

March 24, 1959

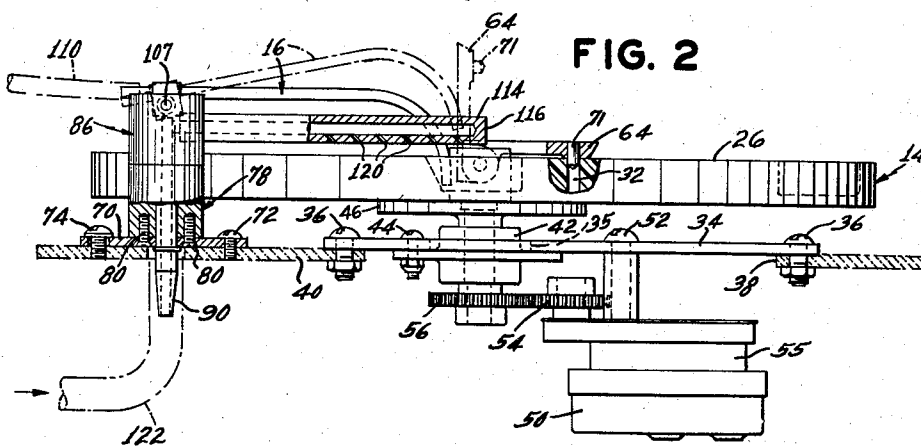
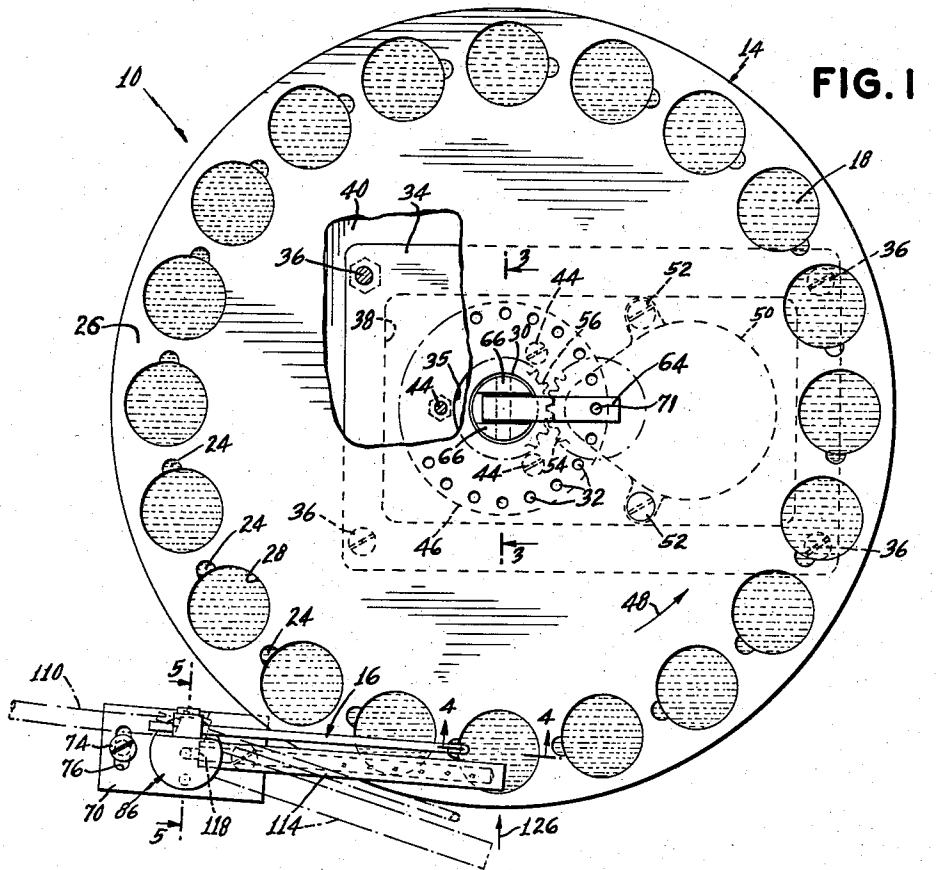
L. T. SKEGGS

