Feb. 10, 1959 N. G. KLING 2,872,893

AUTOMATIC IMMERSION APPARATUS

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FIG. 1

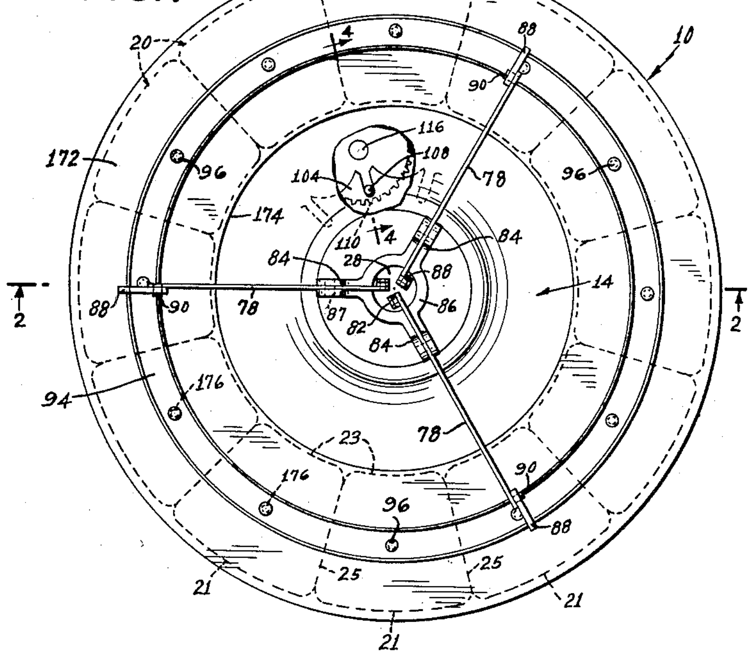
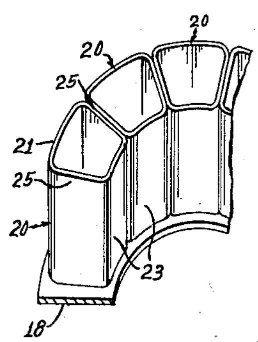


FIG. 1a



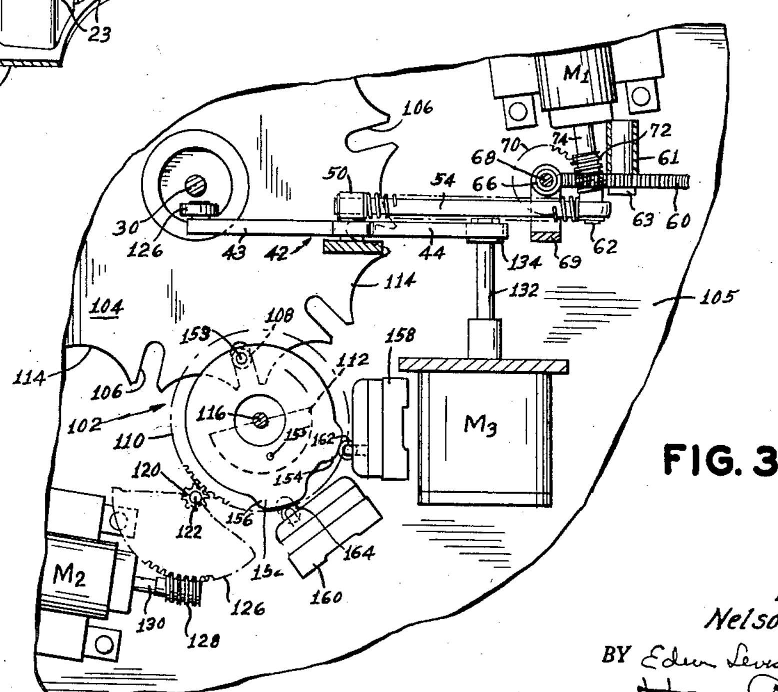


FIG. 3

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AUTOMATIC IMMERSION APPARATUS

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FIG. 2

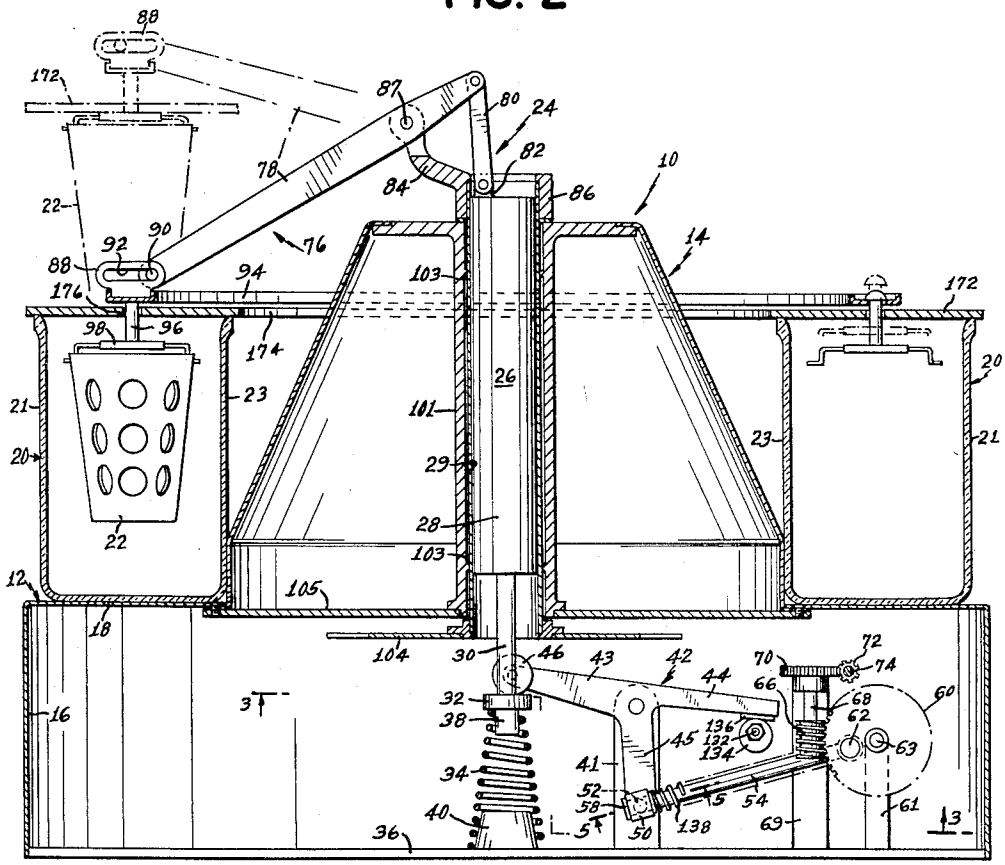


FIG. 4

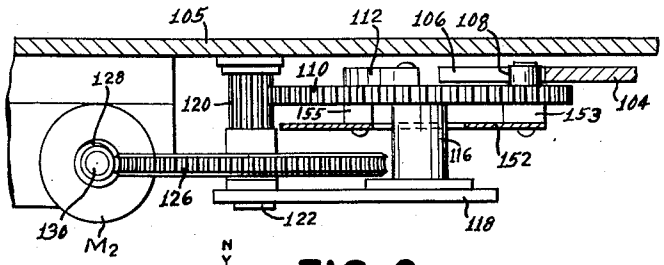


FIG. 5

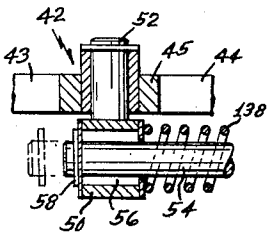
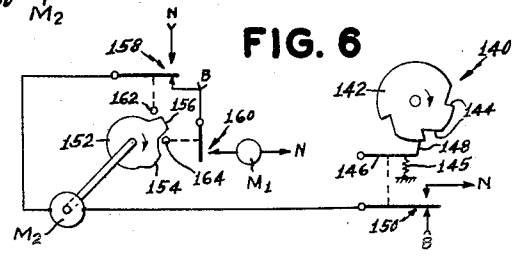


FIG. 6



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2,872,893

AUTOMATIC IMMERSION APPARATUS

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Application December 9, 1954, Serial No. 474,138

36 Claims. (Cl. 118—10)

This invention relates to automatic immersion apparatus and particularly to automatic immersion apparatus which is especially useful for the preparation of histologic tissue for microscopic examination.

