July 29, 1958 E. C. WEISKOPF 2,845,045

APPARATUS FOR PROCESSING HISTOLOGIC TISSUE AND OTHER MATERIALS

Filed Dec. 8, 1954

FIG. 1

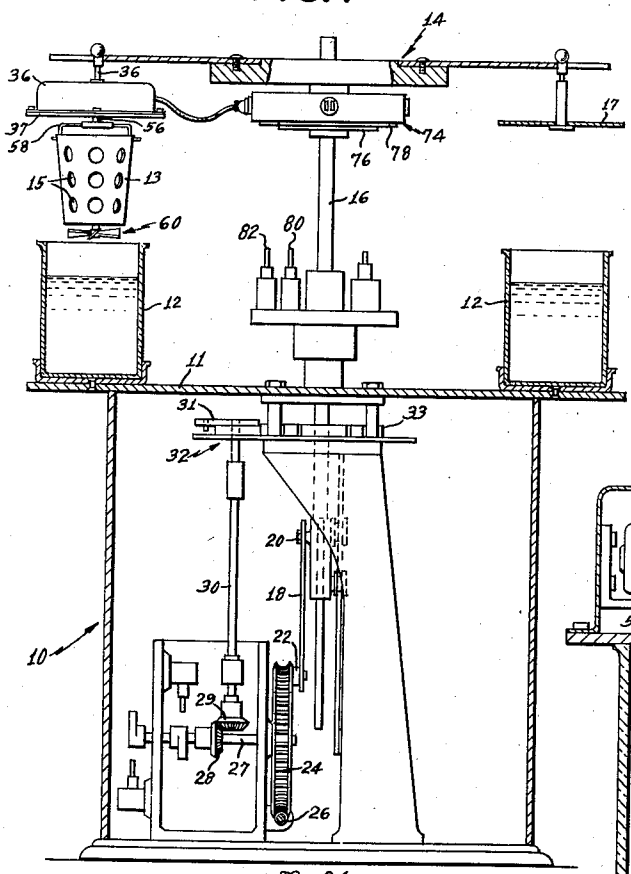


FIG. 5

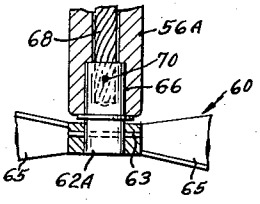


FIG. 4

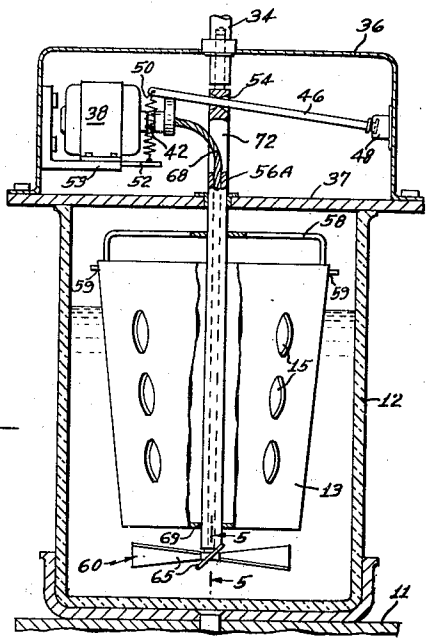


FIG. 2

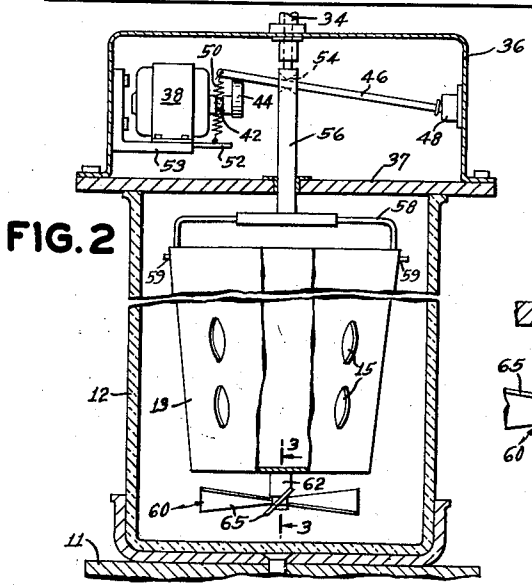
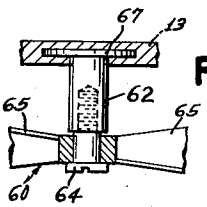