2,879,141

AUTOMATIC ANALYZING APPARATUS

Filed Nov. 16, 1955

3 Sheets-Sheet 1



INVENTOR.
Leonard T. Skeggs
BY Edwin Levinson &
Harry Olsen
ATTORNEYS

March 24, 1959

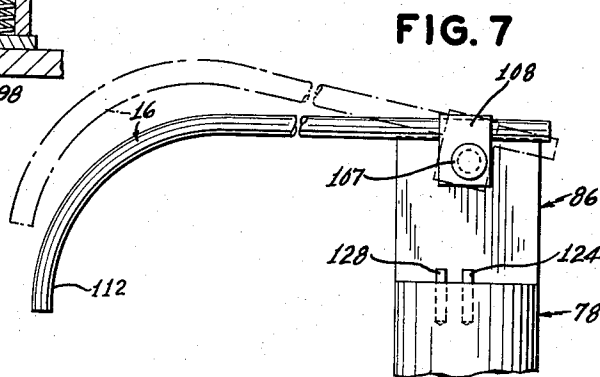
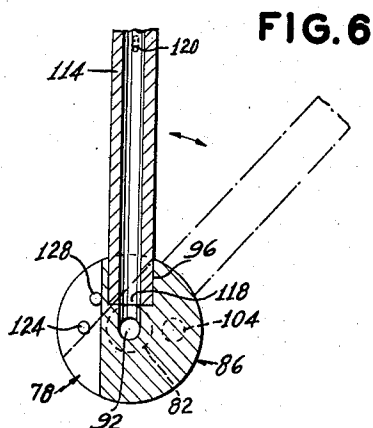
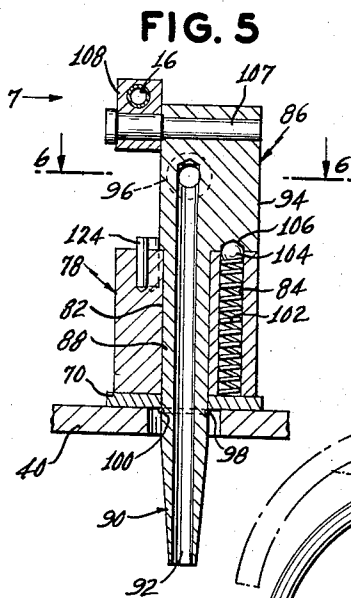
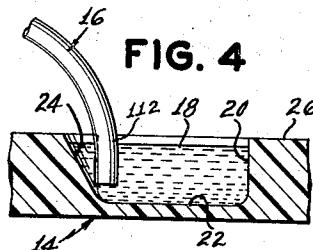
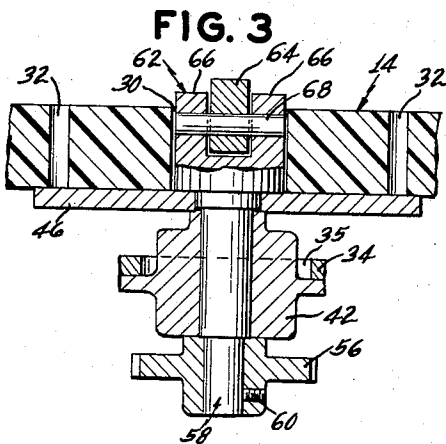
L. T. SKEGGS

