

Sept. 25, 1956

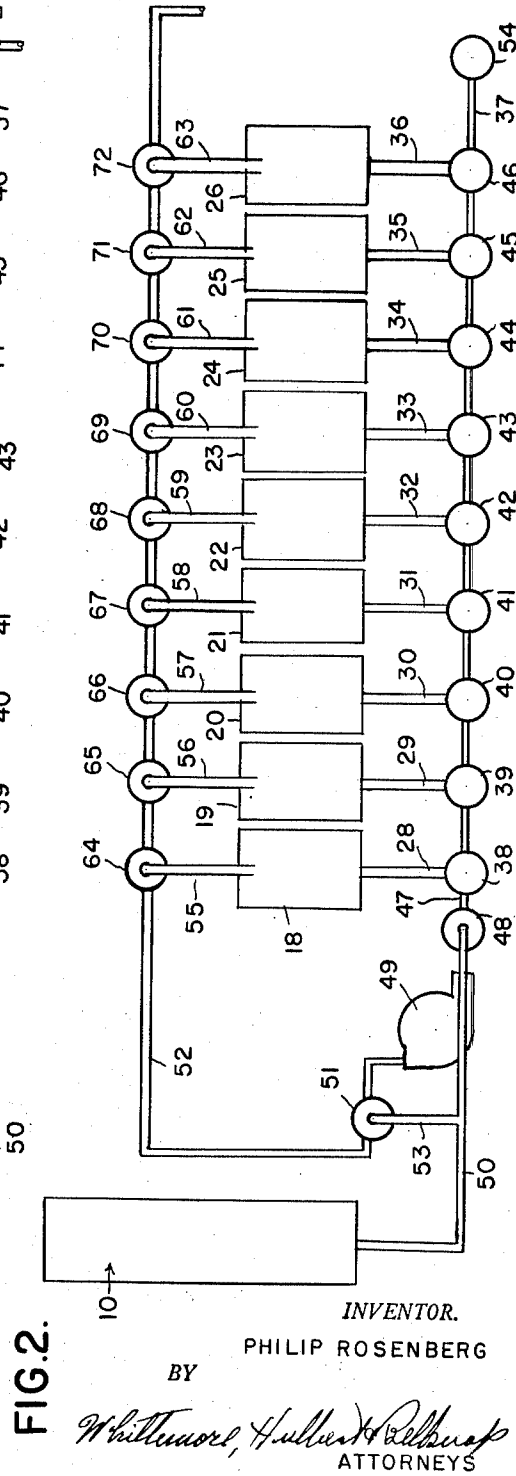
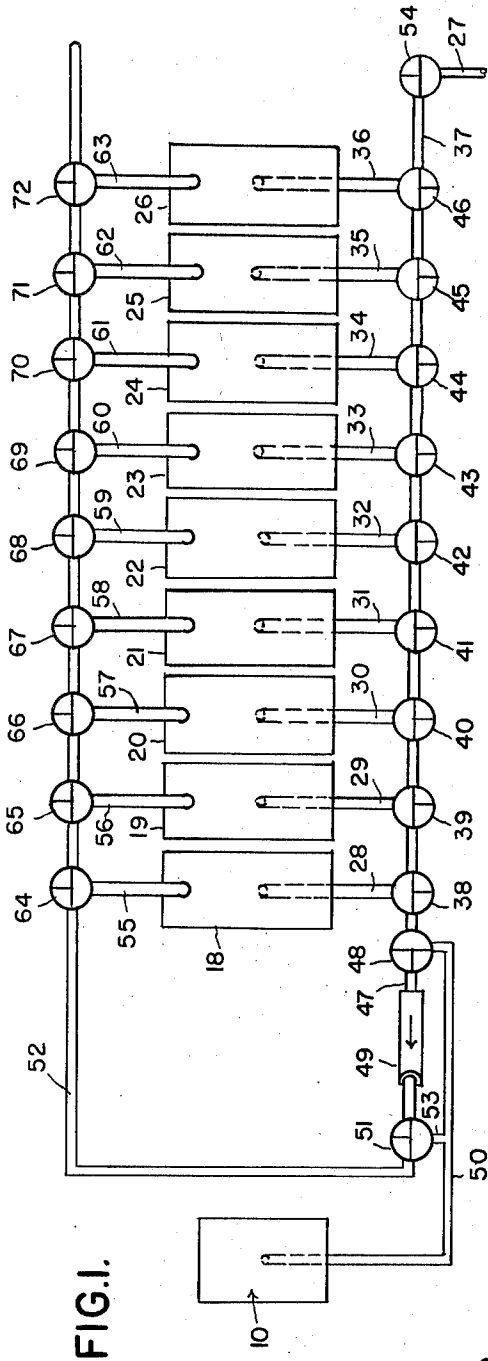
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2,764,074

AUTOMATIC PHOTOGRAPHIC PROCESSOR

Filed Feb. 16, 1953

5 Sheets-Sheet 1



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AUTOMATIC PHOTOGRAPHIC PROCESSOR