FIG. 3



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2,845,045

APPARATUS FOR PROCESSING HISTOLOGIC TISSUE AND OTHER MATERIALS

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Application December 8, 1954, Serial No. 473,979

19 Claims. (Cl. 118—612)

This invention relates to apparatus for preparing histologic tissue for microscopic examination.

The preparation of histologic tissue for microscopic examination involves immersion of the gross specimen of tissue in a series of liquid agents for certain periods of time. More particularly, the gross specimen is immersed in a fixative to fix the tissue, thereafter the tissue is dehydrated, subsequently the tissue is treated with a clearing agent, and thereafter the tissue is immersed in an infiltrating agent such as paraffin, celloidin, or any other suitable substance to imbed the specimen in a block so that it can be cut into sections, for which purpose a microtome is employed. After the sections are cut, they are treated to remove the paraffin or other infiltrating material, after which they are stained, usually with hematoxylin and eosin stains, and are mounted on glass slides for examination under the microscope.

The primary object of this invention is to provide novel means for improving the action of the fixative and the other liquid agents on the tissue and to reduce the time required for treatment of the tissue in the processing thereof for microscopic examination.

Another object of this invention is to provide apparatus which is well adapted for carrying out the improved method of the present invention in a practical and convenient way.

Still another object of this invention is to provide means for maintaining the liquid in motion about the tissue in the liquid receptacle.

The above and other objects and features of this invention will be fully understood as the characteristic features of construction and mode of operation of the present invention are described in detail.

In the drawings:

Fig. 1 is a sectional view of automatic immersion apparatus embodying this invention;

Fig. 2 is a sectional view of a tissue holder provided with liquid moving means embodying one form of the present invention;

Fig. 3 is a sectional view taken along the lines 3—3 of Fig. 2;

Fig. 4 is a sectional view illustrating a tissue holder and liquid moving means embodying another form of my invention both immersed in a suitable liquid container or receptacle; and

Fig. 5 is a sectional view taken along the line 5—5 of Fig. 4.

The present invention is preferably utilized in conjunction with automatic tissue processing apparatus of the type shown and described in U. S. Patent No. 2,341,198, which is owned by the assignee of the present application. Such apparatus includes a housing 10, having a support surface 11 for a plurality of receptacles or beakers 12. The beakers 12 contain the various liquids for treating histologic tissue in order to prepare the tissue for microscopic examination. The tissue specimens are ordinarily placed in small perforated containers

(not shown) which are disposed in a perforated holder or basket holder 13 which is operatively connected by means to be described in detail subsequently to a conveyor generally designated by the reference character 14. The conveyor 14 includes a vertical shaft 16 which imparts lateral and vertical movement to the conveyor and the holder 13 for raising the holder out of one receptacle and then moving it laterally into alignment with another receptacle and then lowering the holder therein for immersing the tissue in the liquid in the receptacle for a predetermined time. Holder 13 is provided with a number of apertures 15 to make the tissue in holder 13 accessible to the liquid in receptacles 12. A number of covers 17 may also be connected to conveyor 14 to engage the tops of beakers 12 when holder 13 is in its lowered position in order to prevent foreign matter from entering the beakers and to reduce evaporation of the liquids therein in the case of the more volatile liquids.