The preparation of tissue to enable the microscopic examination thereof involves a plurality of treatments of the tissue prior to the cutting of sections from the tissue for the staining of the sections which are mounted on microscope slides. More particularly, in the preparation of tissue, it is necessary to immerse the tissue successively in a plurality of liquid agents for certain lengths of time, first to fix the tissue, then to wash the same for removing the fixative, then to dehydrate the tissue, usually by immersion of the tissue successively in a plurality of alcohols or other dehydration agents, then to immerse the tissue in a clearing agent, thereafter to infiltrate the tissue with an infiltration agents such as, for example, paraffin, colloidin, etc. After the tissue is thus treated, it is cut into sections of the desired thickness; then the paraffin or other infiltration medium is removed from said sections, usually by a solvent for the paraffin, after which the sections are mounted on slides and stained.

One object of this invention is to generally provide new and improved automatic immersion apparatus.

Another object of the present tinvention is to provide a new and improved automatic immersion apparatus which is smaller in size than automatic immersion apparatus of the same or greater capacity heretofore employed.

A further object of this invention is to provide a conveyor of new and improved construction for transferring material from one receptacle to another in automatic immersion apparatus.

A yet further object of this invention is to provide novel means for raising and lowering the conveyor in automatic immersion apparatus which raising and lowering means is of simplified and improved construction.

Yet another object of this invention is the provision of new and improved reagent receptacles which occupy an area greatly reduced from that occupied by receptacles heretofore used in automatic immersion apparatus. Conversely, for the same occupied area and height a receptacle of the present invention has a considerably larger volume.

The above and other objects, features and advantages of the present invention will be fully understood from the following description considered in connection with the accompanying drawings which illustrate the presently preferred embodiment of the invention.

In the drawings:

Fig. 1 is a top plan view of automatic immersion apparatus embodying the present invention, partly broken away for illustrative purposes;

Fig. 1A is a perspective view of part of the apparatus and several of the liquid receptacles according to the present invention;

Fig. 2 is a sectional view taken along the line 2—2 of

Fig. 1, with certain parts not shown to more clearly illustrate the parts shown;

Fig. 3 is a partial bottom plan view taken along the line 3—3 of Fig. 2;

Fig. 4 is a sectional view taken along the line 4—4 of Fig. 1;

Fig. 5 is a sectional view taken along the line 5—5 of Fig. 2; and

Fig. 6 is a diagrammatic view of the electro-mechanical control system for the apparatus.

Referring now to the drawings in detail, the automatic immersion apparatus or machine embodying this invention includes a housing **10** having a base **12** and a dome-shaped enclosure **14**. Base **12** includes a cylindrical side portion **16** which is integral with a horizontally extending upper portion **18** forming a support for a plurality of receptacles or beakers **20**. The receptacles contain the various reagents for treating histologic tissue in order to prepare it for microscopic examination. The tissue to be treated is carried in a material or tissue holder **22** which is operatively connected by means to be described in detail hereinafter to a conveyor generally designated by the reference character **24**. Conveyor **24** includes a vertically extending member **26** which is adapted to move vertically up and down and to rotate about its own longitudinal axis so as to move a material holder up out of one receptacle, laterally to a position over a second receptacle and then down into the latter receptacle. In this manner material holder **22** is successively immersed in the reagents in the various receptacles on base **12** in order to treat the tissue within the material holder.

In accordance with one of the principal objects of the present invention provision is made for increasing the volumetric capacity of the liquid receptacles, without increasing the overall size of the apparatus, thereby producing several advantages. Among these advantages are that due to the larger quantity of liquid in the receptacle the action of the liquid on the tissue is improved and accelerated because of the presence in the immediate vicinity of the tissue specimen of a greater quantity of fresh liquid which is available for penetration into the tissue without being significantly impaired by the liquids displaced from the tissue during the period of immersion. Further, in accordance with this object of the invention the liquid receptacles are of such construction, particularly in respect to the peripheral contour thereof as to enable the volumetric capacity of the receptacle to be substantially greater than that of receptacles such as those heretofore used which required as much supporting surface area as the receptacles of the present invention, or conversely, the receptacles of the present invention make it possible to reduce the overall size of the apparatus, especially in respect to the supporting area required therefor, without decreasing the volumetric capacity of the receptacles in comparison with those of predecessor apparatus. It will be noted further, as the description of the receptacles proceeds, that these results are attainable without increasing the height of the receptacles, and concomitantly it is unnecessary to increase the overall height of the apparatus. Another advantage is that by decreasing the horizontal size of the apparatus various parts, especially the horizontally extending conveyor parts, can be of reduced size and weight. Referring now more particularly to Figs. 1 and 1A of the drawings it will be observed that the peripheral contour of each of the receptacles **20** is such that they may be disposed in close side-by-side relation for the full radial extent thereof, thus obviating empty spaces between adjacent receptacles on the support **18**. As here shown, each receptacle **20** is provided with a front wall **21**, a rear wall **23** and a pair of side walls **25** which converge as they extend from the

front wall to the rear wall. As shown herein the receptacles are arranged in a circular group and side walls 25 extend radially from the center of the circle. Accordingly, the plurality of receptacles may be arranged in adjacent side-by-side relation to form a circular group on the horizontal portion or support 18 of base 12. With such a configuration for the receptacles 20 it will be seen that there is no waste space on base 12 as there would be if a substantially cylindrical receptacle were employed. With this reduction in occupied space it becomes possible to reduce the size of base 12 and of the entire apparatus thus making the mechanism smaller, lighter in weight and less expensive. As hereinafter described, the conveyor is arranged to carry a cover for all of the receptacles 20 and in the operation of the conveyor the cover and the material holder or holders are moved vertically and rotatably as required for the transfer of the tissue or other material from one receptacle to another for the required number of immersion treatments.

The vertically extending member 26 of conveyor 24 comprises a plunger 28 which is slidably disposed inside of a hollow shaft 29, the latter being immovable in a vertical direction. Member 26 also includes a rod 30 which is suitably secured to the bottom of plunger 28 and depends therefrom. Fixedly mounted on rod 30 adjacent the bottom thereof is a flange 32. A conical helical spring 34 engages the bottom of flange 32 and a bottom plate 36 of base 12 so as to bias member 26 to a normally raised position. In order to keep spring 34 properly seated on member 26, the upper end of the spring is disposed around the lower part of rod 30 as at 38 and the lower end of the spring is disposed around a stud 40 mounted on bottom plate 36.

The mechanism for imparting vertical movement to conveyor 24 includes a T crank 42 which is pivotally mounted on a bracket 41. T crank 42 has two horizontal arms 43 and 44 and a depending arm 45. A rolle 46 is mounted at the end of arm 43 and engages the top surface of flange 32 on vertically extending member 28. The depending arm 45 of said crank has secured thereon an apertured lug 50 which is best shown in Fig. 5. It will be noted that lug 50 is mounted on a pin 52 which in turn is secured to arm 45 so that lug 50 is free to turn relative to crank 42. A connecting rod 54 which is of smaller diameter than the aperture 56 in lug 50 extends through aperture 56 and is prevented from being removed therefrom by means of a washer 58 which is connected to a connecting rod 54 in any suitable manner. The other end of connecting rod 54 is pivotally mounted on a rotatable worm wheel 60 by means of a connecting pin 62 extending through the worm wheel and connecting rod. Worm wheel 60 is rotatably mounted on a bracket 61 by means of an axle 63. Worm wheel 60 meshes with a worm gear 66 which is suitably mounted on a shaft 68 for rotation therewith. Shaft 68 which is rotatably mounted in a bracket 69 also has mounted thereon for turning it another worm wheel 70 which in turn meshes with a worm gear 72 mounted on a motor shaft 74 of a motor M1.