2,879,141

AUTOMATIC ANALYZING APPARATUS

Filed Nov. 16, 1955

3 Sheets-Sheet 2



INVENTOR.
Leonard T. Skeggs
BY Edwin Leisner &
Harry Cohen
ATTORNEYS

March 24, 1959

L. T. SKEGGS

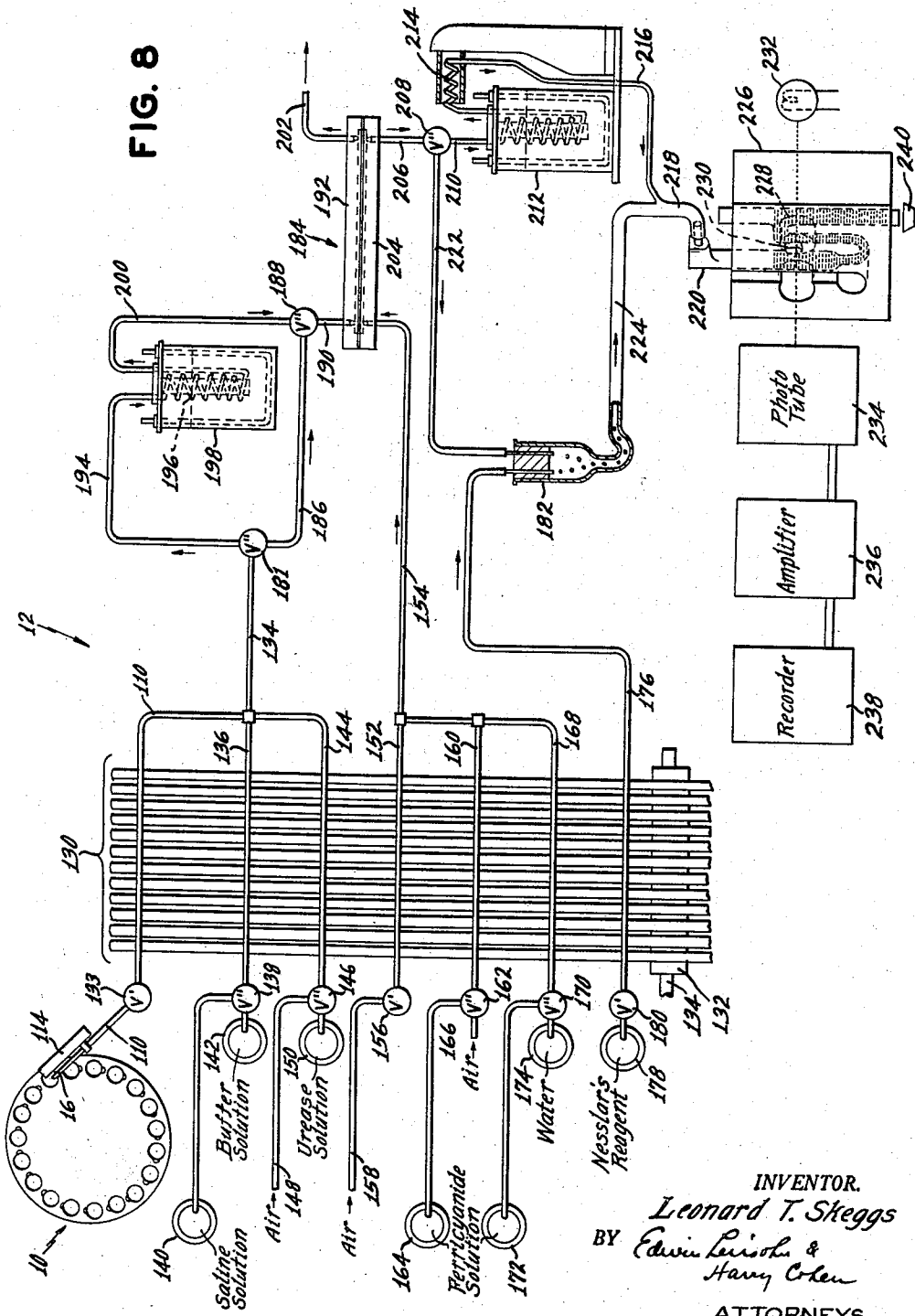
2,879,141

AUTOMATIC ANALYZING APPARATUS

Filed Nov. 16, 1955

3 Sheets-Sheet 3

FIG. 8



INVENTOR.
Leonard T. Skeggs
 BY *Edwin L. Smith & Harry Cohen*
 ATTORNEYS

1

2,879,141

AUTOMATIC ANALYZING APPARATUS

Leonard T. Skeggs, Berea, Ohio, assignor, by mesne assignments, to Technicon Instruments Corporation, Chauncey, N.Y., a corporation of New York

Application November 16, 1955, Serial No. 547,087

18 Claims. (Cl. 23—253)

The present invention relates, in general, to automatic apparatus for treating various liquids for analysis or other purposes.

One object of the present invention is the provision of an apparatus for automatically feeding in succession a plurality of different liquid samples.

Another object is the provision of a sample supplying device which serves to condition or treat the samples before the supply thereof.

A further object is to provide an automatic and self-cleansing action of the tubing through which the various liquids are conducted during the operation of the apparatus, whereby to prevent the contamination of one sample by the vestiges or deposits on the tubing of one or more preceding samples or of any particular liquid and, more generally, to maintain the tubing in clean condition not only when the apparatus is used for processing a plurality of different samples but also when the apparatus is used for analyzing or otherwise processing any particular liquid, so that the process may be continued in operation without requiring frequent interruptions for cleaning purposes.

Another object is the provision of an automatic feed device for the automatic feed of a plurality of body fluid samples to an apparatus for automatically analyzing said samples. In accordance with the foregoing object, a further object is the provision of the sample feeding device which is especially adapted for the feeding of blood samples by preventing the separation of the blood into plasma and red blood cells prior to or during the feed thereof to the analyzing apparatus.

A further object is to provide a generally simplified and highly efficient device for the automatic feed in succession of a plurality of different samples to a testing or analyzing apparatus.

The above and other objects, features and advantages of the present invention will be more fully understood from the following description considered in connection with the accompanying illustrative drawings.

In the drawings which illustrate the best mode presently contemplated by me for carrying out the invention:

Fig. 1 is a top plan view of an automatic sample feeding apparatus pursuant to the present invention, a portion thereof being broken away for purposes of illustration;

Fig. 2 is a side elevation of the automatic feed apparatus with portions broken away and illustrated in section for purposes of illustration;

Fig. 3 is a sectional view, on an enlarged scale, taken on the line 3—3 of Fig. 1;

Fig. 4 is a fragmentary sectional view on an enlarged scale taken on the line 4—4 of Fig. 1;

Fig. 5 is a sectional view on an enlarged scale taken on the line 5—5 of Fig. 1;

Fig. 6 is a sectional view taken on the line 6—6 of Fig. 5;

Fig. 7 is a fragmentary view in elevation taken in the direction of the arrow 7 in Fig. 5; and

Fig. 8 is a diagrammatic representation of an automatic

2

analyzing apparatus provided with the automatic feed device of the present invention.

Pursuant to the present invention, provision is made for an automatic feeding device, generally indicated by the reference numeral 10, for supplying a plurality of samples in succession to the analyzing apparatus, generally indicated by the reference numeral 12, in Fig. 8.

The feed device 10 comprises a rotary plate 14 having provision to hold a plurality of samples, the plate being rotated relative to suction-intake tube 16 through which the samples are fed or supplied to the analyzing apparatus 12.

As here shown, the sample holder is constituted by a circular plate preferably formed of a suitable plastic and provided adjacent the circumference thereof with a plurality of recessed or container portions 18. As here shown, provision is made for twenty recesses or sample receptacles 18 so that the plate 14 is adapted to hold twenty different samples. As best illustrated in Fig. 4, the bounding wall surface 20 of each recess 18 is substantially normal to the bottom wall 22 of the recess. Each bounding wall surface 20 is provided with a sloped portion 24 which extends from the upper surface 26 of the plate 14 to the bottom wall 22 of the recess 18. As is best shown in Fig. 1, the various sloped portions 24 are all similarly related relative to the periphery 28 of each of the recesses 18 and said sloped portions lie upon a circle which has a diameter smaller than the diameter of the plate 14. Centrally thereof the plate 14 is provided with an aperture 30, as best illustrated in Fig. 3. The plate 14 is also provided with a plurality of apertures 32 which are equal in number to the recesses 18, the apertures 32 being radially aligned with said recesses 18 and being defined in the plate 14 along a circle adjacent to the aperture 30.

In order to mount the plate 14 in operative disposition thereof, provision is made for the mounting plate 34 which is suitably secured as at 36 at a cut-out 38 provided in a suitable support member or table 40. The support plate 34 mounts a bearing 42, as by the securing means 44, within an aperture 35 in the support plate. A plate 46 rests on the bearing 42 and the holder plate 14 rests on the plate 46.