The mechanism for imparting the vertical motion to the shaft 16, as described in my above-mentioned patent and also in my earlier U. S. Patent No. 2,157,875 includes a connecting rod 18 which is pivotally mounted at one end on a pin 20 secured to shaft 16 and which is further pivotally mounted at its other end on a pin 22 which in turn is secured to a gear 24. Gear 24 is engaged by a gear 26 which is driven by a motor (not shown). When gear 24 is rotated by gear 26 and the motor, rod 18 moves down to thus impart vertical movement to shaft 16 and hence conveyor 14. Gear 24 is mounted on a shaft 27 which also has mounted thereon for rotation therewith a bevel gear 28. Bevel gear 28 engages a companion bevel gear 29 which is mounted on a shaft 30 operatively connected to the driving member 31 of a Geneva gear mechanism generally shown as 32. Driving member 31 imparts rotary movement to a driven member 33 of the Geneva gear movement when shaft 16 is in its raised position thereby imparting a small rotary movement to shaft 16 to move tissue holder 13 laterally from a position over one receptacle to a position over the adjacent receptacle. Upon completion of the lateral movement, shaft 16 is lowered by the raising and lowering mechanism in order to immerse basket 13 and the tissue therein in the adjacent receptacle. A timing mechanism (not shown) is employed to initiate at predetermined time intervals the series of movement heretofore described. The apparatus for imparting the vertical and lateral movements has been described generally and if a more detailed description is desired, reference may be had to my aforementioned U. S. patents.

In accordance with my present invention, means are also provided for vertically reciprocating the tissue holder when it is positioned in the receptacles 12 and for effecting movement of the liquid about the tissue during the vertical reciprocation of the tissue holder in said receptacles.

As shown in Fig. 2, the means for reciprocating the tissue holder includes a stud 34 which is secured to conveyor 14 at a distance from shaft 16 equal to the distance at which the centers of the several beakers are mounted from the shaft. Secured to stud 34 is a housing 36 having a bottom plate 37. Fixedly mounted in housing 36 is a motor 38 (Fig. 2). Motor 38 preferably has connected therewith in an integrated housing a reduction gearing which operatively connects the motor to a shaft 42. Fixedly mounted on shaft 42 by any suitable means is a cam 44. Cam 44 may be of circular cross section and be eccentrically mounted on shaft 42 or the cam may be concentrically mounted on the shaft but have an irregular peripheral form. A connecting rod 46 is pivotally mounted in bracket 48 which is mounted on the side wall of the housing 36. Rod

46 is held in engagement with cam 44 by means of a biasing spring 50 which is connected at one end to the end of said connecting rod adjacent the cam 44 and is connected at its other end to a bracket 52 mounted on the support 53 for motor 38. Connecting rod 46 is slidably and pivotally mounted in a double funnel shaped aperture 54 in a reciprocating stud 56. Stud 56 is mounted for slidable vertical reciprocating movement in plate 37 and stud 34 and has a portion extending through an aperture in the plate 37 of housing 36 which portion is secured in any suitable manner to a bracket 58, such as for instance by the means shown and described in U. S. Patent No. 2,539,802. Tissue holder 13 is removably connected to bracket 58, as at 59, preferably in the manner fully described and illustrated in said U. S. Patent No. 2,539,802. With the parts arranged and described above it will be seen that when motor 38 is energized, a vertical reciprocating movement is imparted to shaft 56 so that tissue holder 13 moves up and down in a vertical direction. The preferred speed of the reciprocatory movement of the holder 13 is about ten cycles per minute, that is ten up and ten down movements per minute but it will be understood that any suitable frequency of reciprocation may be employed. The amplitude of the reciprocation is small being of the order of about three-fourths of an inch. The means which has just been described for vertically reciprocating the tissue holder 13 is substantially the same as the means shown and described in U. S. patent application, Ser. No. 439,397, filed on June 25, 1954, by Harry Cohen and assigned to the assignee hereof. However, it will be understood that my invention is not limited to vertical reciprocating means such as that shown in the aforementioned Cohen application but may be satisfactorily employed in conjunction with any means for vertically reciprocating the tissue holder such as, for instance, the vertical reciprocation means shown and described in U. S. patent application, Ser. No. 358,812, filed on June 1, 1953 now Patent 2,741,221, by me and Andres Ferrari, Jr., as co-inventors and assigned to the assignee hereof.