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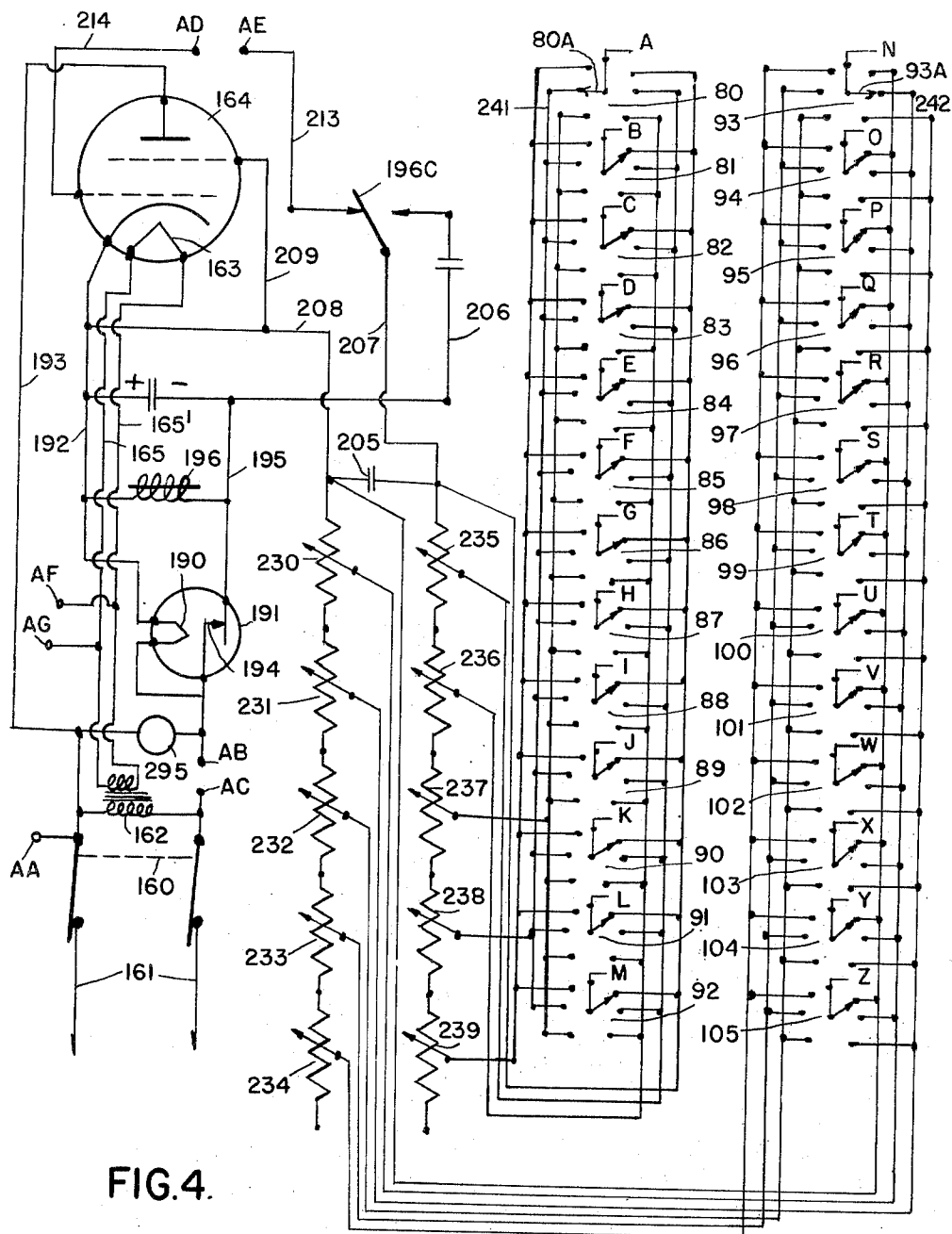


FIG. 4.

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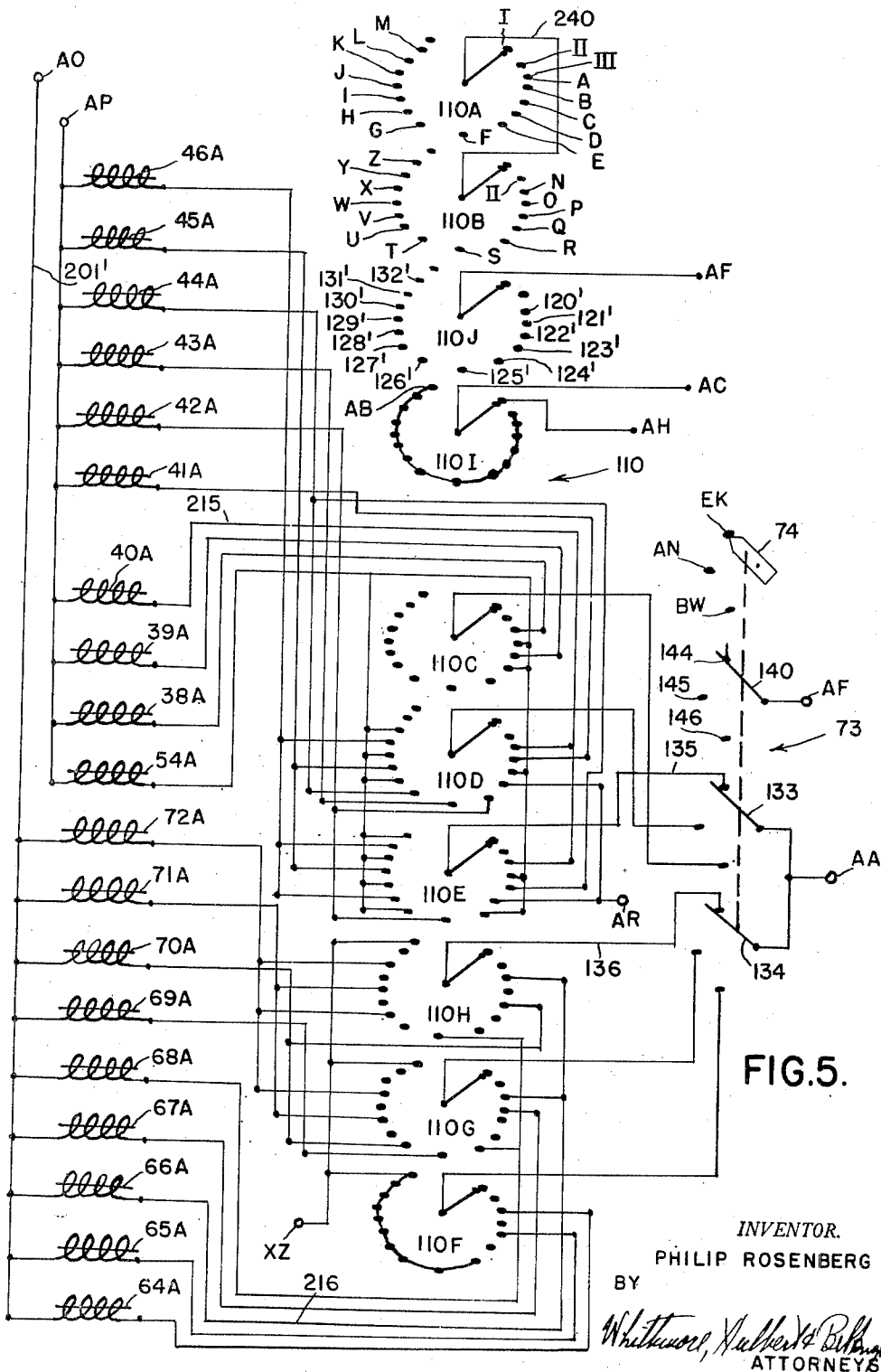
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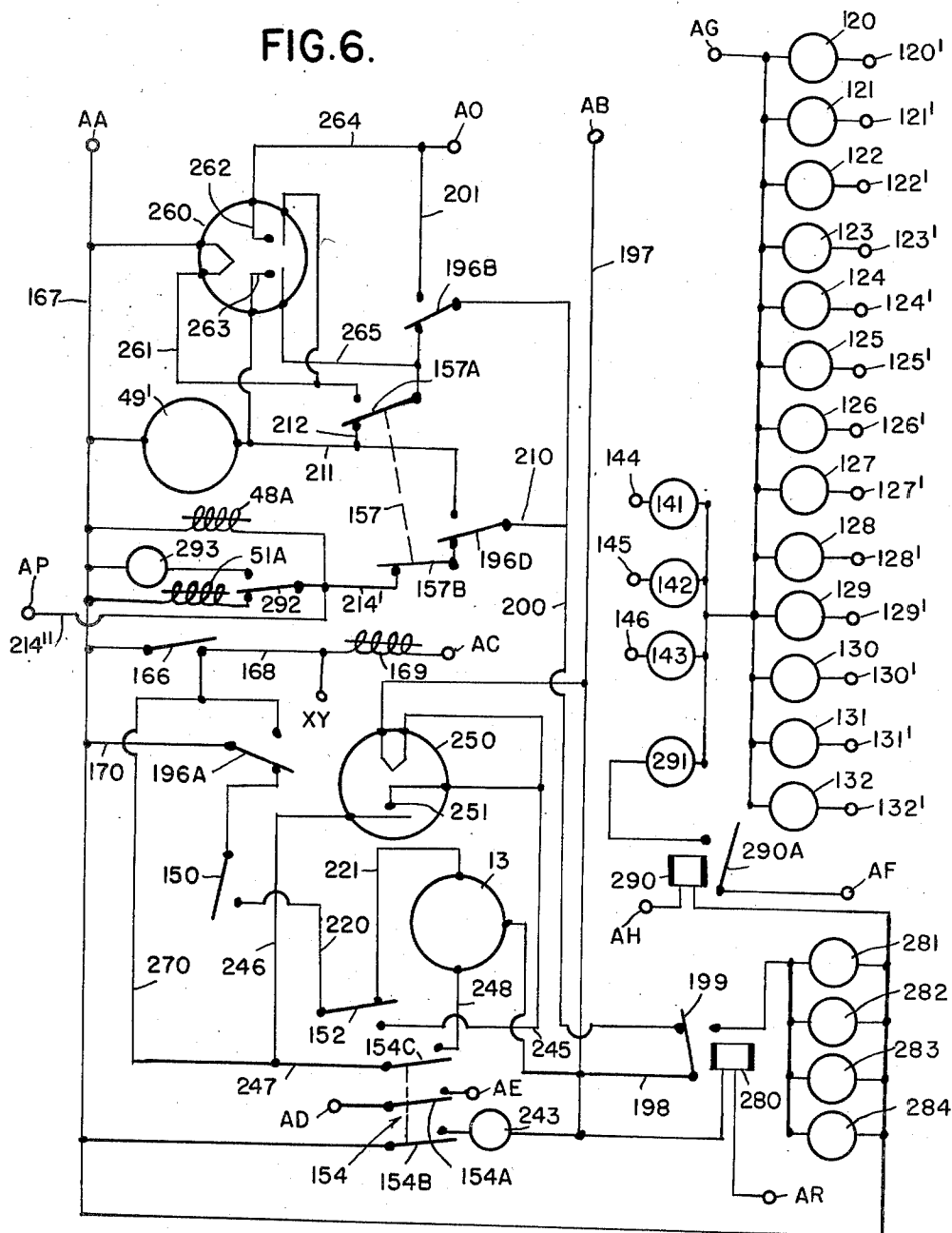
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FIG. 6.



