process steps. Operator variables such as over- or under-processing, contamination, incorrect bath compositions and the like are becoming economically unacceptable since mass handling of articles cannot be accomplished and since finished workpieces do not consistently meet necessary standards.

The operator variables become particularly noticeable in etching operations.

Etching generally refers to methods of removal of selected exposed areas of metallic or dielectric films by means of oxidation and/or dissolution. Many etching steps are used in semi-conductor manufacture and in order to obtain uniform and satisfactory results, require precise temperature control of the etching solution and precise control of etching time. In controlling etching time, the time period during which the workpiece is exposed to etching solution must be precisely controlled. This time of exposure includes not only the time during which the workpiece is immersed in etching solution but also includes the time period between removal of the workpiece from the etching solution to the time that the etching solution is rinsed or washed from the workpiece. In order to obtain a uniform etching result the time period between removal from the solution to the time the workpiece is rinsed must be precisely controlled. Furthermore since etching solution drips from the workpiece after the workpiece is removed from the solution thus causing varying concentrations of etching solution upon the workpiece, the time period between removal from the etching solution bath to the time that the etching solution is rinsed from the workpiece must be minimized. In the prior art the time period between removal from the bath to the time that the etching solution is rinsed from the workpiece has not been sufficiently controlled and in addition has not been sufficiently minimized.

A serious disadvantage of prior art apparatus for processing articles has been cumbersome conveyor systems which necessarily require an extended period of time for transfer of the workpiece from one processing step to another. Such extended time periods should be avoided, particularly when the workpiece is being removed from an etching solution and is being transferred to a processing step for removal of the etching solution from the workpiece.

BRIEF DESCRIPTION OF THE INVENTION

In accordance with this invention an improved apparatus is provided for processing an article which apparatus comprises a carrier for the article, means for moving the carrier and article downwardly into a bath containing a first liquid, means for lifting the carrier and article upwardly from the bath, a spray chamber separate from the bath and means for spraying the article on the carrier with a second liquid when the carrier and article are in the spray chamber. The improvement in the apparatus comprises a spray chamber having a movable portion and means for moving the movable portion to position the spray chamber around the carrier and article and between the article and the bath after the carrier and article are lifted upwardly from the bath by the lifting means.

It has been found that the spray chamber can be positioned around the carrier and article more rapidly than the carrier and article can be lifted by a conveyor, carried horizontally to a position above another processing zone and then lowered into the processing zone. Since less time is required for positioning the spray chamber around the carrier and article, in an etching process, less time is required between removal of the carrier and article from an etching bath to the time that the carrier and article can be sprayed by a rinse liquid to remove and neutralize residual etching solution.

When the apparatus is used in an etching procedure the bath is usually defined by double walls between which a temperature control liquid flows to maintain the bath at a constant temperature. The time between movement of the article downwardly into the bath and the time that the carrier and article are lifted upwardly from the bath is precisely controlled by a timing means, thus precise time control for the processing step is obtained. Such precise time control is particularly important in etching operations.

The apparatus permits mass handling of articles with less contamination and fewer variables in processing conditions, such as varying time and temperatures.

In addition the apparatus permits mechanical and automatic handling of articles in less space than is required by prior art apparatus in that no continuous overhead conveying means is required for moving the article and carrier from one processing zone to another processing zone.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front elevational view of the apparatus of the preferred embodiment of the invention;

FIG. 2 is a right end elevational view of the apparatus shown in FIG. 1;

FIG. 3 is a top view of the apparatus shown in FIG. 1;

FIG. 4 is a top sectional view taken along line 4—4 of FIG. 1;

FIG. 5 is a front sectional view taken along line 5—5 of FIG. 4.

FIG. 6 is the front sectional view of FIG. 5 wherein the article and carrier are in the spray chamber;

FIG. 7 is an end sectional view taken on line 7—7 of FIG. 5;

FIG. 8 is an end sectional view taken on line 8—8 of FIG. 5;

FIG. 9 is a schematic diagram showing the operation of the spray means of the preferred embodiment; and,

FIG. 10 is a schematic diagram showing a means for supplying first liquid to the bath and a means for maintaining the first liquid in the bath at a constant temperature.