The provision for moving the liquid about the tissue specimens will now be described. In the form of the invention shown by Figs. 1, 2 and 3, provision is made for a multi-blade impeller 60 which is mounted for free rotary movement on a shoulder screw 64 which is in threaded engagement with a stud 62. It will be readily understood that the impeller blades 65 have a suitable pitch or angularity as a result of which the impeller will rotate when it is moved up and down in the liquid. Said stud is fixed to the bottom of holder 13 for movement therewith by any suitable means such as by embedding its flanged end 67 in the bottom of the tissue holder 13. With such an arrangement, when the tissue holder is immersed in the liquid and the holder 13 is vertically reciprocated as above described, the impeller rotates in one direction as the tissue holder is moved downwardly and rotates in the opposite direction as the tissue holder is moved upwardly. Thus, the vertical reciprocation of tissue holder 13 by motor 38 is effective not only to cause relative vertical movement of the tissue specimens and liquid but is also effective to cause relative oscillatory movement therebetween. The liquid in the receptacle is thus continuously moved about the tissue specimens in substantially all directions while the tissue holder is in the receptacle. This movement results in improving the action of the liquid and hastens the exchange of the treating liquid in the tissue for the liquids which are required to be removed therefrom in order to properly prepare the tissue for microscopic examination. The continuous movement of the liquid hastens this liquid exchange by constantly presenting to the tissue fresh liquid, i. e. liquid which is not appreciably modified by liquids which leave the tissue during the immersion.

As described above, the oscillation of the impeller is accomplished automatically by the vertical reciprocation of the tissue holder 13 in the liquid contained in the receptacles 12. In the form of the invention illustrated by Figs. 4 and 5, provision is made for rotating the impeller by the motor 38. More particularly in this embodiment of the invention, the impeller 60 is removably mounted on stud 62A by a removable pin 63 and the stud in turn is journalled in a bearing 66 provided in a hollow rod 56A which is secured to bracket 58 in any suitable manner such as by a pressed fit and extends through the bottom of basket 13 as by a close but sliding fit 69. A flexible shaft 68 extends through rod 56A substantially the entire length of the rod. At one end, flexible shaft 68 is secured by any suitable means such as a pin 70 to stud 62A and at the opposite end flexible shaft 68 passes out of the hollow shaft 56A through an elongated aperture 72 provided therein and is connected to the motor operated shaft 42. The structure of shaft 56A above aperture 72 is the same as that of stud 56 and shaft 56A cooperates with rod 46 and the other elements described heretofore to impart vertical reciprocating movement to tissue holder 13 and the tissue therein when motor 38 is energized. Accordingly, when motor 38 is energized to vertically reciprocate the tissue holder 13, the motor will also be effective for rotating impeller 60 by rotation of flexible shaft 68. It will be noted that basket 13 can be removed from the apparatus by taking out pin 63, sliding the impeller off stud 62A and then disconnecting basket 13 from bracket 58 and sliding the basket downward to disengage it from hollow rod 56A.