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AUTOMATIC PHOTOGRAPHIC PROCESSOR

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14 Claims. (Cl. 95—89)

This invention relates generally to apparatus for use in treating work with various solutions and refers more particularly to improvements in apparatus rendering it possible to subject the work to successive baths of the specified solutions for predetermined periods of time.

One specific use of apparatus embodying the features of this invention is in developing photographic films. In accordance with this invention photographic films, either of the black and white or colored variety, may be successively treated with the various specified solutions for the required time period with little or no attention on the part of the operator.

It is another object of this invention to provide apparatus having means for bringing the various solutions in treating relation to the work in the proper sequence and also having means for determining the time the work remains in treating relation to each of the various solutions.

It is still another object of this invention to provide apparatus having time control means for each solution and having provision for independently varying the time control means.

It is a further object of this invention to provide apparatus of the above general type wherein the work is treated in a closed receptacle and wherein means is provided for sequentially connecting the closed receptacle to the sources of supply of the various treating solutions. The arrangement enables storing the solutions in tanks supported at a point remote from the receptacle and, since the receptacle is closed, accidental escape of the solution is avoided. Thus actual treatment of the work may be accomplished in a compact space regardless of the number of solutions used and this is especially desirable in instances where darkroom space is at a premium as, for example, where the apparatus is used to develop films on mobile equipment such as aircraft. Furthermore, the processing chamber being a closed receptacle, there are no fumes in the darkroom. In two color processes now in use, potassium ferricyanide is used, the fumes of which are poisonous.

It is a still further object of this invention to provide means for varying the sequence of flow of the various solutions to the receptacle so that the solutions or any selected combination of the latter may be supplied to the tank in the order required to produce the desired results. This permits the apparatus to be used in all the different processes now in use and adapts it for use in all future processes. In some present film-developing processes, as many as six washes are required. In machines of the type where the film is moved from station to station, this necessitates six additional tanks located at their proper stations and piped for water. This makes it impractical to use a machine of that type for more than one process.

As a feature of the invention, additional processing chambers or receptacles complete with all time and sequence controls may be connected to the storage tanks or sources of supply so that a minimum of solution is required.

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Still another object of the invention is to provide both fluid agitation of the processing solution and mechanical agitation of the film during treatment to obtain more even processing.

A further object is to provide a system whereby the timing action is not started until the work is lowered into the solution so as to obtain very accurate control of the time the processing solutions are in contact with the work. As a feature of the invention, the work is lowered into, and removed from, the tank while the latter is relatively full, thus giving a more even processing to both top and bottom of the work since the work can be raised and lowered much faster than a pump can fill or gravity can empty a tank.

Other and related objects will become apparent as the description proceeds, especially when taken in conjunction with the accompanying drawings wherein:

Figure 1 is a diagrammatic top plan view of a photographic processor;

Figure 2 is a view in side elevation of the apparatus shown in Figure 1;

Figure 3 is a diagrammatic perspective view of the work tank wherein the photographic material is processed;

Figure 4 illustrates a wiring system employed in the automatic control of the sequence of operation for the photographic processor, with particular emphasis on the means and arrangement for timing the period of each step in the process;

Figure 5 is similar to Figure 4 but shows particularly the means for preliminarily selecting the process to be employed, and the mechanism for stepping the process from one step to the next and for controlling the sequence of operation of the valves;

Figure 6 is similar to Figures 4 and 5 but showing especially the means and electrical circuits for obtaining mechanical and fluid agitation while the film is being treated in a particular solution; and

Figure 7 shows diagrammatically a stepping switch mechanism employed in the apparatus.