In order to effect the rotation of the holder 14 in the direction of the arrow 48 in Fig. 1, provision is made for a motor 50 which depends from the support plate 34, being secured thereto as by the securing means 52. The motor 50 drives a gear 54, through a gear reduction device 55, to mesh with a gear 56. Gear 56 is secured to a drive shaft 58, as at 60 (Fig. 3). The drive shaft 58 is journaled in the bearing 42 and, at the upper end thereof, is provided with an enlarged yoke portion 62 which extends through the central aperture 30 provided in the holder plate 14. A lever 64 is pivotally mounted between the arms 66—66 of the yoke portion 62 by a pivot pin 68 carried by said yoke arms. At the free end thereof, the lever 64 is provided with a pin 71 which is adapted to engage in an aperture 32 of the plate 14, as best illustrated in Fig. 2, for releasably connecting the holder plate 14 to the drive shaft 58.

From the foregoing, it will be apparent that with the lever 64 connected to the plate 14, the motor 50 is operative to rotate the plate 14 in the direction of the arrow 48 through the meshed gears 54 and 56, and through the shaft 58 secured to the gear 56.

The previously mentioned inlet tube 16, through which the contents of the recesses 18 are withdrawn from the holder plate 14, is mounted laterally outwardly of the holder plate. More specifically, provision is made for a mounting plate 70 which is secured to the previously mentioned support by the securing elements 72 and 74. It will be noted that the securing element 74 extends

through an enlarged slot 76 for adjustment of the plate 70 on the support 40. The plate 70 mounts a cylindrical mounting member 78 which is secured thereto as at 80-80. The mounting member 78 is provided with a central bore 82 and with an additional bore 84 laterally offset from the central bore. A conduit carrier or anchor member 86 is mounted in the mounting member 78. More specifically, the anchor member 86 is provided with an elongated stem 88 which terminates in a nozzle 90. The stem 88 is provided with a bore or air passageway 92 which extends from the nozzle 90 through the stem and into the enlarged head 94 of the member 86. The head 94 is also provided with a transverse bore 96 which extends from the exterior thereof and communicates with the longitudinal bore 92. The member 86 is mounted for rotation relative to the mount 78 and in this connection it will be noted that the stem 88 extends through the bore 82 in the mount 78 with the nozzle 90 projecting through the plate 70 and the support member 40.

In order to retain the conduit carrier 86 in position on the mounting member 78, provision is made for the spring ring 98 which may be snapped into position in a groove 100 provided on the stem 88 below the mounting plate 70 to prevent the inadvertent upward removal or disengagement of the member 86 from the member 78. A compression spring 102 is disposed in the previously mentioned bore 84 in the mount 78 and at the upper end mounts a ball 104 for engagement in a recess 106 provided in the conduit member 86 for disposing the latter in the operative position thereof, shown in full line in Fig. 6.

A pivot pin 107 is press fitted into the head 94 of the conduit member 86 and mounts a pivot member 108 for pivotal movement thereon. The previously mentioned tube 16, which is preferably formed of stainless steel or other suitable material, is mounted in the pivot member 118 and extends therethrough for connection to the flexible sample inlet tube 110 of the analyzing apparatus 12. The end of the tube 16, remote from its pivot carrier 108, is downturned as at 112 for insertion into a recess 18 of the holder plate 14 in the full line position of the tube 16, as illustrated in Figs. 2 and 4.

An air tube 114, preferably formed of stainless steel or other suitable material, is closed at one end, as at 116, and is open at the other end 118 thereof. The open end 118 is press fitted into the previously mentioned bore 96 so that the tube 114 is in airflow communication with the bore or conduit 92. At the under surface thereof, the tube 114 is provided with a plurality of angular and outwardly directed bores 120 which extend from the hollow interior of the tube, through the lower outer surface thereof, for a substantial distance from the outer closed end 116 thereof toward the inner end 118 thereof. With the nozzle 90 connected to a suitable compressed air supply as by the conduit 122, it will be readily apparent that air will be discharged in angularly directed jets from the various bores 120.

In order to replace or remove a sample holder 14 in the feed device 10, the lever 64 is pivoted to the vertical position thereof indicated in broken line in Fig. 2. This disengages the holder 14 from the drive shaft 58. The sample inlet tube 16 is then pivoted to the broken line position thereof illustrated in Fig. 2, to clear the plate 14 in position in the feed device 10. The conduit holder 86 is then rotated in a clockwise direction, viewing Fig. 1, until the latter engages the detent pin 124 provided in the mounting member 78, as illustrated in the broken line position of the conduit carrier 86 in Fig. 6. In this position, both the air tube 114 and the sample tube 16 are disposed laterally outwardly of the plate holder 14 and clear the latter as best illustrated in broken line in Fig. 1. The sample holder 14 may now be withdrawn upwardly from the plate 46 to clear the upstanding lever 64 and removed from the feed device. Another sample holder, provided with the various samples to be tested,

may now be inserted in position on the plate 46 with the lever 64 extending through the central aperture 30 therein. The new sample holder may then be manually adjustably rotated in position on the mounting plate 46 until the recess 18, containing the first sample which is to be analyzed, is substantially in the position indicated by the arrow 126 in Fig. 1. The locking lever 64 is now moved into the full line position thereof illustrated in Fig. 2 to engage the pin 71, carried by the lever 64, into the underlying aperture 32 provided in the sample holder 14 and radially aligned with the recess containing the first sample to be analyzed. The conduit carrier 86 is now rotated in a counter-clockwise direction, viewing Fig. 1 until the latter engages the detent pin 128 carried by the mount 78, as illustrated in full line in Fig. 6, in which position the spring pressed ball 104 automatically snaps into the recess 106 provided in the conduit mount 86 to releasably lock the latter in its operative position. The sample pick-up tube 16 is now brought down into the full line position thereof illustrated in Figs. 2 and 4 wherein the inlet end 112 thereof is immersed into the liquid contents of the underlying recess or sample container 18.