DETAILED DESCRIPTION OF THE INVENTION

The invention herein comprises an improved apparatus for processing an article which comprises a carrier for the article, means for moving the carrier and article downwardly into a bath containing a first liquid, means for lifting the carrier and article upwardly from the bath, a spray chamber separate from the bath and means for spraying the article on the carrier with a second liquid when the carrier and article are in the spray chamber wherein the improvement comprises a spray chamber having a movable portion and means for moving the movable portion to position the spray chamber around the carrier and article and between the article and the bath after the carrier and article are lifted upwardly from the bath by the lifting means.

In the preferred embodiment the spray chamber comprises a vertically directed stationary first end wall and a horizontally movable portion comprising a bottom wall, first and second vertical side walls secured to the bottom wall at their lower edges and a vertical second end wall having a lower edge. The end wall is secured proximate its lower edge to the bottom wall, is secured proximate its first vertical edge to the first vertical side wall and is secured proximate its second vertical edge to the second vertical side wall. The horizontally movable portion has an open end opposite the second end wall and facing the stationary first end wall portion. The open end is defined by unsecured edges of the side and bottom walls. The open end is contiguous to and engages the stationary first end wall portion when the spray chamber is positioned around the article. Preferably the horizontally movable portion of the spray chamber is supported by and can slide upon at least one horizontal track.

The means for moving the movable portion to the spray chamber around the carrier and article preferably comprises a rack secured along the horizontal length of the movable portion of the spray chamber, a pinion engaged with the rack, a first drive means for rotating the pinion in the rack thus causing the rack and movable portion of the spray chamber to move in a horizontal direction, so that rotating the first drive means in a forward direction causes the movable portion of the spray chamber to move toward the stationary first end wall so that spray chamber is positioned around the article. The means for moving the movable portion desirably further comprises a means for activating the first drive means in a forward direction upon upward lifting of the carrier and article. The apparatus which permits positioning of the spray chamber around the carrier and article permits spraying of the article with a second liquid e.g. a rinse liquid, to commence more rapidly than if the carrier and article had to be conveyed horizontally after being removed from the first liquid e.g. an etching solution, and subsequently lowered into a second treatment zone before spraying of the article with a second liquid could begin.

In the preferred embodiment the apparatus further comprises means for moving the movable portion of the spray chamber away from the stationary first end wall so the carrier holding another article to be processed can again be moved downwardly into the bath.

In the preferred embodiment the means for moving the movable portion of the spray chamber away from the stationary first end wall is the same as the positioning means and the movement away from the stationary first end wall is accomplished by reversing the drive means.

Preferably the means for moving the carrier downwardly comprises a holding means for holding the carrier; an arm having contiguous vertical and horizontal sections and first and second ends, the first end being at the lowermost portion of the vertical section and the second end being at a position on the horizontal sections farthest from the vertical section, said arm being connected to the holding means proximate its first end and extending upwardly from the holding means; a vertically movable plate having an attached vertical rack said vertically movable plate being secured to the arm proximate its second end; a stationary guide for engaging and for holding the vertically movable plate while permitting the vertically movable plate to move in a vertical direction; a second pinion engaged with the rack so that the rack, attached plate, arm and holding means move in a downward vertical direction upon the rotation of the pinion in a forward direction; and a second drive means for rotating the pinion in a forward direction. Preferably the lifting means and means for moving the carrier and article downwardly are the same and the carrier is lifted by causing the drive means to rotate the pinion in a reverse direction.

In the preferred embodiment the means for activating the first drive means in a direction which causes the movable portion of the spray chamber to move toward the stationary first end wall comprises a feeler switch which is activated by the lifting means when the holding means has been lifted from the bath by a sufficient distance to permit positioning of the spray chamber around the article to separate the article from the bath.