Referring now more particularly to the drawings and especially to Figure 3 thereof, there is shown a receptacle or work tank 10 for processing photographic material. The material to be processed is introduced into the work tank through an opening 11 in one side thereof which is adapted to be closed by a light tight door 12 hingedly secured to the side of work tank 10.

Film to be developed is processed entirely within the work tank and solutions necessary to accomplish the entire film processing are introduced to the work tank from remotely located storage tanks and in proper sequence in accordance with the particular developing process employed, by mechanism described below.

As stated above, in order to obtain more even processing of the film, the same is mechanically raised and lowered into and out of a processing solution rather than maintaining the film stationary within the tank and allowing it to become immersed and removed from the solution by filling and emptying the tank with the solution. The film can be raised and lowered mechanically much faster than a pump can fill or gravity empty the tank and accordingly, by my system, the top and bottom of the film is given substantially uniform treatment as a result of the rapid movement of the film into and out of the solution.

To accomplish the mechanical raising and lowering of the film, a reversible motor 13 is provided secured to the top wall of the work tank by a bracket 14. Output shafts 15 of the motor have cables 16 wound thereon which are secured at their lower ends to a film-containing rack 17, whereby the film and rack may be raised and lowered by the reversible motor.

Referring now to Figures 1 and 2, the entire film processing apparatus is shown, including the storage tanks for storing the various solutions required to process the film, as well as the means for filling and emptying work tank 10 with solutions from the said storage tanks. It should be apparent from Figures 1 and 2 that even though darkroom space is at a premium, no difficulty is experienced with the apparatus shown, no matter how many steps or solutions are required, since the work tank alone may be kept in the darkroom and the storage tanks at any location remote therefrom if desired.

As shown by way of illustration, the apparatus is adapted to supply to the work tank any one of nine treating solutions maintained in storage tanks 18—26. In addition, water may be supplied through pipe 27, if not carried in one of the storage tanks. Each of the storage tanks is provided with pipes 28—36 which connect with the main supply pipe 37, outlet valves 38—46 being provided to control fluid communication between the respective pipes 28—36 and main supply pipe 37. Pipe 47 communicates with main supply pipe 37 through pump valve 48, pipe 47 having a pump 49 associated therewith which is driven by a unidirectional motor 49' for pumping fluid in pipe 47 in the direction of the arrow shown in Figure 1.

Thus when it is desired to empty the contents of tank 10 and discharge the same to drain, the solution will be drawn by the pump from tank 10 through pipe 50, valve 48, pipe 47, pump valve 51, and discharge pipe 52 to drain—pump valves 48 and 51 being in the positions shown. If it is desired to fill tank 10 with the solution of storage tank 20 for example, then valves 40, 48 and 51 are merely rotated 90° clockwise from the positions shown in Figure 1, whereupon the solution will be drawn by the operation of pump 49 in the same direction through pipes 30, 37, 47, 53, and 50 to the work tank. By rotating valve 54 90° counterclockwise and valves 48 and 51 90° clockwise, the tank may be filled with water from water supply pipe 27.

Following each step in the film processing, it may be desirable to return the used solution from the work tank 10 to its original storage tank. Thus pipes 55—63 provide fluid communication between discharge pipe 52 and the respective storage tanks, fluid communication between the respective pipes 55—63 and discharge pipe 52 being controlled by inlet valves 64—72. By merely rotating one of the valves 64—72 90° counterclockwise from the position shown, operation of pump 49 will draw liquid from the work tank and return the same to the storage tank controlled by that particular valve.

The storage tank outlet and inlet valves, as well as the pump valves, are controlled by means of solenoids, and the entire sequence of operation and timing thereof is controlled in a manner described below.

Referring now to Figure 5, the selector switch, indicated generally at 73, is manually operable for selection of the developing process to be used, and once the desired process is selected the entire sequence of treating steps to which the film is to be subjected is automatically controlled by the apparatus of my invention and the steps each automatically timed. In the form of the invention herein illustrated, the selector switch includes an indicator 74 for selecting any one of three developing processes. While the apparatus shown is limited to a selection of three processes, it will be understood that this is by way of illustration only and that the invention comprehends apparatus wherein any number of different developing processes may be selected and employed.

With the indicator 74 in the position shown, the apparatus is set up to automatically control a process indicated by EK. The other processes available in the apparatus shown are indicated by reference characters AN and BW.

Referring now to Figure 4, the manually adjustable

timing switches 80—105 are shown. Correct time for each step in the process is set by turning these switches to the desired time. Switches 80—92 may, for example, be adapted to have five minute intervals of time set into them, and switches 93—105 one minute intervals. Pairs of these switches add the time together and jointly control the time for each step. Thus, switches 80 and 93 control the time for the first step in any process chosen, switches 81 and 94 control the time for the second step, etc.

In Figure 5 the stepping switch 110 is shown having ten levels 110A—110J. Levels 110A and 110B select the pair of timing switches which will control the time interval for a particular step in the process. As seen, level 110A has terminals A—M of the respective timing switches 80—92 and level 110B has terminals N—Z of the respective timing switches 93—105. Accordingly as the stepping switch 110 is sequentially stepped, the time control passes from pairs of switches 80, 93 to switches 81, 94 etc. to the end of the process.

Level 110J of the stepping switch serves to indicate the step in the process being carried out at a given instant by selectively contacting terminals 120'—132' to connect to an electrical power source one of the light bulbs 120—132 in accordance with the sequence of operation.

Levels 110C—110H of the stepping switch control the solenoids 38A—46A and 64A—72A of the input and output valves of the storage tanks 18—26 and also control solenoids 54A of valve 54. Levels 110C—110H function in pairs, that is, one pair serves to control the operation of these valve solenoids for one selected process, and the other two pairs respectively control these valve solenoids when the apparatus is set up to operate under one of the other two processes. As herein illustrated, the contactors 133 and 134 of selector switch 73, when the latter is set for the EK process, connect levels 110E and 110H into the control circuit through leads 135 and 136, which levels then control the operation of the solenoids valve. Levels 110C, 110D, 110F, and 110G serve no function whatever during this process. Levels 110C and 110F control the valve solenoids during the BW process, and levels 110D and 110G control the valve solenoids during the AN process.