Compressed or pumped air is now permitted to flow through the conduit 122 into the bore 92 and the motor 50 is energized to rotate the holder plate 14 in the direction of the arrow 48 in Fig. 1. As best illustrated in Fig. 1, the air jet forming bores 120 in the air tube 114 extend over both the recess 18 into which the pick-up tube 16 extends and also overlies the next recess which will be moved into position under the inlet 112 of the pick up tube 16. The air jets issuing from the jet outlets 120 will therefore be directed at the contents both of the recess 18 into which the pick-up tube 16 extends, as well as at the contents in the next following recess 18 which will be moved into position under the inlet 112. These air jets serve to treat or condition the samples by agitating the liquid contents of these recesses so as to prevent the separation of the liquid contents both during the withdrawal thereof into the sample inlet tube 16 and immediately prior to the period during which a recess moves into position for the withdrawal of the contents thereof. This prevents any tendency of the sample being separated out into different constituents thereof and is extremely important in the case where blood samples are being supplied to the analyzing apparatus 12, since the agitation of the blood by the air jets prevents the separation of each blood sample into plasma and red blood cells. The liquid content from each recess 18 are withdrawn therefrom during the relatively slow movement of the holder plate 14 relative to the fixed inlet tube 16. As the sloped portion 24 of each recess 18 engages the inlet end 112 of the sample tube, the sample tube will slowly pivot about pin 107 and gradually ride out of the recess, from which it had been withdrawing a sample, onto the upper surface portion of the sample holder 14 between said recess 18 and the adjacent recess 18 which is moving into the position indicated by the arrow 48 in Fig. 1. When said adjacent recess arrives underneath the inlet end of the sample tube, the tube will drop, by gravity, from the surface of the holder plate into the underlying recess 18. During the period that the tube is withdrawn from a recess 18, and before it falls into the following recess 18, air is being drawn into the suction inlet tube by means of the suction line 110 through which the various samples are being drawn into the body analyzing apparatus, said apparatus providing the necessary suction, as hereinafter explained in detail. It will be noted that the air drawn into the suction inlet tube serves to separate the individual samples which pass as a flowing stream but with the samples separated from each other, into the suction line 110 of the apparatus 12. The feed device 10 operates in the described manner until all of the samples have been withdrawn therefrom at which point the operation of the motor 50 will be stopped and the

ments which thus flow through the tubing serve to prevent the formation of deposits on the walls of the tubing which might otherwise occur as explained in my above-mentioned U. S. Patent No. 2,797,149, with reference to Fig. 3 thereof.

While the feed device of the present invention has been illustrated and described in connection with an apparatus for analyzing body fluids, it will be readily apparent that it is not limited for use with such particular type of apparatus but may be utilized in connection with any type of apparatus where it is desirable to automatically provide a plurality of samples in succession. It will also be apparent that the feed device 10 may be constructed to provide a greater or a lesser number of samples than that illustrated in the present construction.

While I have shown and described the preferred embodiments of my invention, it will be understood that various changes may be made in the present invention without departing from the underlying idea or principles of the invention within the scope of the appended claims.

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

1. Sample supply apparatus comprising means having provision to hold a plurality of samples, sample intake means, and means for effecting relative movement of said sample holding means and said intake means to immerse said intake means in succession in each sample, and air-jet defining means operable to agitate the samples during and prior to the withdrawal thereof by said intake means.

2. An automatic feed device comprising a movable member provided with a plurality of sample receptacles, a suction intake tube mounted relative to said rotary member with the inlet end of said tube overlying said member, and means for moving said member to present each receptacle in succession to said inlet end of said intake tube, and an air-jet defining member overlying said movable member to direct air jets at the receptacles thereof.

3. Automatic sample feed apparatus comprising a rotary member provided with a plurality of sample recesses arranged in a row thereon, a pivoted suction intake tube mounted relative to said rotary member with the inlet end of said tube gravity biased into overlying engagement with said rotary member at said row of recesses for pivotal movement of the inlet end of said tube into an underlying recess, each recess having a cam portion adapted to pivot said tube to withdraw said inlet end from the underlying recess in response to movement of the underlying recess away from said inlet end, and means for rotating said rotary member to effect said pivotal movement of said inlet end into and out of each recess.

4. Automatic sample feed apparatus comprising a rotary member provided with a plurality of sample recesses arranged in a row thereon, a pivoted suction intake tube mounted relative to said rotary member with the inlet end of said tube gravity biased into overlying engagement with said rotary member at said row of recesses for pivotal movement of the inlet end of said tube into an underlying recess, each recess having a cam portion adapted to pivot said tube to withdraw said inlet end from the underlying recess in response to movement of the underlying recess away from said inlet end, means for rotating said rotary member to effect said pivotal movement of said inlet end into and out of each recess, and an air-jet defining tube overlying said rotary member to direct air jets at each recess during and prior to the withdrawal of its sample therefrom.

5. Automatic sample feed apparatus comprising a rotary member provided with a plurality of sample recesses arranged in a row thereon, a pivoted suction intake tube mounted relative to said rotary member with the inlet end of said tube gravity biased into overlying engagement with said rotary member at said row of recesses for pivotal movement of the inlet end of said tube into an underlying recess, each recess having a cam portion adapted to pivot said tube to withdraw said inlet end from the under-

lying recess in response to movement of the underlying recess away from said inlet end, means for rotating said rotary member to effect said pivotal movement of said inlet end into and out of each recess, an air-jet defining tube overlying said rotary member to direct air jets at each recess during and prior to the withdrawal of its sample therefrom, and means mounting said tubes for movement to a position laterally of said rotary member, whereby to facilitate the upward withdrawal of said rotary member from said feed apparatus.