When the novel means for imparting movement to the liquid within the receptacle are employed in an automatic tissue processing machine such as that described earlier in this detailed specification, it has been found desirable and economical, but not necessary, to impart motion to the tissue holder and the impeller only when the tissue holder is immersed in the liquids in receptacles 12. In order to accomplish this, a hub 74 is mounted on shaft 16 for movement therewith. Hub 74 is provided with a plurality of female outlet receptacles and is also provided on its under surface with two rings of conducting material 76 and 78 which are insulated from each other. Fixedly mounted below hub 74 are a pair of contact pins 80 and 82 which are adapted to engage rings 76 and 78, respectively, when shaft 16 is in its lowered position. Pins 80 and 82 are electrically connected to the source of energy for motor 38. It will be seen therefore that when shaft 16 is moved downwardly in order to immerse tissue holder 13 in the liquid in receptacles 12 electrical contact is made between pins 80 and 82 and rings 76 and 78, respectively, to close a circuit for energizing motor 38. With motor 38 energized, tissue holder 13 reciprocates in a vertical direction as already described and, as already stated with regard to the embodiment shown in Fig. 2 this vertical reciprocatory motion of the tissue holder in the liquid imparts a rotary motion to fan 60. With regard to the second embodiment of the present invention as shown in Figs. 4 and 5, with motor 38 energized when the tissue holder 13 is in its lowered position, flexible shaft 68 rotates and thereby imparts a rotary motion to impeller 60 as heretofore described. It will be obvious that with regard to the second embodiment of the present invention, the rotating motion of impeller 60 is not dependent upon the vertical reciprocatory motion of tissue holder 13 but is independent therefrom, and, accordingly, if it is so desired, the means for vertically reciprocating the tissue holder may be eliminated with regard to this second embodiment. It is to be observed that as shown by Fig. 2, the basket 13 when used without the driven impeller is not provided with the hollow rod 56A (Fig. 4).

It will further be noted that when shaft 16 is in its lowered position in order to immerse basket 13 in the liquids in receptacles 12, bottom plate 37 of housing 36 rests on the tops of the receptacles so as to provide a cover therefore in place of one of the covers 17. It will

further be observed that when the plate **37** rests on the receptacle **12**, it supports the motor **38** and its associated mechanism so that the holder may be reciprocated while the carrier **14** itself is stationary.

Although I have described two forms of the present 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 spirit 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 transferring a material holder from one to another of a plurality of liquid receptacles arranged laterally of each other; means for imparting vertical reciprocating motion to said material holder, the distance through which said material holder is reciprocated being substantially less than the up and down movement of said material holder for transferring the latter from one receptacle to another, and additional means movable with said material holder for moving the liquid in the receptacle in relation to the material, said additional means being carried by said material holders.

2. In automatic immersion apparatus having a conveyor movable up and down and laterally for transferring a material holder from one to another of a plurality of liquid receptacles arranged laterally of each other; means for imparting vertical reciprocating motion to said material holder, the distance through which said material holder is reciprocated being substantially less than the up and down movement of said material holder for transferring the latter from one receptacle to another, and means carried by said material holder and rotatable relative to said material holder in the receptacles for moving the liquid therein when said material holder is immersed therein.

3. In automatic immersion apparatus having a conveyor movable up and down and laterally for transferring a material holder from one to another of a plurality of liquid receptacles arranged laterally of each other; means for imparting vertical reciprocating motion to said material holder, the distance through which said material holder is reciprocated being substantially less than the up and down movement of said material holder for transferring the latter from one receptacle to another, and a member having a pitched blade, said member being carried by said material holder and rotatable relative thereto for moving the liquid in a receptacle when said material holder is immersed therein.

4. In automatic immersion apparatus having a conveyor movable up and down and laterally for transferring a material holder from one to another of a plurality of liquid receptacles arranged laterally of each other; means for imparting vertical reciprocating motion to said material holder, the distance through which said material holder is reciprocated being substantially less than the up and down movement of said material holder for transferring the latter from one receptacle to another, and a member having a pitched blade, said member being mounted on said material holder for free rotation relative thereto, whereby when said material holder is immersed in the liquid in a receptacle and is vertically reciprocating, said member first turns in one direction and then in the other direction to move the liquid in which the material holder is immersed.