Selector switch 73 has another contactor 140 which selectively engages contacts 144—146 to energize one of the light bulbs 141—143 depending upon the photographic process selected across terminals AF and AG (see Figs. 5 and 6). In the illustration, light bulb 141 will be energized during operation to indicate the EK process.

Referring again to Figure 3, a plurality of switches will be seen which are provided to control the actuation of the film-containing rack 17 and the liquid level of the solution within tank 10. Switch 150 is actuated by a float 151 when the liquid level rises to the minimum level 151' maintained during processing to close said switch and complete a circuit through double throw switch 152 to actuate reversible motor 13 in a downward direction, thereby lowering the film-containing rack into the solution. When the rack reaches a position adjacent the bottom of work tank 10, it engages contactor 153 of switch 152, breaking the circuit to reversible motor 13. Simultaneously, switch 152 closes a circuit to the up side of motor 13 through switch 154 which is engaged and held open by the rack 17 in its uppermost position but released to close said circuit upon downward movement of the rack. When the rack is thus raised, contactor 153 of switch 152 is released by the rack 17, said switch thereby opening the circuit to the up side of the motor and closing a circuit to the down side to again lower the rack. The rack will at no time be raised above the minimum liquid level of the tank, indicated at 151'. This cycle of operation continues during each step of the process to obtain mechanical agitation.

When the liquid level reaches the "full" point indicated

at 156, float 151 actuates double throw switch 157 to open a circuit to valve solenoids 48A and 51A allowing their corresponding valves 48 and 51 to return to the position shown in Figure 1, whereby continued operation of pump 49 withdraws the solution from work tank 10. Said switch also opens circuit to one of the outlet valve solenoids 38A—46A and closes circuit to one of the inlet valve solenoids 64A—72A of the storage tanks for return of the solution to the proper storage tank. When the liquid level approaches the minimum level, switch 157 is again actuated opening circuit to the said one inlet valve solenoid and closing circuit to the said one outlet valve solenoid and also valve solenoids 48A and 51A, energizing the latter and shifting their corresponding valves to positions 90° clockwise from the positions shown. Continued operation of the pump 49 operates to fill the work tank until the "full" level is again reached. This cycle continues during each step of the process and provides fluid agitation.

When the time for the particular step has expired, a circuit through switch 154 is completed to the up side of the motor, raising the film containing rack rapidly out of the solution. Switch 154 is engaged by the rack when the latter reaches its uppermost position, causing the switch to open the circuit and stop the motor. The valve solenoids 48A and 51A and one of the valve solenoids 64A—72A are positioned so that solution is drawn from the work tank by the pump and discharged into the proper storage tank.

Briefly, the operation of the apparatus is as follows:

1. Master switch 160 (Fig. 4) is turned on.
2. Film is loaded into work tank 10 and door 12 is closed.
3. Selector switch 73 (Fig. 5) is turned to select the desired process—that is, a pair of the levels 110C—110H is selected to determine the sequence of operation of the valve solenoids.
4. Timing switches 80—105 (Fig. 4) are individually set for the desired time for each step.
5. Starter button 166 (Fig. 6) is pushed once and released.

Thereafter the processing cycle will start, a solution from one of the storage tanks will be pumped to the work tank for the first processing step, and the processing will automatically continue through each step in proper sequence for the desired length of time.

In order to facilitate an understanding of the control circuits for automatically selecting and timing the steps of a film developing process, the control circuit will be described in conjunction with a description of its operation.

Assuming that the process designated EK is selected, the selector switch 73 is positioned as indicated in Figure 5. As indicated above, the film to be processed is loaded into work tank 10 to which all of the solutions are brought in proper sequence one at a time and for a specified duration of time, and the correct time for each step in the process is set into timing switches 80—105. Also as indicated, these timing switches operate in pairs to control the time for each step. Thus switches 80 and 93 time the first step, switches 81 and 94 time the second step, etc., no matter which process is selected.

Light-tight door 12 is now closed and master switch 160 is closed connecting the control circuit to electrical main 161 and passing current to transformer 162 whose secondary is supplying low voltage (6.3 volts, for example) to the heater 163 of thyatron tube 164 through leads 165 and 165'. Approximately one minute should be allowed before closing of manual switch 166 to initiate the automatic sequence of operation. This is to allow the thyatron tube to be fully heated when the process is begun.

Closing of switch 166 completes a circuit between terminals AA and AC through leads 167 and 168 of the control circuit, thereby energizing solenoid 169 of the step-

ping switch 110. The starting switch 166 is only momentarily closed and upon release thereof to deenergize solenoid 169, the contactors of stepping switch 110 are stepped one unit.

The stepping switch and means for actuating the same are shown diagrammatically in Fig. 7. Upon energization of solenoid 169, armature 169A thereof is drawn upwardly about pivot 169B, causing pawl 169C to be retracted. Upon deenergization of solenoid 169, pawl 169C is moved upwardly by the action of spring 169D to turn ratchet 169E of stepping switch 110 and thus advance the contactors of the latter, detent 169F maintaining the ratchet in its proper rotation. The mechanism for advancing stepping switch 110 is shown by way of illustration only, as any suitable device may be employed for the purpose.

At this point, with the contactors of stepping switch 110 stepped to position II (that is, one unit clockwise from the position shown in Figure 5), the contactor of level 110I closes the gap between terminals AC and AB in the control circuit and thereby passes current to the rest of the circuit for the duration of the process (see Figures 4 and 5). Closing of the gap AC—AB passes current through (1) the coil 190 of adjustable time delay relay 191 and from there to thyatron tube 164 through lead 192. The circuit through thyatron tube 164 is completed by lead 193 to the electrical main 161; and (2) the normally closed contactor 194 of time delay relay 191 and then through lead 195 to the coil of relay 196. Relay 196 has four contactors 196A, 196B, 196C and 196D and upon energization of relay 196 these contactors act as follows:

(a) 196A (Fig. 6) completes a circuit between terminals AA and AC through leads 167 and 170 and 168 to solenoid 169 of stepping switch 110, energizing it. However, since it is necessary for the solenoid 169 to be both energized and deenergized to cause the stepping switch 110 to step to the next position, no action takes place.

(b) 196B (Fig. 6) closes a circuit from terminal AB through lead 197, 198, contactor 199, leads 200 and 201 to terminal AO. As seen in Figure 5, the circuit to one side of valve solenoids 64A—72A is completed through lead 201' but as the other side of these valve solenoids is not connected into the circuit, no action occurs. It will be noted that in this process, contactors 133 and 134 of selector switch 73 are connected to terminal AA of the circuit closing the circuit to levels 110E and 110H of the selector switch through leads 135 and 136. Accordingly these levels are in complete control of the sequence of operation of the valve solenoids, but their respective contactors are not yet connected in circuit with any of the valve solenoids in position II of the stepping switch.