Desirably the spray means comprises at least one nozzle preferably located at a position above the carrier and article and is preferably secured to the means for moving the carrier and article downwardly. The nozzle is connected to a supply of second liquid under pressure. The spray means preferably further comprises a normally closed automatic valve having an inlet and outlet; a normally open automatic valve having an inlet and outlet; a tee having first, second and third openings; a first conduit connecting the nozzle to the first opening of the tee; a second conduit connecting the second opening of the tee to the outlet of the normally closed valve; a third conduit connecting the third opening of the tee to the inlet of the normally open valve; a fourth conduit connecting the inlet opening of the normally closed valve to the supply of the second liquid; a fifth conduit connecting the outlet of the normally open valve to a drain and means for opening the normally closed valve and closing the normally open valve when the spray chamber has been positioned around the article and carrier thus permitting second liquid to pass from the supply of second liquid through the fourth conduit, the normally closed valve, the second conduit, the tee, the first conduit and the nozzle to the article. The spray means further desirably comprises means for again closing the normally closed valve and opening the normally open valve when spraying is complete thus stopping the flow of second liquid from the supply of second liquid and permitting the second liquid in the nozzle, first conduit, and the tee to

drain through the third conduit, normally open valve and fifth conduit to the drain.

The bath into which the article is moved comprises an open top container which preferably is defined by an internal side wall and internal bottom wall sealed to the internal side wall and an external side wall and external bottom wall sealed to the external side wall which external side wall and external bottom wall are arranged in spaced relationship with the internal side wall and bottom wall so that first liquid in the bath can be maintained at a constant predetermined temperature by circulating a liquid having controlled temperature between the internal and external walls.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT OF THE INVENTION

Referring now to the drawings as best seen in FIGS. 1, 5, 6 and 7 carrier 10 is provided for holding article 11. The means for moving carrier 10 and article 11 downwardly into bath 12 containing first liquid 14 comprises a holding means in the form of basket 16 for holding carrier 10. The means for moving the carrier downwardly further comprises an arm 18 having vertical section 20 and horizontal section 22. The arm has a first end 24 at the lowermost portion of the vertical section and a second end 26 at a position on the horizontal section 22 farthest from vertical section 20. Arm 18 is connected proximate its first end to basket 16. The means for moving the carrier downwardly further comprises a vertically movable plate 28 having an attached vertical rack 30. Vertically movable plate 28 is secured to arm 18 proximate second end 26. A stationary guide 32 is provided for engaging and holding vertically movable plate 28 while permitting vertically movable plate 28 to move in a vertical direction. A pinion 34 is provided and is engaged with vertical rack 30 so that rack 30, plate 28, arm 18 and basket 16 move in a downward vertical direction upon the rotation of pinion 34 in a forward direction. A second drive means 36 is provided as previously discussed, for rotating pinion 34 in a forward direction. The drive means may be any suitable device for providing a rotating motion to pinion 34 such as a gear motor.

In the preferred embodiment the lifting means and means for moving carrier 10 and article 11 downwardly are the same and carrier 10 and article 11 are lifted by causing drive means 36 to rotate the pinion in a reverse direction.

As best seen in FIGS. 5, 6 and 7 bath 12 comprises a first liquid 14 held by container 50 defined by an inner side wall 38 connected proximate its lower edge 40 to an inner bottom wall 42. Located in spaced relationship with inner side wall 38 and inner bottom wall 42 are outer side wall 44 and outer bottom wall 46. Outer side wall 44 is connected at its lower edge to outer bottom wall 46. Inner side wall 38, inner bottom wall 42, outer side wall 44 and outer bottom wall 46 define a hollow space 47 through which a temperature controlled liquid 48 flows to maintain first liquid 14 held by container 50 at a constant temperature. Container 50 is defined by inner side wall 38 and inner bottom wall 42. In the preferred embodiment an over-flow drain 52 is provided so that the level of first liquid 14 does not reach a high enough level to escape from the top of container 50. First liquid 14 is provided to container 50 through inlet 54.