6. Automatic feed apparatus comprising a rotary plate having a central aperture and a plurality of apertures arranged in a row about said central aperture, said plate having defined in its upper surface a row of recesses outwardly of said row of apertures, the recesses and apertures of said rows, respectively, being radially aligned, drive means projecting through said central aperture and having provision to effect a releasable connection with one of said plurality of apertures to rotate said plate, a pivotally mounted suction tube having an inlet biased into overlying contact with said rotary plate along said row of recesses for movement of said inlet into an underlying recess, and means for effecting movement of said inlet out of the underlying recess as the latter is moved away from said inlet, whereby the rotation of said plate will result in the pivotal movement of said tube inlet successively into and out of said recesses.

7. Automatic feed apparatus comprising a rotary plate having a central aperture and a plurality of apertures arranged in a row about said central aperture, said plate having defined in its upper surface a row of recesses outwardly of said row of apertures, the recesses and apertures of said rows, respectively, being radially aligned, drive means projecting through said central aperture and having provision to effect a releasable connection with one of said plurality of apertures to rotate said plate, and a pivotally mounted suction tube having an inlet biased into overlying contact with said rotary plate along said row of recesses for movement of said inlet into an underlying recess, and each recess having a sloped wall portion extending to said upper surface of said rotary plate to effect the pivotal movement of said tube outwardly of each of said recesses, whereby the rotation of said plate will result in the pivotal movement of said tube inlet successively into and out of said recesses.

8. Automatic feed apparatus comprising a rotary plate having a central aperture and a plurality of apertures arranged in a row about said central aperture, said plate having defined in its upper surface a row of recesses outwardly of said row of apertures, the recesses and apertures of said rows, respectively, being radially aligned, drive means projecting through said central aperture and having provision to effect a releasable connection with one of said plurality of apertures to rotate said plate, and a pivotally mounted suction tube having an inlet biased into overlying contact with said rotary plate along said row of recesses for movement of said inlet into an underlying recess, and means for effecting movement of said inlet out of the underlying recess as the latter is moved away from said inlet, whereby the rotation of said plate will result in the pivotal movement of said tube inlet successively into and out of said recesses, and an air jet defining member overlying said rotary plate and having provision to direct air jets at each recess during and prior to the withdrawal of the contents thereof.

9. Automatic feed apparatus comprising a rotary plate having a central aperture and a plurality of apertures arranged in a row about said central aperture, said plate having defined in its upper surface a row of recesses outwardly of said row of apertures, the recesses and apertures of said rows, respectively, being radially aligned, drive means projecting through said central aperture and having provision to effect a releasable connection with one of said plurality of apertures to rotate said plate, and a pivotally mounted suction tube having an inlet biased

5

locking lever 64 disengaged from the sample holder 14 for replacement of the latter, as previously described.

The feed device 10 may be utilized in connection with an analyzing apparatus of the type illustrated and claimed in my copending application Serial No. 330,211 filed January 8, 1953 which has matured into Patent No. 2,797,149, owned by the assignee of this application. As fully illustrated and described therein, and as shown diagrammatically in Fig. 8 herein, provision is made for the conventional pump in which a plurality of parallel metal fingers 130, actuated by a cam 132 and a cam shaft 134 rotating at a predetermined speed, press consecutively against a section of a highly flexible tubing of relatively small diameter, thus progressively moving through the tubing the material that is being pumped. In lieu of a finger pump, any other pump suitable for the purpose may be used, for example, the pump illustrated and claimed in the copending application of Andres Ferrari, Jr. and Jack Isreeli, Serial No. 463,860, filed October 22, 1954, and assigned to the assignee hereof, may be used. The previously mentioned flexible tube 110 connected to the damper inlet tube 16 extends through a valve 133 into the conduit 134, the pump fingers 130 providing the necessary suction for withdrawing the samples from the feeding device 10, as previously described. A flexible tube 136 extends from the conduit 134 through the two way valve 138 into a supply 140 of saline solution or into a supply 142 of buffer solution. A flexible tube 144 extends from the conduit 134 through the two-way valve 146 to the open air, as at 148, or into a supply 150 of urease solution. A flexible tube 152 extends from a conduit 154 through a one-way valve 156 to the open air, as at one 158. A flexible tube 160 extends from the conduit 154 through a two way valve 162 to a supply 164 of ferricyanide solution or to the open air as at 166. A flexible tube 168 extends from the conduit 154, through a two way valve 170, to a supply 172 of ferricyanide solution, or to a supply 174 of water. A flexible tube 176 extends from a supply 178 of Nessler's reagent through a one-way valve 180 to a reaction tube 182.

As illustrated herein, the analyzing apparatus is equally adapted to take samples containing either glucose or urea to analyze the samples for these factors. The valves are designated V' and V'' depending on whether they are one-way or two-way valves. As indicated, a sample containing glucose or urea or some other diagnostically significant factor is supplied to the apparatus 12 by the feed device 10 by means of the suction line 110 provided with the one-way valve 133. The containers 140, 164 and 172, by means of lines 136, 160 and 168, supply the saline solution and the solution of potassium ferricyanide. Air is supplied by lines 144 and 152, the latter being provided with a one-way valve 156. Each of the lines 136, 144, 160 and 168 includes a two way valve, as described, which is provided in order that the operator operating apparatus may, if he desires to switch from an analysis of glucose to an analysis for urea. The two way valve 138 permits for the processing media to be drawn either from the saline solution in container 140 or from the buffer solution in container 142. The two-way valve 146 permits for the supply of either air or urea solution from the container 150. The two-way valve 162 provides for the supply of either ferricyanide solution from the container 164 or air. The two-way valve 170 provides for the supply of either ferricyanide solution from the container 172 or water from the container 174. The two way valve designated 181 permits the mixtures of processing media and sample to be directed to a dialyzer 184 by either one of two alternative routes. One of these, for use where the sample is being analyzed for glucose, is through line 186 through the two-way valve 188, and then through line 190 leading to the upper half 192 of dialyzer 184. The other route, for use where the analysis is for urea, is through line 194, through a coil 196 in a low temperature water bath 198, and thence through line 200, the