(c) 196C (Fig. 4) closes the circuit from time delay relay 191 to capacitor 205 through leads 195, 206, 207, 208 and 192. This allows the capacitor to charge up to full peak line voltage with D. C. current (A. C. current rectified to D. C. through thyatron tube 164).

(d) 196D (Fig. 6) closes circuit to pump motor 49' between terminals AA and AB through leads 197, 198, contactor 199, leads 200, 210, 211 and 167. The pump 49 will then pump out any solution remaining in the work tank 10 from a previous operation.

After the time set into the time delay relay 191 has elapsed the contactor 194 thereof is opened cutting off the flow of current to relay 196 de-energizing it and causing its contactors to do as follows:

(a) Contactor 196A opens the circuit to solenoid 169 of stepping switch 110, causing it to be de-energized, which action steps the contactors of the stepping switch one position to position III. Contactor 196A also closes the circuit to float switch 150. Float switch 150 is open since the liquid level has not yet reached it and therefore no action of motor 13 takes place.

(b) Contactor 196B closes the circuit to pump motor 49' through contactor 157A of float switch 157 and through leads 200, 211 and 212.

(c) Contactor 196C closes the capacitor discharge circuit of capacitor 205 through leads 207, 213, 214, 208, 209 and limit switch 154. However, as the work is still in raised position, switch 154 is held open, creating a gap between terminals AD and AE (see Fig. 4), and therefore capacitor 205 cannot discharge since the circuit is still open.

(d) Contactor 196D closes the circuit to valve solenoids 48A and 51A through contactor 157B of float switch 157 and lead 214', energizing said valve solenoids to cause the corresponding valves to shift to a position 90° clockwise from that shown in Fig. 1 so as to allow solution to be pumped from one of the storage tanks to work tank 10. Contactor 196D also closes the circuit to the storage tank outlet valve solenoids 38A-46A and water supply valve solenoid 54A by way of lead 214' to terminal AP, permitting a selected one of these valve solenoids to be energized as determined by the stepping switch 110.

With the stepping switch 110 in position III, its levels 110A and 110B place resistance across capacitor 205 as determined by the settings of timing switches 89 and 93. In the positions shown in Fig. 4 of contactors 80A and 93N of the respective timing switches 80 and 93, the resistance placed across capacitor 205 includes resistances 235, 236, 237 and part of 238 and part of 230. The rest of the resistance circuit includes leads 241 and 242, the circuit between terminals A and N of the timing switches for the first step being connected together through levels 110A and 110B of the stepping switch by lead 240. In the illustration, resistances 231-234 and 239 are also available. The time it takes the capacitor 205 to discharge across the resistances placed in circuit therewith by the timing switches and through thyatron tube 164 determines the time interval for step I in the process.

Level 110E of the stepping switch, in the position III thereof, will be seen to be connected to valve solenoid 40A through lead 215 thereby completing the circuit to said valve solenoid to actuate the latter and cause the corresponding valve 40 to be turned 90° clockwise from the position in Fig. 1 to permit solution to be drawn from storage tank 20.

Level 110H of the stepping switch, in the position III thereof, is connected to valve solenoid 66A through lead 216, but as the other side of valve solenoid 66A is open at terminal AO, this valve solenoid remains de-energized maintaining valve 66, as well as the other inlet valves, in the position shown in Fig. 1.

In the position III of stepping switch 110, level 110I is connected to indicator bulb 120. Said level is connected to terminal AF on lead 165 and bulb 120 is connected to terminal AG on lead 165' to close a circuit to the low voltage secondary of transformer 162. Bulb 120 now indicates that the process is in the first step.

As stated above, contactor 196B of relay 196 closes the circuit to pump motor 49' and contactor 196D closes the circuit to valve solenoids 40A, 51A and 48A, causing the corresponding valves to be rotated 90° clockwise, permitting solution to be drawn from storage tank 20 by pump 49 and discharged into work tank 10 to initiate the first step in the process. As the solution fills work tank 10, it reaches a minimum level which will completely cover the work-containing rack 17 indicated at 151', and at this instant the float 151 closes float switch 150, thereby closing the circuit to the "down" side of motor 13 through leads 220, 221, and switch 152, causing the work-containing rack 17 to be lowered into the solution. When the rack 17 is substantially at the bottom of work tank 10, contactor 153 of limit switch 152 is engaged causing the latter to open the circuit and cut off current to motor 13.

When the rack 17 is thus lowered, limit switch 154

is released and allowed to close causing its contactor 154A to close gap between terminals AD and AE (Fig. 6) in the capacitor discharge circuit of capacitor 205 allowing the capacitor to start discharging across resistance selected by timing switches 80 and 93 through thyatron tube 164, causing the latter to stop conducting current. This is the capacitor-resistance action known as time-constant action and is the timing control. When the thyatron tube stops conducting, it cuts off current to time delay relay 191, allowing it to de-energize.

Closing of limit switch 154 also energizes clock 243 through contactor 154B thereof to indicate the time elapsed in this step.

The third contactor 154C of limit switch 154 is likewise closed and closes a circuit to the "up" side of motor 13, said circuit including switch 150, lead 220, switch 152, leads 245, 246, 247 and 248. An adjustable time delay relay 250 is included in this circuit, the contactor 251 thereof being normally open preventing current from flowing in the circuit to the "up" side of motor 13. However, when the time set into time delay relay 250 has elapsed, its contactor closes the circuit to motor 13 which latter is energized in the "up" direction to lift rack 17 until the contactor 153 of switch 152 is released.

When switch 152 is thus actuated, it (1) opens circuit to the "up" side of motor 13; and (2) closes circuit to the "down" side of motor 13 causing the work to be lowered until switch 152 is opened. Thereafter the rack 17 will again be raised following the elapse of a predetermined interval of time determined by the adjustable setting of time delay relay 250.

This action of alternately raising and lowering the work containing rack 17 slightly, gives a complete cycle of mechanical agitation. The rate of the cycle is controlled by varying the time delay set into adjustable time delay relay 250. It is understood of course that during this mechanical agitation, the rack 17 will not be raised above the minimum liquid level 151' within the work tank because the contactor 153 of limit switch 152 will be adjusted to open circuit to the "up" side of the motor 13 and close circuit to the "down" side before the rack has been raised to this minimum level.

