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Lartigue et al.

[11] **3,810,720**

[45] **May 14, 1974**

[54] **APPARATUS FOR TRANSFERRING LIQUIDS**

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[73] Assignee: **Hoffmann-La Roche Inc.,** Nutley, N.J.

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[30] **Foreign Application Priority Data**

May 18, 1971 France 71.17955

[52] **U.S. Cl.** **417/429,** 417/515, 222/135, 222/137

[51] **Int. Cl.** **F04b 23/06,** F04b 7/00, B67d 5/18

[58] **Field of Search** 417/426; 92/13.51; 222/137, 135

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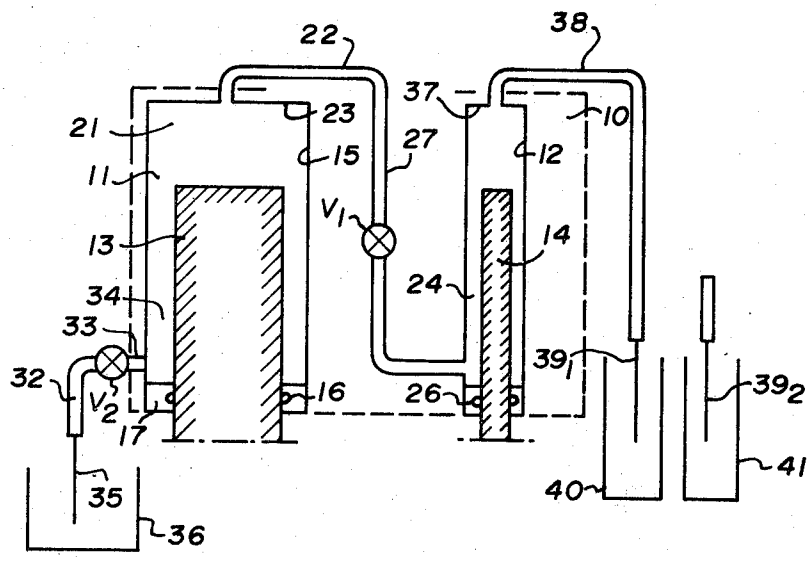
Primary Examiner—William L. Freeh

Attorney, Agent, or Firm—Samuel L. Welt; Bernard S. Leon

[57] **ABSTRACT**

The present invention relates to a device for transferring predetermined quantities of different liquid medium contained in separate containers which device comprises pump means for selectively withdrawing predetermined amounts of different liquid media from different containers and then transferring the withdrawn liquid media to the same receptacle.