It will be seen that when the vertically extending part 26 of the conveyor is in its raised position due to the bias of compression spring 34, as shown in Fig. 2, and motor M1 (Fig. 3) is energized, rotary motion will be imparted to the two worm and worm wheel arrangements heretofore described including worm wheel 60. When worm wheel 60 rotates, crank pin 62 moves connecting rod 6 so as to pivot T crank 42 counter-clockwise. With th T crank pivoting counter-clockwise, roller 46 which is in engagement with flange 32 moves member 26 downwardly against the bias of spring 34. This downward movement of member 26 continues for one half of a revolution of worm wheel 60. During the second half of its revolution, worm wheel 60 actuates rod 54 in a direction to pivot T crank 42 in a clockwise direction thus

permitting member 26 to be moved upward under the pressure of spring 34.

In accordance with the present invention, the upper part 76 of conveyor 24 is moved in a vertical direction a distance substantially greater than the distance of the vertical movement of the vertically extending part 26 of conveyor 24. For this purpose, a plurality of radially extending lever arms 78, here shown as three equi-spaced arms are each pivotally connected at one end to links 80. Links 80 are in turn pivotally connected to ears 82 which are in fixed relation to and extend upwardly from the top of plunger 28. Lever arms 78 are further pivotally connected to three upwardly extending bracket arms 84 of a collar 86, as at 87, which is connected to shaft 29 and which further rests on the upper surface of enclosure 14 to prevent downward movement of shaft 29. Lever arms 78 are connected at their other ends to a number of brackets 88 by means of a lost motion connection which imparts vertical movement to the brackets but not movement in a radial direction. This lost motion connection includes pins 90 fixedly mounted in said other end of arms 78. Pins 90 fit into slots 92 in brackets 88 and are adapted to move radially along the slots. The slots are of sufficient extent to take up all of the radial movement of the arms when they are pivoted upwardly and downwardly without such movement being imparted to the brackets.

Secured to brackets 88 in underlying relation thereto is a carrier 94 which takes the form of a U-shaped ring. Depending from carrier 94 is a plurality of studs 96 which have connected to their lower ends U-shaped brackets 98. Brackets 98 are adapted to be releasably connected to the material holders 22, here shown as a perforated basket as shown for example in United States Patent No. 2,539,802. As clearly shown in Fig. 2, the distance between the two pivotal connections on lever arms 78 is substantially smaller than the distance from the pivotal connection of the arms on upwardly extending portions 84 to the bracket connections. Accordingly, when pivotal movement is imparted to T crank 42 in the aforedescribed manner, vertically extending part 28 of the conveyor moves downwardly and thus moves the ends of lever arms 78 which are operatively connected thereto by means of links 80 a corresponding distance. This downward movement of the short ends of lever arms 78 imparts a correspondingly large upward movement to the ends of the lever arms operatively connected to the carrier 94 by means of brackets 88. Accordingly, material holders 22 move upwardly with the ends of the long parts of lever arms 78 and their upward movement is sufficient to remove the material holders from receptacles 20.

By employing a conveyor of the character just described the movement of the actuating mechanism within base 12 is relatively small as compared with the movement of carrier 94. Accordingly, the base 12 can be reduced in size since the parts therein move through such relatively small distances. To further enhance this result and as presently preferred, arm 45 of T crank 42 is shorter than arm 43 so that arm 43 moves a greater distance to thus impart a greater vertical movement to member 28 than the distance of horizontal movement imparted to arm 45 by connecting rod 54.

For turning conveyor 24 so as to move material holders 22 laterally from a position over one receptacle to a position over another receptacle, a Geneva gear drive mechanism 102 (Figs. 3 and 4) is provided. Geneva gear mechanism 102 includes a driven gear member 104 which is fastened in any suitable manner to hollow shaft 29 so that when driven member 104 turns shaft 29 turns therewith. Since, as heretofore described, shaft 29 is connected to conveyor 24 by means of collar 86, lever arms 78 and links 80, rotation of shaft 29 imparts turning movement to conveyor 24. Hollow shaft 29 is disposed for rotation within a central hollow tubular part

101 of enclosure 14. The inner surface of tube 101 is provided with a pair of ring bearings 103 which permit shaft 29 to rotate relative to part 101. Part 101 is preferably relatively rigid and extends from the top of enclosure 14 to a plate 105 underlying the enclosure so as to prevent shaft 29 from moving laterally out of its intended vertical disposition. Spaced around the circumference of the driven member 104 are a plurality of radially extending slots 106. For driving driven member 104 a driving member or roller 108, which is adapted to move into and out of slots 106 is mounted on a spur gear 110 for rotation therewith. Also mounted on spur gear 110 for rotation therewith is a locking member 112 which is adapted to fit into the concave portions 114 in driven member 104 when roller 108 is not in said slots.

When a material holder 22 is immersed in one of the receptacles 20, locking member 112 is in one of the concave portions 114 on driven member 104 to prevent turning movement of the conveyor and hence shaft 29 and conveyor 24. When it is desired to move the material holders laterally from a position over one receptacle to a position over another receptacle, spur gear 110 is turned through one revolution by means to be described hereinafter. During the first part of the turning movement of spur gear 110 locking member 112 moves out of concave portion 114 to free driven member 104 for turning movement. As member 112 disengages from concave portion 114, roller 108 moves into a slot 106 to turn driven member 104 and hence conveyor 24 a predetermined angular distance here shown as 30° whereupon the roller moves out of the slot and locking member 112 moves into another concave portion 114 to prevent further turning movement.

To actuate the Geneva gear mechanism spur gear 110 is rotatably mounted on a shaft 116 which is supported by a bracket 118. Gear 110 is driven by a companion spur gear 120, rotatably mounted on a shaft 122 which extends between a support plate 105 underlying enclosure 14 and bracket 118 to thereby fixedly position said bracket. Also mounted on shaft 122 for rotation with spur gear 120 is a worm wheel 126 which is driven by a worm gear 128 mounted on shaft 130 of a motor M2. It will be obvious that when motor M2 is energized to rotate shaft 130, spur gear 110 and hence driving member 108 of the Geneva gear mechanism will turn to impart rotary movement to driven member 104 and to conveyor 24. As will be described subsequently, this turning movement of gear member 104 and therefore conveyor 24 is in timed relation with the upward and downward movement heretofore described so that when the apparatus is actuated for transferring the material holders from receptacle to receptacle, the conveyor lifts the material holders out of the receptacles, it remains in the lifted position for a predetermined time, then moves the material holders laterally to positions over other receptacles and then lowers the material holders therein.

According to another feature of the present invention, novel means are provided in the automatic immersion apparatus described herein for vertically reciprocating the material holders 22 when they are immersed in receptacles 20. To accomplish this a continuously energized motor M3 having a rotary shaft 132 is provided. Mounted at the end of shaft 132 is an eccentric cam 134 which engages a cam follower plate 136 mounted on arm 44 of T crank 42. When the conveyor is in the lowered position shown in Fig. 2 cam follower 136 is held in engagement with cam 134 by spring 34 and, accordingly, when cam 134 is rotated by shaft 132 of motor M3, it causes the crank to pivot first in one direction and then in the opposite direction. This pivotal movement of crank 42 is imparted to the conveyor by means of roller 46 and flange 32 so that the entire conveyor moves up and down through a short stroke at a relatively slow speed. As has already been described in detail in U. S. patent application, Serial No. 358,812, applied for by Edwin C. Weiskopf and Andres Ferrari, Jr., and assigned to the assignee hereof, now U. S. Patent No. 2,741,221, when the material holder is vertically reciprocated during its immersion in the various reagents the effectiveness of the reagents on the material within the material holders is greatly enhanced thus reducing the necessary immersion time. It will be obvious that when T crank 42 is pivoted counterclockwise by connecting rod 54 to raise the material holders out of the receptacles, arm 44 of the T crank moves out of engagement with cam 134 to thereby discontinue the vertical reciprocation of the conveyor. When the material holders are subsequently lowered into the receptacles, the vertical reciprocation is resumed.