6

two-way valve 188 and the line 190 into the upper half 192 of the dialyzer 184. Whatever the nature of the mixture of processing media and sample, which depends on the nature of the diagnostically significant factors for which the analysis is being made, the crystalloid constituents of the samples diffuse through the dialyzer from the upper half to the lower half thereof and what remains after the diagnostically significant factor or crystalloids have been removed in the dialyzer 184 is discarded through the line 202.

If the analysis that is being made is for glucose, potassium ferricyanide solution is drawn from containers 164 and 172 through the two way valves 162 and 170 into the lines 160 and 168. Simultaneously, air is drawn into the system by way of airline 152. The mixture that results where lines 152, 160 and 168 meet is fed by way of common line 154 to the lower half 204 of dialyzer 184, from which the mixture passes by means of line 206 into the two-way valve 208 and through it to line 210. It proceeds thence to the high temperature bath 212, in which it is heated to a temperature equal to or approaching that of boiling water. After passing through a cooling coil 214, the mixture passes through the lines 216 and 218 to a continuous flow cell 220.

If, however, the analysis that is being made is not for glucose but for urea, the mixture sent to the lower half 204 of the dialyzer 184 by way of the common line 154 consists of water from container 174 and air from lines 152 and 160. After having passed through the lower half 204 of dialyzer 184, this mixture, which now includes ammonium salt derived from urea in the sample, passes through line 206, two-way valve 208 and line 222 into reaction tube 182. Simultaneously, Nessler's reagent from container 178 is admitted to the reaction tube 182 by way of line 176. The final mixture, which is colored, passes into the flow cell 220 by way of the discharge line 224 into the common line 218. In the system illustrated in Fig. 8 there is a minimum of seven flexible lines on which the pump can operate by means of the pump fingers 130, the cam 132 and the cam shaft 134. With seven lines arranged as shown, the operator can switch from glucose to urea or vice versa by opening or closing one-way valves marked V' and setting two-way valves marked V'', as indicated by the foregoing description. Thus the apparatus can be operated to provide an analysis for the contents of the various samples in the feed device 10 for either glucose or urea.

By suitable adaptation, the analysis to be made may be for other constituents of blood, urine and like body fluids; for example, the metallic constituents. The colored mixture flows into the flow cell 220, which preferably is of the type illustrated and claimed in the copending application of Andres Ferrari, Jr., Serial No. 516,300, filed June 17, 1955, and assigned to the assignee hereof. The flow cell 220 is mounted in a holder 226 provided with a light passageway 228 having a constricted opening 230 adjacent one arm of the flow cell 220. Light passing from the light source 232 through the restricted light aperture 230 is transmitted through the colored mixture in the flow cell 220 to a photoelectric device or photo tube 234. The output of the photo-tube 234 is amplified by the amplifier 236 and then applied to a recorder 238 which makes a continuous record of the changes in the color concentration of the mixture flowing through the flow cell 220 into the discharge outlet 240. The samples being drawn into the inlet line 110 through the feed device 10 are separated from each other by air which is drawn into the system as the inlet tube 16 moves out of each sample recess 18 into the next recess 18, to form air bubbles between succeeding samples.

It will be apparent that during the flow of the liquids through the tubing, the air which is introduced into the fluid streams during the flow of the liquids in the tubing divides each of said streams into alternate liquid segments separated by intervening air segments, and the air seg-

into overlying contact with said rotary plate along said row of recesses for movement of said inlet into an underlying recess, and means for effecting movement of said inlet out of the underlying recess as the latter is moved away from said inlet, whereby the rotation of said plate will result in the pivotal movement of said tube inlet successively into and out of said recesses, an air jet defining member overlying said rotary plate and having provision to direct air jets at each recess during and prior to the withdrawal of the contents thereof, and a rotary mount for said suction tube and said air jet member for moving said tube and air jet member laterally of said rotary plate to clear the latter for withdrawing the plate from said drive means.

10. Apparatus for analyzing or processing a series of individual liquid samples, comprising means in which said series of samples are received for subjecting them to treatment required for their analysis processing, said treatment means having an intake device for said samples, a device for holding said series of samples, means for immersing said intake device successively into said samples for feeding said series of samples automatically in succession and separated from each other to and through said treatment means in the form of a flowing stream but with the samples separated from each other in said stream, and means responsive automatically in succession to changes in said samples, respectively, during the flow thereof in said stream for automatically passing air through said intake device between successive samples.

11. Apparatus for analyzing or processing a series of individual liquid samples, comprising means in which said series of samples are received for subjecting them to treatment required for their analysis processing, said treatment means having an intake device for said samples, a device for holding said series of samples, means for immersing said intake device successively into said samples for feeding said series of samples automatically in succession and separated from each other to and through said treatment means in the form of a flowing stream but with the samples separated from each other in said stream, and means responsive automatically in succession to changes in said samples, respectively, during the flow thereof in said stream for indicating said changes, means operable automatically between successive immersions of said intake device for passing air through said intake device between successive samples, and means operable automatically at least during the periods of immersion of said intake to introduce air into said liquid samples in the treatment means whereby each sample of said flowing stream is divided into alternate segments of liquid separated by an intervening segment of air.