As best seen in FIGS. 1, 4, 5, 6 and 8, spray chamber 56 which is separate from bath 12 comprises and is defined by vertically directed stationary first end wall 58 and horizontally movable portion 60. Horizontally movable portion 60 comprises bottom wall 62, first and second vertical side walls 64 and 66 and second vertical end wall 68. First and second vertical side walls 64 and 66 have lower edges 70 and 72 secured to bottom wall 62. End wall 68 has a lower edge 74 which may be secured to bottom wall 62, a first vertical edge 76 secured to the first vertical side wall 64 and a second vertical edge 78 secured to second vertical side wall 66. A drain 75 is preferably provided between second end wall 68 and bottom wall 62. Horizontally movable portion 60 has an open end 80 opposite second vertical end wall 68 and facing stationary first end wall 58. Open end 80 is defined by unsecured edges 82, 84 and 86 of vertical side walls 64 and 66 and bottom wall 62. Open end 80 is contiguous with and engages stationary first end wall 58 when spray chamber 56 is positioned around carrier 10 and article 11.

Preferably horizontally movable portion 60 of spray chamber 56 is supported by, and can slide upon, horizontal tracks 88 and 90.

In the preferred embodiment the means for positioning the spray chamber preferably comprises racks 92 and 94 secured along the horizontal length of movable portion 60 of spray chamber 56. Pinions 96 and 98 are engaged with racks 92 and 94 respectively and are each attached to a first drive means 100 for rotating each pinions 96 and 98 in racks 92 and 94 thus causing racks 92 and 94 and movable portion 60 of spray chamber 56 to move in a horizontal direction. Means is provided for activating first drive means 100 in a direction which causes movable portion 60 of spray chamber 56 to move toward stationary first end wall 58 upon upward lifting of carrier 10 and article 11 so that spray chamber 56 is positioned around carrier 10 and article 11. In the preferred embodiment the means for activating first drive means 100 upon upward lifting of carrier 10 and article 11 is a first feeler switch 102 which is contacted by arm 18 upon upward movement of carrier 10, article 11, basket 16 and arm 18. First feeler switch 102 activates a relay, not shown, located in control box 104 which relay in turn activates first drive means 100. In the preferred embodiment the apparatus further comprises means for moving movable portion 60 of spray chamber 56 away from stationary first end wall 58 so that the carrier 10 can again be moved downwardly into bath 12. Preferably the means for moving movable portion 60 of spray chamber 56 away from stationary first end wall 58 is the same as the positioning means and the movement away from stationary first end wall 58 is accomplished by reversing the drive means. In the preferred embodiment the drive means is reversed either by manually closing a switch, not shown, thus reversing drive means 100 or by means of feeler switch 142 which feeler switch 142 activates a relay which in turn reverses drive means 100.

The means for spraying article 11 on carrier 10 with a second liquid 106 preferably comprises at least one and desirably a plurality of nozzles 108 connected to a conduit or pipe 110 which nozzle 108 and conduit 110 are secured to arm 18 at a position above carrier 10 and article 11. Preferably the conduit 110 is connected to one end of a flexible coiled hose 112. The other end of flexible hose 112 is connected to one orifice of the

tee 114. Another orifice of the tee is connected to a conduit 116 which is in turn connected with a normally open solenoid valve 118. The remaining opening of the tee is connected by means of a conduit 120 to a normally closed solenoid valve 122 which is in turn connected with a supply 125 of second liquid 106. A means is provided for opening normally closed solenoid valve 122 and closing normally open solenoid valve 118 when carrier 10 and article 11 have been positioned in spray chamber 56.