The level of the liquid continues to rise after closing of switch 150 until it reaches the "full" position 156, at which point float 151 is raised to a level which results in shifting double pole-double throw float switch 157 which opens the circuit to valve solenoids 48A, 51A and 40A, de-energizing the latter and permitting them to return to the positions shown in Figs. 1 and 2 to shut off the flow of solution from storage tank 20. The circuit to the pump motor 49' through leads 211 and 212 and contactors 157A of switch 157 is also opened to stop operation of the pump.

The contactor 157A now closes a circuit to adjustable time delay relay 260 through lead 261 and after the time set into said time delay relay has elapsed, the contactors 262 and 263 thereof close circuits to (1) valve solenoid 66A through lead 264 energizing it and opening the path from work tank 10 to storage tank 20 by way of return pipe 52 and storage tank inlet valve 66; and (2) pump motor 49' through leads 265 and 266 causing pump 49 to draw solution from work tank 10 and return same to storage tank 20 until the liquid level in work tank 10 falls to a point low enough to shift float switch 157 back to the position shown in Figure 6 (but still not below level 151').

When float switch 157 is thus actuated, it deenergizes time delay relay 260 and energizes valve solenoids 48A, 51A and 40A, and pump motor 49', causing the said valve solenoids to return to their positions 90° clockwise from that shown in Fig. 1 and causing fluid to be pumped from storage tank 20 to work tank 10 until the full position 156 is reached. This action of alternately

withdrawing and returning solution to the work tank provides fluid agitation during processing of the film in the solution, and the rate of alternately adding and withdrawing solution is controlled by the time delay set into adjustable time delay relay 260.

Both the mechanical and fluid agitation continue until the time for the step has elapsed, that is the time required for capacitor 205 to discharge across the resistance, whereupon thyatron tube 164 again starts to conduct, thereby energizing time delay relay 191 and accordingly energizing the coil of relay 196.

Energizing of relay 196 causes its contactors to act as follows:

(a) Contactor 196A closes circuit to solenoid 169 of stepping switch 110 energizing the solenoid and likewise closes circuit to motor 13 through leads 270, 247 and contactor 154C of switch 154 causing motor 13 to lift the work containing rack 17 out of solution until the rack reaches the top of the tank, engaging and opening limit switch 154 which cuts off current to motor 13, stopping the latter.

(b) Contactor 196B closes circuit to valve solenoid 66A energizing it and positioning the same 90° counter-clockwise from the position shown to permit return of the solution from the work tank to storage tank 20.

(c) Contactor 196C closes circuit to capacitor 205 through leads 195, 206, 207, and 208 and through the thyatron tube, allowing the capacitor to charge up to full peak line voltage with D. C. current.

(d) Contactor 196D opens circuit to valve solenoids 48A, 51A and 40A, and closes circuit to pump motor 49 through lead 211, allowing pump 49 to pump solution from work tank 10 back to storage tank 20 via pipe 52.

The length of time allowed for emptying the work tank of the solution employed in the previous step is determined by the time delay set into adjustable time delay relay 191 and is to be long enough to assure that the work tank is completely emptied and prepared for the next step.

After the time delay set into time delay relay 191 has elapsed, the contactor 194 thereof is opened, thereby de-energizing relay 196 causing its contactor 196A to open circuit to solenoid 169 of stepping switch 110, de-energizing the solenoid and causing the contactors of stepping switch 110 to step one position to position IV to initiate the second step in the process. Thereafter the action repeats, as described above in connection with step I of the process. In position IV or step 2, the time interval for this second step is controlled by timing switches 81, 94, and storage tank 21 is brought into use through valves 67 and 41.

The action described above continues through all of the steps in the process in sequence with the exception of step 4 in the EK process, which step calls for re-exposure to light instead of a liquid solution. At step 4 or position VI, level 110E of the stepping switch closes the circuit to terminal AR and relay 280 (Fig. 6), energizing the latter and causing its contactor 199 to open circuit to contactors 196B and 196D to prevent energization of the pump motor and the valve solenoids, thereby preventing any solution from being pumped into work tank 10. Contactor 199 also closes circuit to bulbs 281—284 to provide the light necessary for the reexposure step. Time for this step is determined by the setting of timing switches 83 and 96.

At the end of the last step in the process, the contactor of level 110H of stepping switch 110 (as well as the contactors of levels 110F and 110G for the other processes) is connected to terminal XZ of the "off-normal" switch 300 on stepping switch 110, closing the circuit to solenoid 169, through terminal XY, and energizing the solenoid. When solenoid 169 is thus energized, it opens the circuit through switch 300 (contactor 300' of switch being carried by armature 169A of the solenoid) causing solenoid 169 to be de-energized and stepping all the

levels 110A—110J one step. This repeats until the levels of the stepping switch are stepped to position I.

When stepping switch 110 is at position I, level 110I (which serves to open gap AB—AC) energizes relay 290 (Fig. 6), causing its contactor 290A to close a circuit from terminals AF to AG across leads 165 and 165' of the low voltage circuit from transformer 162 through a visual or audible signal such as the bulb 291, for example, to indicate that the process is completed.

In order to empty the storage tanks, switch 292 is opened and the device started. The open switch 292 will prevent valve solenoid 51A from being energized. Thus all solutions flowing out of the storage tanks will be pumped to the drain instead of to the work tank.

When in the open position aforesaid, switch 292 may close a circuit to a light such as 293, for example, to signal that the piping circuit is open to the drain. This will caution against starting a processing cycle with film and a fresh solution until switch 292 is closed and normal operation can take place.

Clock 295, in Figure 4, indicates the total time the machine is in use from the time it was purchased.

While the particular embodiment shown is especially adapted for developing photographic films, it will be understood that this is by way of illustration only and that the invention comprehends any device for subjecting work to successive baths of specific solutions for predetermined periods of time.

What I claim as my invention is:

1. Apparatus for treating work with a solution comprising a receptacle for the work to be treated, means for introducing and withdrawing the solution to and from said receptacle, means for immersing the work into and for removing the work from the solution in said receptacle, and control means for said first and second means operative, when the level of solution in said receptacle has risen to a predetermined level, to actuate said second means to immerse the work in the solution, and operative to actuate said first means to withdraw the solution from said receptacle in response to removal of the work from the solution by said second means.

2. Apparatus for treating work with a solution comprising a receptacle for the work to be treated, means for introducing and withdrawing the solution to and from said receptacle, means for immersing the work into and for removing the work from the solution in said receptacle, and control means for said first and second means operative, when the level of solution in said receptacle has risen to a predetermined level, to actuate said second means to immerse the work in the solution, after a predetermined time interval to actuate said second means to remove the work from the solution, and to actuate said first means to withdraw the solution from said receptacle in response to removal of the work from the solution by said second means.