5. In automatic immersion apparatus having a conveyor movable up and down and laterally for transferring a material holder from one to another of a plurality of liquid receptacles arranged laterally of each other; means for imparting vertical reciprocating motion to said material holder, the distance through which said material holder is reciprocated being substantially less than the up and down movement of said material holder for transferring the latter from one receptacle to another, and a pitched blade fan mounted on said material holder below the bottom thereof for free rotation relative thereto, whereby when said material holder is immersed in the liquid in a receptacle and is vertically reciprocating, said member first turns in one direction and then in the other direction to move the liquid in which the material holder is immersed.

6. In automatic immersion apparatus having a conveyor movable up and down and laterally for transferring a material holder from one to another of a plurality of liquid receptacles arranged laterally of each other; means for imparting vertical reciprocating motion to said material holder, the distance through which said material holder is reciprocated being substantially less than the up and down movement of said material holder for transferring the latter from one receptacle to another, a rotatable shaft in fixed position relative to said material holder, an impeller member operatively connected to said shaft for rotation therewith relative to said material holder, and means for rotating said shaft when said material holder is in one of said receptacles to thereby rotate said impeller member.

7. In automatic immersion apparatus having a conveyor movable up and down and laterally for transferring a material holder from one to another of a plurality of liquid receptacles arranged laterally of each other; means for imparting vertical reciprocating motion to said material holder, the distance through which said material holder is reciprocated being substantially less than the up and down movement of said material holder for transferring the latter from one receptacle to another, a rotatable shaft in fixed position relative to said material holder, an impeller operatively connected to said shaft for rotation therewith relative to said material holder, said impeller being positioned below the bottom of said material holder, and means for rotating said shaft when said material holder is in one of said receptacles to thereby rotate said impeller member.

8. In automatic immersion apparatus having a conveyor movable up and down and laterally for transferring a material holder from one to another of a plurality of liquid receptacles arranged laterally of each other; a member operatively connecting said conveyor to said material holder for imparting movement of said conveyor to said material holder, a rotatable shaft, means for rotating said rotatable shaft, means operatively connecting said rotatable shaft to said member for vertically reciprocating the latter and said material holder when said material holder is in one of said receptacles, the distance through which said material holder is reciprocated being substantially less than the up and down movement of said material holder for transferring the latter from one receptacle to another, another shaft, means operatively connecting said rotatable shaft to said other shaft for concomitant rotation, and an impeller member operatively connected to said other shaft for rotation therewith to thereby move the liquid in a receptacle when said material holder is immersed therein.

9. In automatic immersion apparatus having a conveyor movable up and down and laterally for transferring a material holder from one to another of a plurality of liquid receptacles arranged laterally of each other; a hollow member operatively connecting said conveyor to said material holder for imparting movement of said conveyor to said material holder, a rotatable shaft, means for rotating said rotatable shaft, means operatively connecting said rotatable shaft to said member for vertically reciprocating the latter and said material holder when said material holder is in one of said receptacles, the distance through which said material holder is reciprocated being substantially less than the up and down movement of said material holder for transferring the latter from one receptacle to another, a flexible shaft disposed within said hollow member, means operatively connecting said rotatable shaft to said flexible shaft for

concomitant rotation, and an impeller member operatively connected to said flexible shaft for rotation therewith to thereby move the liquid in a receptacle when said material holder is immersed therein.

10. In automatic immersion apparatus having a conveyor movable up and down and laterally for transferring a material holder from one to another of a plurality of liquid receptacles arranged laterally of each other; means carried by said material holder and rotatable relative to said material holder in the receptacles for moving the liquid therein when said material holder is immersed therein.

11. In automatic immersion apparatus having a conveyor movable up and down and laterally for transferring a material holder from one to another of a plurality of liquid receptacles arranged laterally of each other; rotary means carried by said material holder and rotatable relative thereto for moving the liquid in a receptacle when said material holder is immersed therein.