Desirably the means for closing solenoid valve 118 and opening solenoid valve 122 is a feeler switch 124 which is activated by movable portion 60 of spray chamber 56 when movable portion 60 is positioned so that its open end 80 is in contact with stationary first end wall 58. Feeler switch 124 is in turn connected with a relay located in control box 104 which relay in turn closes solenoid valve 118 and opens solenoid valve 122.

The spraying is stopped either by actuating a manual switch which again opens solenoid valve 118 and closes solenoid valve 122 thus permitting liquid which is retained in conduit 110 to drain through hose 112, tee 114, conduit 116, and normally open solenoid valve 118 to a waste line thus preventing residual second liquid retained in conduit 110 from dripping from nozzle 108. Solenoid valve 118 can again be opened and solenoid valve 122 can again be closed automatically by means of a timer connected to solenoid valves 118 and 122 which timer is located in control box 104.

In operation of the preferred apparatus of the invention first liquid e.g. etching solution 14 contained in reservoir 126 is supplied through conduit or pipe 128 by means of pump 130 to bath 12. Pump 130 is activated by any suitable means which determines when additional first liquid 14 is needed in bath 12. The means for determining when additional liquid is needed in bath 12 may be manual or any suitable device such as a capacitance level control indicator float switch, or means for determining liquid dragout and evaporation. Desirably additional liquid is added to the bath only when article 11 is not in the bath. The temperature of first liquid 14 in bath 12 is maintained by circulating a temperature controlled liquid 48 between inner wall 37 and outer wall 43 of bath 12. The temperature controlled liquid 48 is held in a container 130 and is heated by a heating coil 132 through which hot water is circulated when a valve 134 is opened. Temperature controlled liquid 48 is cooled by cooling coil 136 through which cold water passes when valve 138 is opened. A sensing device 139 determines when first liquid 14 is either too hot or too cold. Sensing device 139 is connected to relays in control box 104 so that when the temperature of first liquid 14 is too low sensing device 139 activates a relay in control box 104 which in turn opens valve 134 thus permitting hot water to pass through heating coil 132. When sensing device 139 detects that the temperature of first liquid 14 is too hot it activates another relay which opens valve 139 and closes valve 134 thus preventing hot water from passing through heating coil 132 and permitting cold water to pass through cooling coil 136. When sensing device 139 detects that first liquid 14 is neither too hot nor too cold a relay is activated which closes both valves 134 and 138. The temperature controlled liquid 48 is circulated from container 130 through a pipe or conduit 140 by means of pump 142. Bath 12 is provided with an

over-flow drain 52 which prevents first liquid 14 from reaching a level above the overflow drain in bath 12.

In operating the apparatus of the preferred embodiment as best seen in FIGS. 1 and 7 basket 16 is initially in a position above both bath 12 and spray chamber 56 so that a carrier 10 and article 11 can easily be placed upon and removed from the basket. After carrier 10 and article 11 are placed upon the basket the apparatus of the invention is manually activated by closing a switch located in control box 104. The closing of the switch either directly or through a relay causes drive means 36 to rotate pinion 34 so that vertical rack 30 moves in a downward direction which in turn simultaneously moves vertically movable plate 28, arm 18 and attached basket 16 in a downward direction. As arm 18 moves downwardly feeler switch 142 is closed thus activating drive means 100 either directly or through a relay, in a direction which causes horizontally movable portion 60 of spray chamber 56 to move away from stationary first end wall 58 thus permitting basket 16, carrier 10 and article 11 to pass by spray chamber 56 downwardly into bath 12. Alternately the switch in control box 104 can directly activate drive means 100. When horizontally movable portion 60 of spray chamber 56 moves a sufficient distance away from stationary first end wall 58 it contacts switch 144 which either directly or through a relay deactivates drive means 100 thus preventing further movement of movable portion 60 to spray chamber 56 until drive means 100 is again activated.

When basket 16, carrier 10 and article 11 have reached a position where carrier 10 and article 11 are immersed in first liquid 14 contained in bath 12, arm 18 contacts switch 146 which either directly or through a relay causes drive means 36 to become deactivated thus preventing further downward movement of basket 16, carrier 10 and article 11. Simultaneously switch 146 activates a timer located in control box 104.