In order to permit the oscillatory motion of crank 42 under the urging of cam 134, a helical spring 138 is disposed around connecting rod 54 and extends between pin 62 and lug 50. Spring 138 is sufficiently stiff to maintain crank 42 in the desired position relative to connecting rod 54. However when cam 134 imparts oscillatory motion to crank 42 depending arm 45 pivots in a counterclockwise direction against the bias of spring 138 and thus compresses the spring a slight bit to thereby permit such pivotal movement. It will be noted that because connecting rod 54 is of substantially smaller diameter than the aperture 56 in lug 50 there is substantial freedom of movement of lug 50 relative to the connecting rod and, accordingly, there is no impairment of the motion of the connecting rod relative to lug 50 during the time that the material holders are vertically reciprocating.

For controlling the automatic operation of the apparatus a timing mechanism 140 is provided. This timing mechanism is schematically shown in Fig. 6 and is provided with a timing disc 142 which is turned at a predeterminde rate by a suitable clock motor (not shown). The timing disc is arranged to turn one revolution for each complete immersion cycle of the apparatus and in the preferred embodiment shown herein, the immersion cycle takes approximately 24 hours. Of course, other total immersion times such as one hour or 36 or 48 hours may be employed without departing from the spirit and scope of this invention. Timing disc 142 is provided with a plurality of peripheral notches 144 which are spaced from one another at an angular distance which is proportional to the time of immersion of the material holders in any particular receptacle. For instance, if it is desired to immerse a material holder in a receptacle for an hour, then the angular distance between two adjacent notches is 1/24 of the circumference of the timing disc, that is 15°. Biased by a spring 145 into engagement with the periphery of timing disc 142 is a sensing arm 146 having a free end 148 which is in engagement with the periphery of the timing disc. Free end 148 of sensing arm 146 normally rests on the circular periphery of timing disc 142 but when the timing disc turns so that one of the notches 144 registers with free end 148, the free end moves into the notch in the timing disc due to the urging of spring 145. Sensing arm 146 is operatively connected to a limit switch 150 of any suitable construction such as that of the well known micro-switch. The connection between sensing arm 146 and switch 150 is so arranged that when the sensing arm is in engagement with the circular periphery of disc 142, the switch is in one circuit controlling condition and when the free end of sensing arm 146 is in one of the notches 144 the switch 150 is in another circuit controlling condition. The timing mechanism heretofore described may be substantially the same as that shown and described in U. S. Patent No. 2,157,875 granted to Edwin C. Weiskopf and assigned to the assignee hereof. If a more detailed description of the timing mechanism is desired reference may be had to the aforementioned patent.

A cam 152 (Figs. 3 and 4) is operatively connected to spur gear 110 by means of pins 155 and 153 for rotation with said gear and the cam operates in conjunction with

the timing mechanism 140 heretofore described to control the movements of the apparatus. Cam 152 is a substantially circular disc and has provided on the periphery thereof a first raised cam portion 154 which extends outwardly from the periphery a relatively small amount and a second raised cam portion 156 which extends outwardly a greater amount than cam portion 154. Associated with cam 152 are a pair of switches of suitable construction such as micro-switches herein designated as 158 and 160. Switch 158 is provided with a contact actuator 162 which is positioned relative to the cam so that the switch is in a first circuit controlling condition except when it is in engagement with the high cam portion 156. When in engagement with high cam portion 156, switch 158 operates to a second circuit controlling condition. Switch 160 is provided with a similar contact actuator 164 which is located relative to the cam so that when it is in engagement with either raised cam portion 154 or raised cam portion 156 it operates its contacts to their closed condition and when the contact actuator is not in engagement with either of these raised cam portions the contacts of switch 160 are open.

When the material holders 22 are positioned within the receptacles so that the material therein is immersed in the reagents in the various receptacles, cam follower 136 on T crank 42 is in engagement with cam 134 which is constantly rotating as heretofore described and, accordingly, a vertical reciprocatory motion is imparted to conveyor 24 and hence to material holders 22. At this time, for reasons which will become clear hereinafter, free end 148 of sensing arm 146 is on the periphery of timing disc 142 and not in any of the notches 144 so that switch 150 is in its first circuit controlling condition. Furthermore, contact actuator 162 is out of engagement with high cam portion 156 so that switch 158 is in its first circuit controlling condition, contact actuator 164 is positioned between the two raised cam portions 154 and 156 so that switch 160 is open. The above described condition is shown in Fig. 6 and, as may be seen from a perusal of that figure, in the stated condition both motors M1 and M2 are de-energized thus causing the conveyor to remain stationary except for the vertical reciprocating motion already noted. This condition of the apparatus persists until timing disc 142 has turned sufficiently to cause free end 148 of sensing arm 146 to move into one of the notches 144 on timing disc 142. When this occurs switch 150 reverses its circuit controlling condition and thereby closes a circuit for energizing motor M2. This circuit may be traced in Fig. 6 from terminal B of the energy source, through switch 158 in its first circuit controlling condition, through motor M2 and over switch 150 in its second circuit controlling condition to terminal N of the energy source. Accordingly, motor M2 starts turning shaft 130 which through the gearing arrangement heretofore described imparts a rotary motion to spur gear 110. With gear 110 turning, cam 152 turns and almost immediately upon cam 152 commencing turning cam portion 156 engages contact actuator 164 to thereby close switch 160. With switch 160 closed, motor M1 is energized and, accordingly, through the gear train heretofore described imparts a rotary motion to worm wheel 60 which commences turning to thereby pivot T crank 42 in a counter-clockwise direction against the bias of spring 34. Accordingly, vertically extending part 26 of conveyor 24 moves downwardly and thus imparts through lever arms 78 an upward movement to material holders 22. At the time that material holders 22 reach their uppermost position cam 152 will have rotated sufficiently far to cause contact actuator 164 to move down the face of raised cam portion 156 and out of engagement therewith to thereby open switch 160 and de-energize motor M2. Accordingly, the conveyor remains in the condition described with the material holders stationary out of and over the receptacles as best shown in dotted lines in Fig. 2. During the aforedescribed movement of conveyor 24 locking member 112 of the Geneva gear mechanism is turning relative to driven member 104 but has not as yet moved out of concave portion 114 thereof. Accordingly, there is no lateral or turning movement of the conveyor during the upward movement of the material holders. After the material holders are moved to their raised position spur gear 110 continues rotating and a predetermined time after the material holders reach their raised positions, locking member 112 moves out of concave portion 114 of driven member 104 and at that time roller 108 enters one of the slots 106 on the driven member and driven member 104 commences rotating and hence imparts rotary movement to conveyor 24. It is to be noted that during the turning movement of the conveyor, roller 46 on T crank arm 43 is in engagement with flange 32 on rod 30 and the flange rotates relative to roller 46, the friction therebetween being greatly reduced by the provision of roller 46. At the time that roller 108 moves out of slot 106 on the driven member of the Geneva drive, locking member 112 moves into one of the concave arcuate portions 114 to prevent further turning movement of driven member 104 and hence prevent lateral movement of the material holders 22. Furthermore, cam portion 154 which has passed under contact actuator 162 without effecting the circuit controlling condition of switch 158 engages contact actuator 164 to again close switch 160 and re-energize motor M1. Accordingly, motor M1 operates to rotate worm wheel 60 and this second turning movement of worm wheel 102 moves connecting rod 54 to the left as viewed in Fig. 2 and thereby rotates T crank 42 in a clockwise direction so as to lower the material holders into the receptacles. At the time T crank 42 is turned sufficiently to bring cam follower 136 into engagement with cam 134 to restart the vertical reciprocation to the material holders, contact actuator 164 moves out of engagement with cam portion 154 to again de-energize motor M1 to stop the pivotal movement of T crank 42 and hence the vertical movement of conveyor 24. Furthermore, at the same time, contact actuator 162 comes into engagement with the high cam portion 156 to thereby operate switch 158 to its second circuit controlling condition in which motor M2 becomes de-energized to thus stop all operation of the actuating mechanism save for that imparting the vertical reciprocation. However, at this time free end 148 of sensing arm 146 is still in notch 144 of timing disc 142. As the timing disc continues turning it will force the free end out of the notch back onto the circular periphery of the timing disc and thus reoperate switch 150 to its first circuit controlling condition. When this occurs, a second circuit is established for energizing motor M2 which circuit may be traced from terminal B of the energy source, over switch 150 in its first circuit controlling condition, motor M2, and switch 158 in its second circuit controlling condition to terminal N of the energy source. With motor M2 re-energized shaft 130 again commences turning and thereby imparts rotary movement to cam 152 which turns until contact actuator 162 passes over cam portion 156 and moves out of engagement therewith at which time switch 158 is reoperated to its first circuit controlling condition to thereby de-energize motor M2. During this small movement of cam 152, contact actuator 164 moves over the periphery of the cam face between the two raised cam portions and thus does not operate switch 160. With this short re-energizing-de-energizing cycle which is usually referred to as a reload cycle, it will be noted that the apparatus is now set for another transfer of the material holders when free end 148 of sensing arm 146 falls into the next notch on timing disc 142.