12. In automatic immersion apparatus having a conveyor movable up and down and laterally for transferring a material holder from one to another of a plurality of liquid receptacles arranged laterally of each other; a rotatable shaft carried by said material holder and an impeller member operatively connected to said rotatable shaft for rotation therewith relative to said material holder, said impeller member being positioned relative to said material holder so that when said holder is in a receptacle said impeller member is immersed in the liquid therein, and means for rotating said shaft when said material holder is in a receptacle.

13. In automatic immersion apparatus having a conveyor movable up and down and laterally for transferring a material holder from one to another of a plurality of liquid receptacles arranged laterally of each other; a rotatable shaft extending from above to below said material holder and being fixed relative thereto, an impeller member operatively connected to said rotatable shaft for rotation therewith, said impeller member being positioned adjacent the lower end of said rotatable shaft so that when said material holder is in a receptacle said impeller member is in said receptacle, and means for rotating said shaft when said material holder is in a receptacle.

14. In immersion apparatus having a material holder adapted to hold material in a liquid receptacle for treatment by the liquid therein; means for moving said holder in opposite directions to thereby similarly move the material in relation to the liquid in said receptacle, and additional means carried by said holder for moving the liquid in the receptacle in relation to the material in said holder, said first mentioned means comprising an electric motor and mechanism actuated thereby, and said additional means comprising an impeller freely rotatable in relation to said holder and actuated by the liquid in response to the movement of the holder by said mechanism.

15. In immersion apparatus having a material holder adapted to hold material in a liquid receptacle for treatment by the liquid therein; means for moving said holder in opposite directions to thereby similarly move the material in relation to the liquid in said receptacle, and additional means carried by said holder for moving the liquid in the receptacle in relation to the material in said holder, said first mentioned means comprising an electric motor and mechanism actuated thereby and said additional means comprising an impeller and a shaft actuated by said motor and operatively connected to said motor for turning said impeller.

16. In automatic immersion apparatus having a conveyor movable up and down and laterally for transferring a material holder from one to another of a plurality of liquid receptacles arranged laterally of each other; means carried by said holder for moving the liquid in the receptacle in relation to the material in said holder, means including a motor carried by said conveyor for actuating said liquid moving means, and a housing for said last mentioned means for supporting said holder for movement into and out of said receptacles.

17. In automatic immersion apparatus having a conveyor movable up and down and laterally for transferring a material holder from one to another of a plurality of liquid receptacles arranged laterally of each other; means additional to said holder, and movable together with the latter as a unit by said conveyor into and out of said receptacles, for moving the liquid in the receptacle in relation to the material in said holder.

18. In automatic immersion apparatus having a conveyor movable up and down and laterally for transferring a material holder from one to another of a plurality of liquid receptacles arranged laterally of each other; means for imparting vertical reciprocating motion to said material holder, the distance through which said material holder is reciprocated being substantially less than the up and down movement of said material holder for transferring the latter from one receptacle to another, and additional means for moving the liquid in the receptacle in relation to the material, said additional means being movable concomitantly with said material holder for transferring said additional means from one receptacle to another.

19. In automatic immersion apparatus having a conveyor movable up and down and laterally for transferring a material holder from one to another of a plurality of liquid receptacles arranged laterally of each other; means for imparting vertical reciprocating motion to said material holder, the distance through which said material holder is reciprocated being substantially less than the up and down movement of said material holder for transferring the latter from one receptacle to another, and rotary means movable concomitantly with said material holder for transfer from one receptacle to another, said rotary means being adapted to rotate relative to said material holder for moving treating liquid relative to said material holder.

References Cited in the file of this patent

UNITED STATES PATENTS

501,347	Insinger	July 11, 1893
1,236,832	Frye	Aug. 14, 1917
1,724,240	Wheeler	Aug. 13, 1929
2,104,456	Friedman	Jan. 4, 1938
2,341,198	Weiskopf	Feb. 8, 1944
2,657,668	Maier	Nov. 3, 1953
2,741,221	Weiskopf et al.	Apr. 10, 1956