After the expiration of a predetermined amount of time set on the timer, drive means 36 is reactivated in a direction which causes pinion 34 to move vertical rack 30 in an upward direction thus carrying vertically movable plate 28, arm 18 and attached basket 16 which is holding carrier 10 and article 11 upwardly from bath 12.

When arm 18 has moved a sufficient distance in an upward direction it contacts switch 102 which directly or through a relay deactivates drive means 36 and activates drive means 100 in a direction which causes racks 92 and 94 to move horizontally movable portion 60 of spray chamber 56 toward stationary first end wall 58. When horizontally movable portion 60 has moved to a position where open end 80 contacts stationary first end wall 58 switch 124 is opened by the position of horizontally movable portion 60 which again deactivates drive means 100. Switch 124 simultaneously closes valve 118 and opens valve 122 thus permitting second liquid 106 to pass through conduit 110 to nozzles 108. Second liquid 106 then passes through nozzles 108 and is directed by the nozzles upon article 11 thus rinsing residual first liquid 14 from article 11. Switch 124 also activates a timer located in control box 104 which after the expiration of a preset amount of time activates a warning buzzer thus signalling an operator. The operator then manually closes a switch located on control box 104 which activates drive means 36 in a direction which causes basket 16, carrier 10 and article 11 to

move upwardly into the original load-unload position. Alternatively the timer, either directly or through a relay may activate drive means 36 in a direction which causes basket 16, carrier 10 and article 11 to move upwardly to the load-unload position. After basket 16, carrier 10 and article 11 have reached the load-unload position arm 18 contacts switch 142 which deactivates drive means 36 thus preventing further upward motion of basket 16, carrier 10 and article 11.

The apparatus of the invention is desirably provided with a channel 148 located around the periphery of spray chamber 56 when horizontally movable portion 60 is located in a position so that open end 80 abuts stationary first end wall 58. Channel 148 is provided so that second liquid being sprayed upon article 11 flows downwardly into channel 148 and along channel 148 into either chamber 150 or chamber 152. Chambers 150 and 152 may be connected to drains 154 and 156 respectively for disposing of second liquid which has been used.

The apparatus desirably is provided with a venting means 158 for removing vapors above bath 12 which may be emitted by first liquid 14. Venting means 158 preferably comprises an exhaust fan 160 which is connected by any suitable conduit 162 to a position directly above the liquid level of first liquid 14 in bath 12.

The apparatus of the invention permits basket 16, carrier 10 and article 11 to be rapidly positioned within spray chamber 56 without unnecessary vertical motion which would be required by an overhead conveyor for moving basket 16, carrier 10 and article 11 to a separate spray zone. The elimination of unnecessary vertical motion permits spraying of article 11 to remove excess first liquid remaining on article 11 after it is removed from bath 12 to commence in less time than would otherwise be required. In addition the apparatus of the invention permits elimination of overhead conveyors thus desirably reducing the size of the apparatus.

We claim:

1. In an apparatus for processing an article comprising a carrier for the article, means for moving the carrier and article downwardly into a bath containing a first liquid, means for lifting the carrier and article upwardly from the bath, a spray chamber separate from the bath and means for spraying the article on the carrier with a second liquid when the carrier and article are in the spray chamber; the improvement comprising a spray chamber having a movable portion and means for moving the movable portion to position the spray chamber around the carrier and article and between the article and the bath after the carrier and article are lifted upwardly from the bath by the lifting means.

2. The apparatus of claim 1 wherein the spray chamber comprises a vertically directed stationary first end wall and a horizontally movable portion comprising a bottom wall, first and second vertical side walls secured to the bottom wall at their lower edges and a vertical second end wall having a lower edge, said end wall being secured proximate its lower edge to the bottom wall, secured proximate its first vertical edge to the first vertical side wall and proximate its second vertical edge to the second vertical sidewall, said horizontally movable portion having an open end opposite the second end wall facing the stationary first end wall portion, said open end being defined by unsecured edges of the side and bottom walls, said open end being contiguous

to and engaging the stationary first end wall portion when the spray chamber is positioned around the article.