From the foregoing description it will be noted that after the material holders are raised out of the receptacles there is a period of time during which the material holders remain positioned over the receptacles they have last been removed from to thereby permit some dripping

of the liquids on the material and material holders back into the receptacles. Accordingly, when the material holders are moved laterally to a position over the next receptacles, and are then lowered therein, there will be a relatively small amount of liquid on the material holder and material to contaminate the liquids in the next receptacles. It will further be noted that since the main determining factor in the speed of transferring the material holders from one receptacle to the other is the time necessary to permit the dripping of the liquids back into the proper receptacles, since a period of dwell is provided for that purpose, the remaining parts of the transfer cycle may be speeded up to thereby cut down the total time of transferring the material holder from one receptacle to another.

In order to prevent contamination and evaporation of the reagents in the aforedescribed receptacles, a cover **172** is provided. Said cover is in the form of a flat apertured disc having central opening **174** which is sufficiently large so that the cover will not engage enclosure **14**. The radial width of cover **172** is slightly greater than the distance between the front and rear walls of the receptacles so that when the cover rests on the tops of receptacles **20**, it covers the entire receptacle.

It will be observed that said cover is mounted on carrier **94** for vertical and horizontal movements therewith. Cover **172** is provided with a plurality of apertures **176**, here shown as twelve in number, through which studs **96** slidably extend in order to mount material holder brackets **98** as already described. When the material holders are in their lowered position for immersing the material in the reagents in the receptacles, cover **172** rests on the tops of all the receptacles to thereby cover the latter. With the cover so resting, the conveyor can vertically reciprocate the material holders since studs **96** can move freely in apertures **176** without imparting movement to the cover. When the conveyor is actuated to move the material holders up out of the receptacles, the material holders move upwardly a short distance while cover **172** stays in covering relationship with the receptacles. When brackets **98** engage the bottom of the cover, the further upward movement of the conveyor imparts a corresponding upward movement to the cover to move the latter out of covering relation with the receptacles. When the conveyor turns to move the material holders laterally from a position over one receptacle to a position over another receptacle, cover **172** of course will move therewith. When the conveyor is again actuated to move the material holders into said other receptacles, the cover moves downwardly therewith until it again engages the tops of the receptacles to recover them, the material holders continuing their downward movement a short distance further and then starting their vertical reciprocatory movement.

In its broad aspects, certain features of the present invention are related to certain features of the invention disclosed in the application of Jack Isreeli, Serial No. 474,210, owned by the assignee of the present application.

Although I have herein shown and described only one form of automatic immersion apparatus embodying my invention, it will be understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirt and scope of this invention.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. In automatic immersion apparatus having a conveyor movable up and down and laterally for moving a material holder into and out of a plurality of receptacles arranged laterally of each other, said conveyor having a downwardly extending portion, means operatively connected to a lower part of said downwardly extending portion of said conveyor for vertically moving said conveyor so that said material holder moves out of and into said receptacles, and means for moving said conveyor laterally so that said material holder moves from a position over one receptacle to a position over another receptacle, said last mentioned means comprising a Geneva gear operatively connected to a lower part of said downwardly extending portion of said conveyor.

2. In automatic immersion apparatus having a housing adapted to support a plurality of receptacles arranged in a circular row, a conveyor having a vertical part at the center of said circle and mounted in said housing for vertical and turning movement, said conveyor being further provided with an outwardly extending part adapted to move a material holder from receptacle to receptacle, means operatively connected to a lower part of said downwardly extending portion of said vertical part for imparting vertical motion to said conveyor so that said material holder moves out of and into said receptacles, and means for intermittently turning said conveyor so that said material holder is moved from a position over one receptacle to a position over another receptacle, said last mentioned means comprising a Geneva gear operatively connected to a lower part of said downwardly extending portion of said conveyor and being located adjacent the bottom of said vertical part.

3. In automatic immersion apparatus having a conveyor mounted for vertical movement and for rotation about a vertical axis for moving a material holder into and out of a plurality of receptacles for liquids in which the material is to be immersed, said conveyor having an upper part for carrying said material into and out of said receptacles; means for actuating said conveyor to raise and lower said part thereof and to turn said part when said part is in a raised position, and means operatively connecting said conveyor to said actuating means for operation thereby comprising vertically extending relatively slidable parts, said relatively slidable parts being held against relative rotation, means for raising and lowering one of said relatively slidable parts in relation to the other of said relatively slidable parts to raise and lower said upper part of the conveyor, said other relatively slidable part being held against vertical movement, a Geneva driven gear carried by a lower part of said other relatively slidable part, and Geneva gear mechanism positioned adjacent said lower part of said other relatively slidable part for turning said Geneva driven gear when said one relatively slidable part is in raised position.

4. In automatic immersion apparatus having a conveyor mounted for vertical movement and for rotation about a vertical axis for moving a material holder into and out of a plurality of receptacles for liquids in which the material is to be immersed, said conveyor having an upper part for carrying said material into and out of said receptacles; means for actuating said conveyor to raise and lower said part thereof and to turn said part when said part is in a raised position, and means operatively connecting said conveyor to said actuating means for operation thereby comprising vertically extending co-axial relatively slidable parts, said relatively slidable parts being held against relative rotation, means for raising and lowering one of said relatively slidable parts to raise and lower said upper part of the conveyor, said other relatively slidable part being held against vertical movement, and means for imparting said turning movements to the conveyor connected to said other relatively slidable part adjacent the lower portion of the latter, said upper part of said conveyor being operatively pivotally connected to both said relatively slidable parts whereby when relative slidable movement is imparted to said relatively slidable parts, said upper part of said conveyor pivotally moves to raise and lower said material holder and when turning movement is imparted to said other relatively slidable part, said upper part of said conveyor turns therewith to move said material holder

laterally from a position over one receptacle to a position over another receptacle.

5. In automatic immersion apparatus having a conveyor mounted for vertical movement and for rotation about a vertical axis for moving a material holder into and out of a plurality of receptacles for liquids in which the material is to be immersed, said conveyor having an upper part for carrying said material into and out of said receptacles; means for actuating said conveyor to raise and lower said part thereof and to turn said part when said part is in a raised position, and means operatively connecting said conveyor to said actuating means for operation thereby comprising co-axial relatively slidable parts, said actuating means comprising intermittent rotary driving means operatively connected to one of said relatively slidable parts adjacent the bottom portion of the latter, and means engageable with the other of said slidable parts of said conveyor for moving the latter up and down, said upper part of said conveyor being operatively pivotally connected at the upper portions of said relatively slidable parts, whereby when said slidable part of said conveyor slides relative to said slidable part of said actuating means in one direction and in the opposite direction, said upper part of said conveyor pivotally moves to raise and lower said material holder and when turning movement is imparted to said other relatively slidable part, said upper part of said conveyor turns therewith to move said material holder laterally from a position over on receptacle to a position over another receptacle.