3. Apparatus for treating work with a solution comprising a receptacle for the work to be treated, means for introducing and withdrawing the solution to and from the receptacle, means for raising and lowering the work into and out of the solution in said receptacle, control means operative, when the level of solution in said receptacle has rise to a predetermined point, to actuate the second mentioned means to lower the work into the solution, and time control means being energized by initial lowering of the work into the solution in said receptacle, and being operative after a predetermined time interval to actuate said second mentioned means to raise the work out of the solution.

4. Apparatus for treating work with a solution comprising a receptacle for the work to be treated, means for introducing and withdrawing the solution to and from said receptacle, means including a reversible electric motor for raising and lowering the work into and out of the solution in said receptacle, means including an electric circuit adapted to actuate said motor to lower the work

into the solution, and a float switch in said circuit adapted to close the latter when the level of solution in said receptacle has risen to a predetermined level thus to actuate said motor, time control means for controlling the time interval of immersion, said time control means being energized by initial lowering of the work into the solution in said receptacle, and being operative after a predetermined time interval to actuate said motor to raise the work out of the solution.

5. Apparatus set forth in claim 4, including means for actuating the first mentioned means to withdraw the solution from the receptacle in response to the expiration of the predetermined time interval.

6. Apparatus for treating work with a solution comprising a receptacle for the work to be treated, means for introducing and withdrawing the solution to and from said receptacle, means including a reversible electric motor for raising and lowering the work into and out of the solution in said receptacle, means including an electric circuit adapted to actuate said motor to lower the work into the solution, and a float switch in said circuit adapted to close the latter when the level of solution in said receptacle has risen to a predetermined level thus to actuate said motor, time control means for controlling the time of immersion including a capacitor discharge circuit and a capacitor bridging said capacitor discharge circuit, a switch adapted to close said capacitor discharge circuit upon initial lowering of the work into the solution in said receptacle permitting said capacitor to discharge to initiate the predetermined time interval, means including an electric circuit adapted to actuate said motor to raise the work out of the solution, and a switch in said circuit adapted to close the latter in response to the expiration of the predetermined time interval determined by the time required for said capacitor to discharge, and means for actuating said first means to withdraw solution from said receptacle in response to the expiration of the predetermined time interval.

7. Apparatus for treating work with a plurality of solutions comprising a receptacle for the work to be treated, means for introducing and withdrawing the solutions in sequence to and from said receptacle, means for raising and lowering the work into and out of a solution in said receptacle, control means operative, when the level of solution in said receptacle has risen to a predetermined point, to actuate the second mentioned means to lower the work into the solution, time control means energized by initial lowering of the work into the solution in said receptacle, and operative after a predetermined time interval to actuate said second mentioned means to raise the work out of the solution, means for actuating the first mentioned means to withdraw the solution from said receptacle in response to expiration of the predetermined time interval, and means for actuating said first mentioned means to introduce a solution into said receptacle after a second time interval for allowing the previous solution to be completely withdrawn.

8. Apparatus set forth in claim 7, including means selectively operable for predetermining the sequence in which the solutions are introduced to and withdrawn from said receptacle.

9. Apparatus for treating work with a solution comprising a receptacle for the work to be treated adapted to contain the solution, means for lowering and raising the work into and out of the solution in said receptacle, control means for controlling the interval of immersion including a normally open capacitor discharge circuit, a capacitor bridging said circuit and means for closing said circuit upon initial lowering of the work into the solution in said receptacle permitting said capacitor to discharge, said control means being operative to actuate said first means to raise the work out of the solution when the capacitor has fully discharged.

10. Apparatus for treating work with a solution comprising a receptacle for the work to be treated, means for introducing the solution into the receptacle and for withdrawing the solution therefrom, and control means operative in response to a certain maximum level of solution within the receptacle, to actuate said first means to withdraw solution from the receptacle, said control means being operative, in response to a certain minimum level of solution within the receptacle, to actuate said first means to introduce solution into the receptacle, and means for supporting work in the receptacle below the minimum level.

11. Apparatus set forth in claim 10, said control means including electric circuits respectively operative to actuate said first means for thus introducing and withdrawing the solution, and switch means for alternately closing one of said circuits while opening the other in response to the level of the solution within said receptacle.

12. Apparatus set forth in claim 11, one of said circuits including an adjustable time delay relay for varying the cycle of fluid agitation.

13. Apparatus for treating work with a solution comprising a receptacle for the work to be treated, means for introducing and withdrawing the solution to and from the receptacle, means for raising and lowering the work into and out of the solution in said receptacle, control means operative, when the level of solution in said receptacle has risen to a predetermined point, to actuate the second mentioned means to lower the work into the solution, and time control means being energized by initial lowering of the work into the solution in said receptacle, and being operative after a predetermined time interval to actuate said second mentioned means to raise the work out of the solution, and means for actuating the first mentioned means to withdraw the solution from the receptacle in response to the expiration of the predetermined time interval.

14. Apparatus for treating work with a solution comprising a receptacle for the work to be treated adapted to contain the solution, means for lowering and raising the work into and out of the solution in said receptacle, time control means for controlling the time interval of immersion, said time control means being energized in response to initial lowering of the work into the solution in said receptacle, being operative after a predetermined time interval to actuate said first means to raise the work out of the solution, said time control means including a capacitor discharge circuit, a capacitor bridging said circuit, a switch adapted to close said circuit upon initial lowering of the work into the solution in said receptacle permitting said capacitor to discharge to initiate the predetermined time interval, said time control means being operative to actuate said first means to raise the work out of the solution at the end of the predetermined time interval determined by the time required for said capacitor to discharge.

References Cited in the file of this patent

UNITED STATES PATENTS

1,233,109	Nesbit	July 10, 1917
1,254,300	Baker	Jan. 22, 1918
1,943,389	Mercer	Jan. 16, 1934
1,985,554	Smith	Dec. 25, 1934
2,281,094	Chambers	Apr. 28, 1942
2,428,681	Pratt	Oct. 7, 1947
2,446,668	Tuttle	Aug. 10, 1948
2,534,603	Katzen et al.	Dec. 19, 1950
2,542,830	Newton et al.	Feb. 20, 1951
2,570,627	Albin	Oct. 9, 1951
2,621,571	Katzen et al.	Dec. 16, 1952
2,629,304	Tuttle	Feb. 24, 1953
2,665,619	Tuttle et al.	Jan. 12, 1954