3. The apparatus of claim 2 wherein the horizontally movable portion of the spray chamber is supported by and can slide upon at least one horizontal track.

4. The apparatus of claim 3 wherein the means for moving the movable portion comprises a rack secured along the horizontal length of the movable portion of the spray chamber, a pinion engaged with the rack, a first drive means for rotating the pinion in said rack thus causing the rack and movable portion of the spray chamber to move in a horizontal direction, so that rotating the first drive means in a forward direction causes the movable portion of the spray chamber to move toward the stationary first end wall to position the spray chamber around the carrier and the article.

5. The apparatus of claim 4 wherein the positioning means further comprises a means for activating the first drive means in a forward direction.

6. The apparatus of claim 4 wherein the apparatus further comprises means for moving the movable portion of the spray chamber away from the stationary first end wall to permit the carrier to again be moved downwardly into the bath.

7. The apparatus of claim 6 wherein the means for moving the movable portion of the spray chamber away from the stationary first end wall is the same as the positioning means and the movement away from the stationary first end wall is accomplished by reversing the drive means.

8. The apparatus of claim 1 wherein the means for moving the carrier downwardly comprises a holding means for holding the carrier; an arm having vertical and horizontal sections and first and second ends, the first end being at the lowermost portion of the vertical section and the second end being at a position on the horizontal section farthest from the vertical section, said arm being connected to the holding means proximate its first end and extending upwardly from the holding means; a vertically movable plate having an attached vertical rack said vertically movable plate being secured to the arm proximate its second end; a stationary guide for engaging and for holding the vertically movable plate while permitting the vertically movable plate to move in a vertical direction; a second pinion engaged with the rack so that the rack, attached plate, arm and holding means move in a downward vertical direction upon the rotation of the pinion in a forward direction; and a second drive means for rotating the pinion in a forward direction.

9. The apparatus of claim 8 wherein the lifting means and means for moving the carrier and article downwardly are the same and the carrier and article are lifted by causing the drive means to rotate the pinion in a reverse direction.

10. The apparatus of claim 7 wherein the means for activating the first drive means in a forward direction which causes the movable portion of the spray chamber to move toward the stationary first end wall comprises a feeler switch which is activated by the lifting means when the holding means has been lifted from the bath a sufficient distance to permit positioning of the spray chamber around the article to separate the article from the bath.

11. The apparatus of claim 1 wherein the spray means comprises at least one nozzle located at a posi-

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tion above the carrier and article, said nozzle being connected to a supply of second liquid under pressure.

12. The apparatus of claim 11 wherein the nozzle is secured to the means for moving the carrier and article downwardly at a position above the carrier and article; and the spray means further comprises a normally closed automatic valve having an inlet and outlet, a normally open automatic valve having an inlet and outlet; a tee having first, second and third openings; a first conduit connecting the nozzle to the first opening of the tee; a second conduit connecting the second opening of the tee to the outlet of the normally closed valve; a third conduit connecting the third opening of the tee to the inlet of the normally open valve; a fourth conduit connecting the inlet opening of the normally closed valve to the supply of second liquid; a fifth conduit con-

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necting the outlet of the normally open valve to a drain; means for opening the normally closed valve and closing the normally open valve when the spray chamber has been positioned around the article and carrier thus permitting second liquid to pass from the supply of second liquid through the fourth conduit, the normally closed valve, the second conduit, the tee, the first conduit and the nozzle to the article; and means for again closing the normally closed valve and opening the normally open valve when spraying is complete thus stopping the flow of second liquid from the supply of second liquid and permitting second liquid in the nozzle, first conduit, and the tee to drain through the third conduit, normally open valve and fifth conduit to the drain.

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