6. In automatic immersion apparatus having a conveyor mounted for vertical movement and for rotation about a vertical axis for moving a material holder into and out of a plurality of receptacles for liquids in which the material is to be immersed and means for raising and lowering said conveyor; means for rotating said conveyor when the latter is in a raised position for moving the material holder from a position above one receptacle to a position above another receptacle, comprising a vertically extending hollow tubular member mounted for turning movement, a driven member connected to said vertically extending tubular member for turning the latter about said axis, said driven member being connected to said vertically extending tubular member adjacent the lower portion of the latter, said driven member having a plurality of circumferentially spaced slots, rotary driving means including a driving member movable into and out of each of said slots in succession for intermittently turning said driven member, means holding said hollow member against vertical movement, said conveyor having a vertically movable part extending through said vertically extending member in slidable relation thereto, means for operatively connecting said conveyor to said vertically extending member so that said conveyor turns with said vertically extending member but is free to move up and down relative thereto, said connecting means being located adjacent the upper part of said vertically extending member, and means operatively connected to said vertically movable part of said conveyor for moving the latter up and down relative to said vertically extending tubular member.

7. In automatic immersion apparatus having a conveyor movable up and down and laterally for moving a material holder into and out of plurality of receptacles arranged laterally of each other, means for operating said conveyor including means for moving the conveyor up and down, said last mentioned means comprising a lever mounted for pivotal movement and operatively connected to said conveyor, means operatively connected to said lever for pivotally moving the latter through one distance for moving the material holder into and out of the receptacles, and means operatively connected to said lever for moving the latter a distance substantially less than said one distance for moving the material holder repeatedly in opposite directions while it is positioned in each of said receptacles.

8. In automatic immersion apparatus having a conveyor movable up and down and laterally for moving a material holder into and out of a plurality of receptacles arranged laterally of each other, said conveyor having a vertically movable part and an upper part disposed above said receptacles and adapted to carry said material holder at one end of said upper part, said upper part being operatively pivotally connected to said vertically movable part at the other end of the former, said upper part being further pivotally mounted at a point closer to said other end than to said one end, said point of said further pivotal mounting being vertically immovable, means for moving said conveyor up and down comprising a pivotally mounted crank having one arm operatively engaging said conveyor and another arm disposed at an angle relative to said one arm, and means operatively connected to said other arm for at times imparting reciprocating motion thereto, said one arm being relatively longer than said other arm, whereby a relatively small movement of said other arm will cause a relatively large movement of said one end of said upper part to thereby move said material holder into and out of said receptacles.

9. In automatic immersion apparatus having a conveyor movable up and down and laterally for moving a material holder into and out of a plurality of receptacles arranged laterally of each other, means for operating said conveyor including means for moving the conveyor up and down, said last mentioned means comprising a lever mounted for pivotal movement and operatively connected to said conveyor, means operatively connected to said lever for pivotally moving the latter through one distance for moving the material holder into and out of the receptacles, and means operatively connected to said lever for moving the latter a distance substantially less than said one distance for moving the material holder repeatedly in opposite directions while it is positioned in said receptacles, said lever being pivoted between its ends thereby providing two lever arms and having a third arm extending laterally therefrom, one of said lever moving means being operatively connected to one of said two arms and the other of said lever moving means being operatively connected to said third arm.

10. In automatic immersion apparatus having a conveyor movable up and down and laterally for moving a material holder into and out of a plurality of receptacles arranged laterally of each other, means for operating said conveyor including means for moving the conveyor up and down, said last mentioned means comprising a lever mounted for pivotal movement and operatively connected to said conveyor, means operatively connected to said lever for pivotally moving the latter through one distance for moving the material holder into and out of the receptacles, and means operatively connected to said lever for moving the latter a distance substantially less than said one distance for moving the material holder repeatedly in opposite directions while it is positioned in said receptacles, said lever being pivoted between its ends thereby providing two lever arms and having a third arm extending laterally therefrom, one of said lever moving means being operatively connected to one of said two arms and the other of said lever moving means being operatively connected to said third arm, said last mentioned connection comprising a lost motion device effective in one direction for actuating the lever to raise and lower the conveyor through said one distance without interfering with the motion of said lever for raising and lowering the conveyor through said lesser distance.

11. In automatic immersion apparatus having a conveyor movable up and down and laterally for moving a material holder into and out of a plurality of receptacles arranged laterally of each other, means for moving said conveyor up and down comprising a pivotally mounted crank having one arm operatively engaging said conveyor

and another arm disposed at an angle relative to said one arm, and means operatively connected to said other arm for at times imparting reciprocating motion thereto, and eccentric means operatively connected to said crank when said conveyor is in its lowered position for imparting oscillatory motion to said crank, whereby said conveyor vertically reciprocates through a distance which is less than the distance of movement when said conveyor is raised and lowered.

12. In automatic immersion apparatus having a conveyor movable up and down and laterally for moving a material holder into and out of a plurality of receptacles arranged laterally of each other, means for raising and lowering said material holder for moving the latter into and out of receptacles comprising a rotary member, a pivotally mounted crank having three arms disposed to form a T, a connecting rod pivotally connected at one end to said rotary member and slidably connected at its other end to one arm of said T crank, spring means for yieldably holding said other end of said connecting rod in fixed position relative to said one arm of said T crank so that when said rotary member turns oscillatory movement is imparted to said T crank, the second arm of said T crank being operatively connected to said conveyor whereby when said crank oscillates, said conveyor moves vertically to move said material holder into and out of said receptacles, eccentric means, and the third arm of said crank operatively releasably engageable with said eccentric means when said material holder is in one of said receptacles for oscillating said crank an amount substantially less than the degree of oscillation imparted by said rotary member, whereby to impart vertical reciprocatory motion to said material holder when it is in said receptacle.

13. Automatic immersion apparatus, comprising means for supporting a plurality of receptacles laterally of each other, a conveyor operable to move a material holder vertically into and out of said receptacles and laterally for transferring the material holder from a position over one receptacle to a position over another receptacle to be lowered into the latter by the conveyor in the operation thereof, said conveyor comprising a member disposed above the receptacles and extending laterally thereof and having provision for supporting at least one material holder for movement into and out of the receptacles, means including a plurality of pivoted levers forming upper parts of said conveyor and operatively connected to said laterally extending member at laterally spaced points, respectively, to raise and lower the latter when the conveyor is raised and lowered said laterally extending member forming a cover for all of said receptacles, and means for raising and lowering said conveyor.

14. Automatic immersion apparatus, comprising means for supporting a plurality or receptacles laterally of each other in an arcuate row, a conveyor mounted for vertical movement and for rotation about a vertical axis for moving a material holder into and out of a plurality of receptacles for liquids in which the material is to be immersed and means for raising and lowering said conveyor; said conveyor comprising a member disposed above the receptacles and extending laterally thereof and having provision for supporting at least one material holder for movement into and out of the receptacles, means including a plurality of pivoted levers forming upper parts of said conveyor and operatively connected to said laterally extending member at laterally spaced points, respectively, to raise and lower the latter when the conveyor is raised and lowered, and means operatively connected to said levers to bodily rotate the latter as a group for rotating said conveyor member, said conveyor having a vertically movable member co-axially disposed at said axis of rotation and pivotally connected to said levers for raising and lowering said first member, mechanism connected to said vertically movable member for raising and lowering the latter, and means for turning said conveyor about said axis when the conveyor is in raised position.