12. Apparatus for analyzing or processing a series of individual liquid samples, comprising means in which said series of samples are received for subjecting them to treatment required for their analysis, a device for including sample receptacle means feeding said series of samples automatically in succession and separated from each other to and through said treatment means in the form of a flowing stream but with the samples separated from each other, dialyzer means, and means responsive automatically in succession to changes in said samples, respectively, during the flow thereof in said stream for indicating said changes, said device having provision to agitate said series of samples during and prior to the feed thereof to said dialyzer, means for preventing the separation of the various samples into the respective components thereof, said agitating means comprising a member having provision to direct air-jets at the samples in said sample receptacle means.

13. Apparatus for analyzing a series of individual liquid samples containing crystalloid and non-crystalloid constituents to obtain a quantitative indication of a substance contained in said crystalloid constituent, comprising a movable device having a plurality of compartments for holding said series of samples, means for intermittently

moving said device, means for forming a flowing stream of said samples but with said samples separated from each other in said stream, said stream forming means having an intake device, means for automatically operating said intake device in timed relation to said holding device successively immersing said intake device into said liquid samples, dialyzer means in the path of flow of said stream for separating from said flowing stream a portion of the crystalloid constituent of each sample from the non-crystalloid constituent thereof in proportion to the quantity thereof in the liquid sample to be analyzed, means for forming a second liquid stream flowing concurrently with said first stream in a path to intercept and mix with the separated portions of said crystalloid substances, and means in the path of flow of the second stream for analyzing said second stream.

14. Apparatus for analyzing a series of individual liquid samples containing crystalloid and non-crystalloid constituents to obtain a quantitative indication of a substance contained in said crystalloid constituent, comprising a rotary device having a plurality of compartments for holding said series of samples, means for intermittently moving said device, means for forming a flowing stream of said samples but with said samples separated from each other in said stream, said stream forming means having an intake device, means for automatically operating said intake device in timed relation to said holding device successively immersing said intake device into said liquid samples, dialyzer means in the path of flow of said stream for separating from said flowing stream a portion of the crystalloid constituent of each sample from the non-crystalloid constituent thereof in proportion to the quantity thereof in the liquid sample to be analyzed, means for forming a second liquid stream flowing concurrently with said first stream in a path to intercept and mix with the separated portions of said crystalloid substances, and means in the path of flow of the second stream for analyzing said second stream, and means associated with said sample holding device to agitate said series of samples during and prior to the feed thereof to said dialyzer means.

15. Apparatus for analyzing or processing a series of individual liquid samples, comprising means in which said series of samples are received for subjecting them to treatment required for their processing, said treatment means having an intake device for said samples, a device for holding said series of samples, means for immersing said intake device successively into said samples for feeding said series of samples automatically in succession and separated from each other to and through said treatment means in the form of a flowing stream but with the samples separated from each other in said stream, said treatment means comprising tubing through which said stream flows, and means operable automatically during the flow of said stream for injecting air into said tubing for dividing the fluid of each sample into a series of alternate segments of liquid separated by intervening air segments, respectively.

16. Apparatus for treating a liquid for analysis or other processing, comprising tubing for conducting said liquid, means operable in conjunction therewith for passing a stream of the liquid therethrough together with a fluid for treating said liquid to at least partially condition it for processing and means operable during the flow of said stream in said tubing to inject air into said tubing and thereby dividing the liquid stream into alternate segments of liquid separated from each other by intervening air segments, respectively, while said stream flows through said tubing.

17. Apparatus for treating a liquid for analysis or other processing, comprising tubing for conducting said liquid, means operable in conjunction therewith for passing a stream of the liquid therethrough together with a fluid for treating said liquid to at least partially condition it for processing and means operable during the flow of

11

said stream in said tubing to inject air into said tubing and thereby dividing the liquid stream into alternate segments of liquid separated from each other by intervening air segments, respectively, while said stream flows through said tubing, and pump means for pumping said liquid and air segments through said tubing and for injecting the air therein. 5

18. Automatic sample feed apparatus comprising a rotary member provided with a plurality of sample receptacles arranged in a row thereon, a suction intake tube positioned laterally of said rotary member outwardly thereof and having its inlet end in a position overlying said receptacles during the rotation of said rotary member, means mounting said suction intake tube in said position for movement in relation to said rotary member for moving said inlet end of said suction intake tube into and out of said receptacles, means for intermittently rotating said rotary member to position said receptacles in 10 15

12

succession in registry with and under the inlet end of said suction intake tube, and means for effecting the movement of the inlet end of said suction intake tube into each of said receptacles.

References Cited in the file of this patent

UNITED STATES PATENTS

897,170	Spinelli	Aug. 25, 1908
1,350,673	Sebring	Aug. 24, 1920
1,742,871	North	Jan. 7, 1932
1,873,010	Mitton	Aug. 23, 1932
1,971,852	Goebels	Aug. 28, 1934
2,377,624	Gordon	June 5, 1945
2,408,900	Alston et al.	Oct. 8, 1946
2,797,149	Skeggs	June 25, 1957

FOREIGN PATENTS

738,614	France	Oct. 18, 1932
---------	--------	---------------

Disclaimer and Dedication

2,879,141.—*Leonard T. Skeggs*, Berea, Ohio. AUTOMATIC ANALYZING APPARATUS. Patent dated Mar. 24, 1959. Disclaimer and dedication filed Mar. 24, 1966, by the assignee, *Technicon Instruments Corporation*.

Hereby disclaims and dedicates to the public that portion of the term of said patent subsequent to June 25, 1974.
[*Official Gazette May 3, 1966.*]