15. Automatic immersion apparatus, comprising means for supporting a plurality of receptacles laterally of each other, a conveyor operable to move a material holder vertically into and out of said receptacles and laterally for transferring the material holder from a position over one receptacle to a position over another receptacle to be lowered into the latter by the conveyor in the operation thereof, said conveyor comprising a member disposed above the receptacles and extending laterally thereof and having provision for supporting at least one material holder for movement into and out of the receptacles, and means including a plurality of pivoted levers forming upper parts of said conveyor and operatively connected to said laterally extending member at laterally spaced points, respectively, to raise and lower the latter when the conveyor is raised and lowered, said conveyor having a vertically movable member operatively connected to said levers for raising and lowering said first member, and movable means operatively connected to said vertically movable member for raising and lowering the latter covering means for said receptacles, and means carried by said first member for supporting said covering means for movement by said conveyor, said last mentioned means having provision for relative vertical movement between said first member and said covering means so that said conveyor first member may move downwardly a short distance after the covering means rests on said receptacles for closing the latter without exerting pressure on said receptacles.

16. Automatic immersion apparatus, comprising means for supporting a plurality of receptacles laterally of each other, a conveyor operable to move a material holder vertically into and out of said receptacles and laterally for transferring the material holder from a position over one receptacle to a position over another receptacle to be lowered into the latter by the conveyor in the operation thereof, said conveyor comprising a member disposed above the receptacles and extending laterally thereof and having provision for supporting at least one material holder for movement into and out of the receptacles, and means including a plurality of pivoted levers forming upper parts of said conveyor and operatively connected to said laterally extending member at laterally spaced points, respectively, to raise and lower the latter when the conveyor is raised and lowered, said levers having a laterally lost motion connection with said laterally extending member.

17. Automatic immersion apparatus, comprising means for supporting a plurality of receptacles laterally of each other, a conveyor operable to move a material holder vertically into and out of said receptacles and laterally for transferring the material holder from a position over one receptacle to a position over another receptacle to be lowered into the latter by the conveyor in the operation thereof, said conveyor comprising a member disposed above the receptacles and extending laterally thereof and having provision for supporting at least one material holder for movement into and out of the receptacles, a lever pivotally mounted at the upper part of said conveyor for movement in a vertical plane and having a lost motion connection with said member, and means operatively connected to said lever for pivotally moving the latter to vertically reciprocate the material holder in the receptacles while the conveyor is in a lowered position.

18. In automatic immersion apparatus having a conveyor movable up and down and laterally for moving a material holder into and out of a plurality of receptacles arranged laterally of each other, means including a motor for moving said conveyor laterally, and means including another motor for moving said conveyor up and down, and means for controlling the operation of said two moving means in timed relation to each other whereby said means for moving the conveyor laterally of said

receptacles is effective only when the material holder is moved upwardly a predetermined distance required to remove the material holder from the receptacles.

19. In automatic immersion apparatus having a conveyor movable up and down and laterally for moving a material holder into and out of a plurality of receptacles arranged laterally of each other, means including a motor for moving said conveyor laterally, said last mentioned means being effective for moving said conveyor laterally during only a part of the time said motor is energized, and means including another motor for moving said conveyor up and down in timed relation with said first mentioned means, and means controlled by said first motor for controlling said second motor whereby said second motor is energized and de-energized to raise said material holder out of a receptacle prior to said first mentioned means becoming effective, said de-energization of said second motor with said material holder in said raised position occuring a predetermined time prior to said first mentioned means becoming effective to provide a period of dwell of said material holder over said receptacle, said control means being further effective to energize and de-energize said second motor to lower said material holder into another receptacle after said first mentioned means has moved said material holder laterally to a position over said other receptacle.

20. In automatic immersion apparatus having a conveyor movable up and down and laterally for moving a material holder into and out of a plurality of receptacles arranged laterally of each other, means including a motor for moving said conveyor laterally, said last mentioned means being effective for moving said conveyor laterally during only a part of the time said motor is energized, and means including another motor for moving said conveyor up and down in timed relation with said first mentioned means, and means controlled by said first motor for controlling said second motor whereby said second motor is energized and de-energized to raise said material holder out of a receptacle prior to said first mentioned means becoming effective, and said second motor is energized and de-energized to lower said material holder into another receptacle after said first mentioned means has moved said material holder laterally to a position over said other receptacle.

21. In automatic immersion apparatus having a conveyor movable up and down and laterally for moving a material holder into and out of a plurality of receptacles arranged laterally of each other, means including a motor for moving said conveyor laterally, said last mentioned means being effective for moving said conveyor laterally during only a part of the time said motor is energized, and means including another motor for moving said conveyor up and down in timed relation with said first mentioned means, said other motor being de-energized when said first mentioned means is effective for moving said conveyor laterally, whereby said conveyor does not move up and down when it moves laterally.

22. In automatic immersion apparatus having a conveyor mounted for vertical movement and for rotation about a vertical axis for moving a material holder into and out of a plurality of receptacles for liquids in which the material is to be immersed and means for raising and lowering said conveyor; means for rotating said conveyor when the latter is in a raised position for moving the material holder from a position above one receptacle to a position above another receptacle comprising a driven member operatively connected to said conveyor for turning the latter about said axis, said driven member having a plurality of circumferentially spaced slots, rotary driving means including a driving member movable into and out of each of said slots in succession for intermittently turning said driven member, a first electric motor for actuating said means for raising and lowering said conveyor, a second electric motor for actuating said rotary driving means, switching means for controlling the circuits of said motors, means operable to actuate said switching means to energize said first motor only when said driving member is out of said slots so that said conveyor is moved vertically when it is stationary in the lateral direction and is turned only when it is vertically stationary, and time controlled means for controlling the operations of said switch actuating means.

23. In automatic immersion apparatus having a conveyor mounted for vertical movement and for rotation about a vertical axis for moving a material holder into and out of a plurality of receptacles for liquids in which the material is to be immersed and means for raising and lowering said conveyor; means for rotating said conveyor when the latter is in a raised position for moving the material holder from a position above one receptacle to a position above another receptacle comprising a driven member operatively connected to said conveyor for turning the latter about said axis, said driven member having a plurality of circumferentially spaced slots, rotary driving means including a driving member movable into and out of each of said slots in succession for intermittently turning said driven member, a first electric motor for actuating said means for raising and lowering said conveyor, a second electric motor for actuating said rotary driving means, switching means for controlling the circuits of said motors, means operable by said rotary driving means to actuate said switching means to energize said first motor only when said driving member is out of said slots so that said conveyor is moved vertically when it is stationary in the lateral direction and is turned only when it is vertically stationary, and time controlled means for controlling the operations of said switch actuating means.

24. In automatic immersion apparatus having a frame, a conveyor for a material holder mounted in said frame for vertical movement and for rotation about a vertical axis, and a receptacle support on said frame extending completely around said axis of the conveyor; a series of separate individual receptacles for liquids adapted to be arranged laterally of each other in adjacent relation on said support in a circular row extending around said axis so that the material holder may be moved into and out of said receptacles for immersion in the liquids therein when said conveyor is operated, and a single cover for said receptacles movable with said conveyor, said receptacles having substantially flat planar vertical side walls which converge radially of and toward said axis when on said support, whereby said receptacles may be disposed on said support in adjacent side-by-side relation completely therearound.

25. In automatic immersion apparatus having a conveyor mounted for vertical movement and for rotation about a vertical axis for moving a material holder into and out of a plurality of receptacles for liquids in which the material is to be immersed, said conveyor having an upper part for carrying said material into and out of said receptacles; means for actuating said conveyor to raise and lower said part thereof and to turn said part when said part is in a raised position, and means operatively connecting said conveyor to said actuating means for operation thereby comprising vertically extending relatively slidable parts on said actuating means and on said conveyor, respectively, said relatively slidable parts being held against relative rotation, means for raising and lowering one of said relatively slidable parts to raise and lower said upper part of the conveyor, means for holding said other slidable part against vertical movement and means for imparting said turning movements to the conveyor connected to said other relatively slidable part adjacent the lower portion of the latter, and a cover for all said receptacles carried by said conveyor and vertically and rotatably movable therewith.

26. In automatic immersion apparatus having a conveyor mounted for vertical movement and for rotation about a vertical axis for moving a material holder into

and out of a plurality of receptacles for liquids in which the material is to be immersed, said conveyor having an upper part for carrying said material into and out of said receptacles; means for actuating said conveyor to raise and lower said part thereof and to turn said part when said part is in a raised position, and means operatively connecting said conveyor to said actuating means for operation thereby comprising vertically extending relatively slidable parts on said actuating means and on said conveyor, respectively, said relatively slidable parts being held against relative rotation, means for raising and lowering one of said relatively slidable parts to raise and lower said upper part of the conveyor, means for holding said other slidable part against vertical movement and means for imparting said turning movements to the conveyor connected to said other relatively slidable part adjacent the lower portion of the latter, and a cover for all said receptacles carried by said conveyor and vertically and rotatably movable therewith, and means on said conveyor for mounting the material holder for movement concomitantly with said cover.

27. In automatic immersion apparatus having a conveyor movable up and down and laterally for transferring a material holder into and out of a plurality of receptacles arranged laterally of each other, means for raising and lowering said conveyor, and means for operating said conveyor to move said material holder laterally in the raised position thereof whereby to move said material holder from a position over one receptacle to a position over another receptacle; said means for raising and lowering said conveyor comprising a movable member which is intermittently actuated during the transfer of said material holder for raising and lowering said conveyor and being stationary in an intermediate position for holding said conveyor in raised position for a predetermined period of time prior to said conveyor being operated to move said material holder laterally, whereby to hold said material holder stationary over the receptacle from which it has just been removed prior to the material holder being moved laterally for transferring it to the next receptacle.

28. In automatic immersion apparatus having a conveyor movable up and down and laterally for transferring a material holder into and out of a plurality of receptacles arranged laterally of each other, means for raising and lowering said conveyor, and means for operating said conveyor to move said material holder laterally in the raised position thereof whereby to move said material holder from a position over one receptacle to a position over another receptacle; said means for raising and lowering said conveyor comprising a member which is intermittently movable during the transfer of said material holder for raising and controlling the lowering of said conveyor, said intermittently movable member moving to raise said conveyor at the beginning of the transfer of said material holder and moving to permit the lowering of said conveyor prior to the end of said transfer, said member being stationary for a predetermined period of time extending from the time said conveyor is moved to its raised position to the time said member moves to permit the lowering of said conveyor, whereby to hold said conveyor in raised position for said predetermined period of time.

29. In automatic immersion apparatus having a conveyor movable up and down and laterally for transferring a material holder into and out of a plurality of receptacles arranged laterally of each other, means for raising and lowering said conveyor, and means for operating said conveyor to move said material holder laterally in the raised position thereof whereby to move said material holder from a position over one receptacle to a position over another receptacle; said means for raising and lowering said conveyor comprising a member which is intermittently movable during the transfer of said material holder for raising and controlling the lowering of said conveyor, said intermittently movable member moving to raise said conveyor at the beginning of the transfer of said material holder and moving to permit the lowering of said conveyor prior to the end of said transfer, said member being stationary for a predetermined period of time extending from the time said conveyor is moved to its raised position to the time said member moves to permit the lowering of said conveyor, whereby to hold said conveyor in raised position for said predetermined period of time, said means for operating said conveyer to move said material holder laterally becoming effective a given time after said intermittently movable member becomes stationary with said conveyor in raised position, whereby said material holder is held stationary over the receptacle from which it has just been removed for said given time before being moved laterally to transfer it to the next receptacle.

30. Automatic immersion apparatus, comprising means for supporting a plurality of receptacles arranged in a circular row completely therearound, a conveyor mounted for vertical movement and for rotation for transferring a material holder from one receptacle to another, means for vertically reciprocating said conveyor through a short distance when said conveyor is in its lowered position for vertically reciprocating said material holder in said receptacles, a single cover for all said receptacles, and means for operatively connecting said cover to said conveyor for vertical and rotary movement therewith to cover said plurality of receptacles when said material holder is lowered into one of said receptacles by said conveyor, said connecting means being arranged to permit limited relative movement between said conveyor and said cover, whereby said cover remains stationary in covering relation with said receptacles when said material holder is being vertically reciprocated within one of said receptacles.

31. Automatic immersion apparatus comprising a plurality of receptacles arranged laterally of each other in an arcuate row, and a conveyor mounted for vertical movement and for rotation about a vertical axis at the center of said arc for moving a material holder into and out of each of said receptacles, said receptacles having substantially flat side walls which converge toward the center of the arc and extend radially thereof whereby said receptacles may be disposed in adjacent side-by-side relation in said arcuate arrangement, a single cover for all of said receptacles operatively carried by said conveyor for vertical and rotary movement therewith to cover all of said receptacles when the material holder is lowered into one of said receptacles by said conveyor, and means for moving the material holder in each receptacle when the holder is positioned therein and said cover is in receptacle covering position.

32. Automatic immersion apparatus, comprising means for supporting a plurality of individual receptacles arranged adjacent to and laterally of each other in a row, said receptacles having flat side walls, a conveyor operable for moving a material holder from one receptacle to another, a single cover for said plurality of receptacles, means for moving said cover in the direction of said row of receptacles during said movement of said material holder from one receptacle to another for permitting the withdrawal of said material holder from one receptacle and the insertion of said material holder into another receptacle, and means for repeatedly moving said material holder when in said receptacles, said means for moving said cover permitting movement of said material holder relative to said cover when said material holder is in said receptacles, whereby to maintain said cover in covering relation with said plurality of receptacles during the movement of said material holder when in the receptacle.

33. In automatic immersion apparatus having a support for a plurality of liquid receptacles arranged laterally of each other in a circular row completely there-

around and a conveyor which is rotatable and vertically movable for transferring a material holder from one to another of said receptacles; said receptacles being spaced from the rotary axis of said conveyor and having flat side walls which converge toward the rotary axis of said conveyor so that said receptacles may be disposed with their adjacent side walls in close relation substantially throughout the extent thereof, a single unitary cover member for said plurality of receptacles, and means for moving said cover in the direction of said row of receptacles when said material holder is transferred from one receptacle to another to permit the withdrawal of said material holder from one receptacle and to permit the insertion of the material holder into another material holder, and means for moving the material in each receptacle during the periods of immersion and while the cover is in receptacle covering relation.

34. In automatic immersion apparatus having a support for a plurality of liquid receptacles arranged laterally of each other in a circular row completely therearound and a conveyor which is rotatable and vertically movable for transferring a material holder from one to another of said receptacles; said receptacles being spaced from the rotary axis of said conveyor and having flat side walls which converge toward the rotary axis of said conveyor so that said receptacles may be disposed with their adjacent side walls in close relation substantially throughout the extent thereof, a unitary cover member for all of said of receptacles, means for operatively connecting said cover to said conveyor for vertical and rotary movement therewith, and means for repeatedly moving the holder in the receptacle without substantial movement of said cover when the holder is in receptacle covering relation.

35. In automatic immersion apparatus, a support for a row of liquid receptacles, including a receptacle for melted paraffin or other heated infiltrating material, a plurality of such receptacles mounted in adjacent side-by-side relation on said support and having flat side walls in close relation so that the heat from said receptacle which contains the heated infiltrating material is transmitted to adjacent receptacles, single cover means for said receptacles movable horizontally in the direction of said row of receptacles, a material holder movable in the direction of said row of receptacles and vertically up and down for transferring the material from one receptacle to another for successive immersions in the liquids in said receptacles, and variable time-controlled means for imparting said movements to said cover and said material holder, respectively.

36. In automatic immersion apparatus, a support for a row of liquid receptacles, including a receptacle for melted paraffin or other heated infiltrating material, a plurality of such receptacles mounted in adjacent side-by-side relation on said support and having flat side walls in close relation so that the heat from said receptacle which contains the heated infiltrating material is transmitted to adjacent receptacles, single cover means for said receptacles movable horizontally in the direction of said row of receptacles, a material holder movable in the direction of said row of receptacles and vertically up and down for transferring the material from one receptacle to another for successive immersions in the liquids in said receptacles, and variable time-controlled means for imparting said movements to said cover and said material holder, respectively, and means for moving the material holder in each receptacle during the period of immersion without substantial movement of said cover means.

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