5 Claims, 9 Drawing Figures



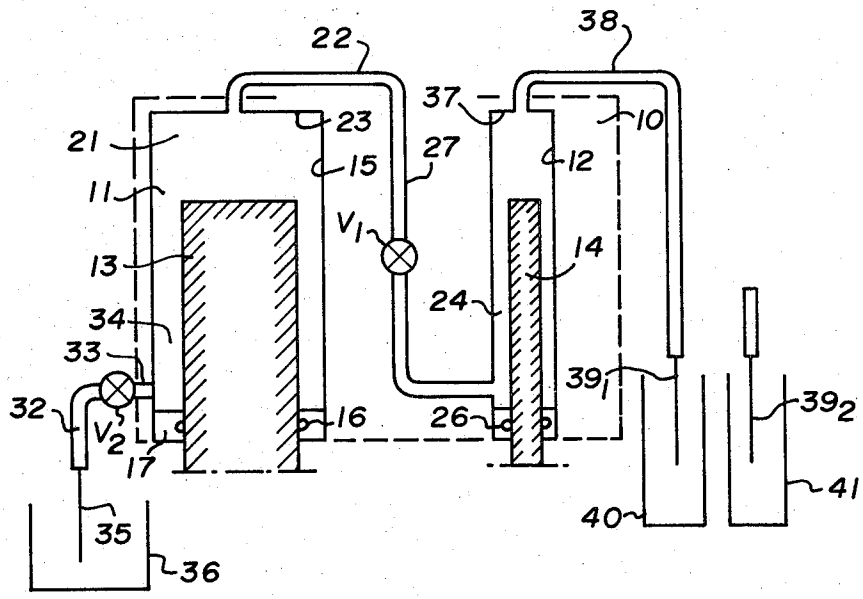


FIG. 1

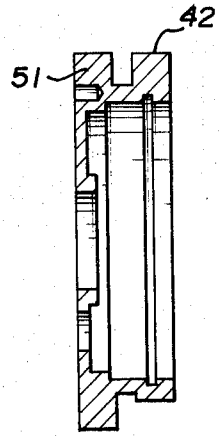


FIG. 5

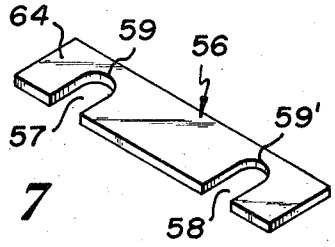


FIG. 7

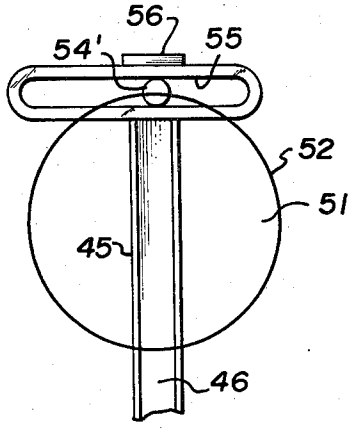


FIG. 6

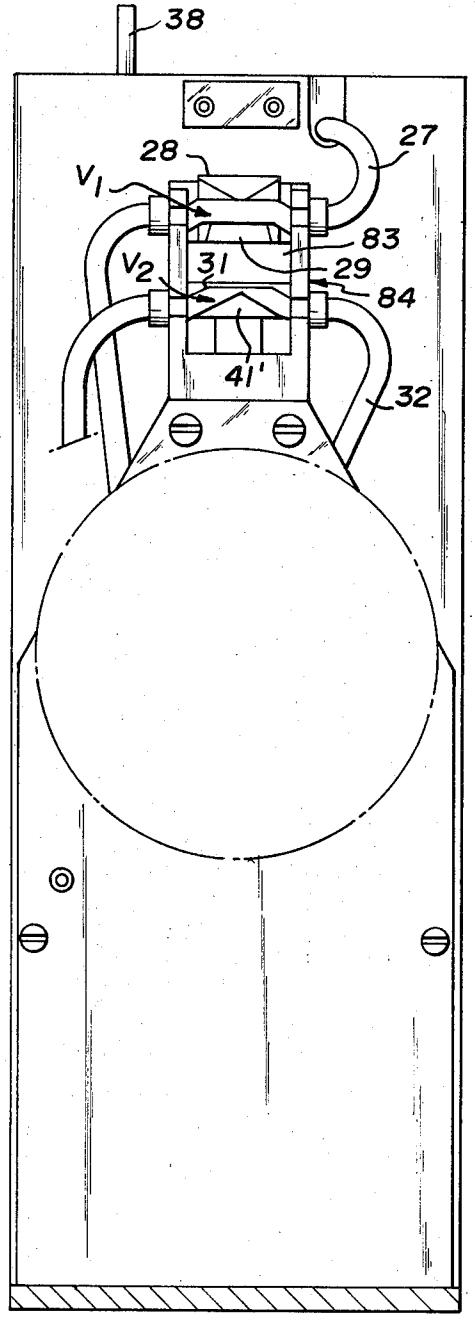


FIG. 2

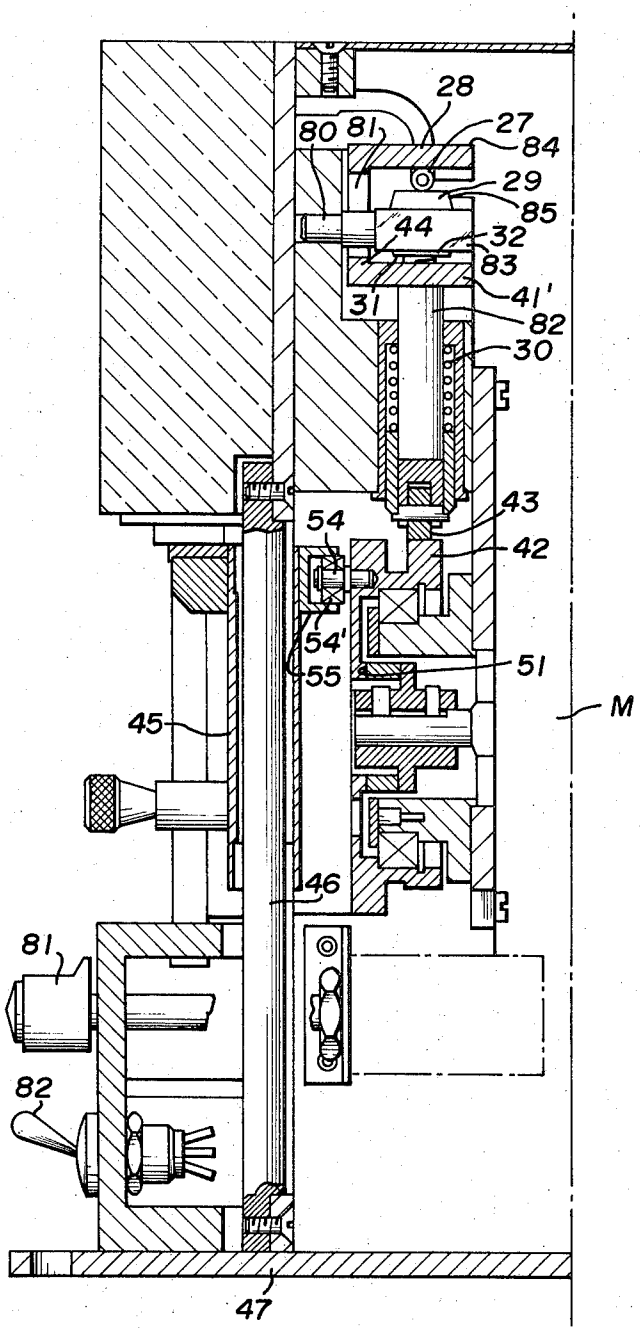
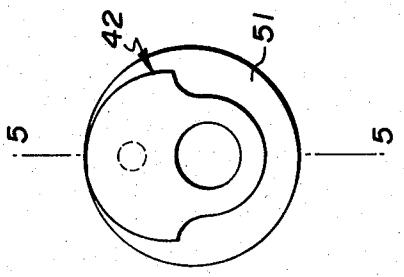

28
80
81
27
84
29
85
44
32
83
31
41'
82
30
43
54
42
54'
55
51
M
45
46
81
82
47

FIG. 3


42
51
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5

FIG. 4

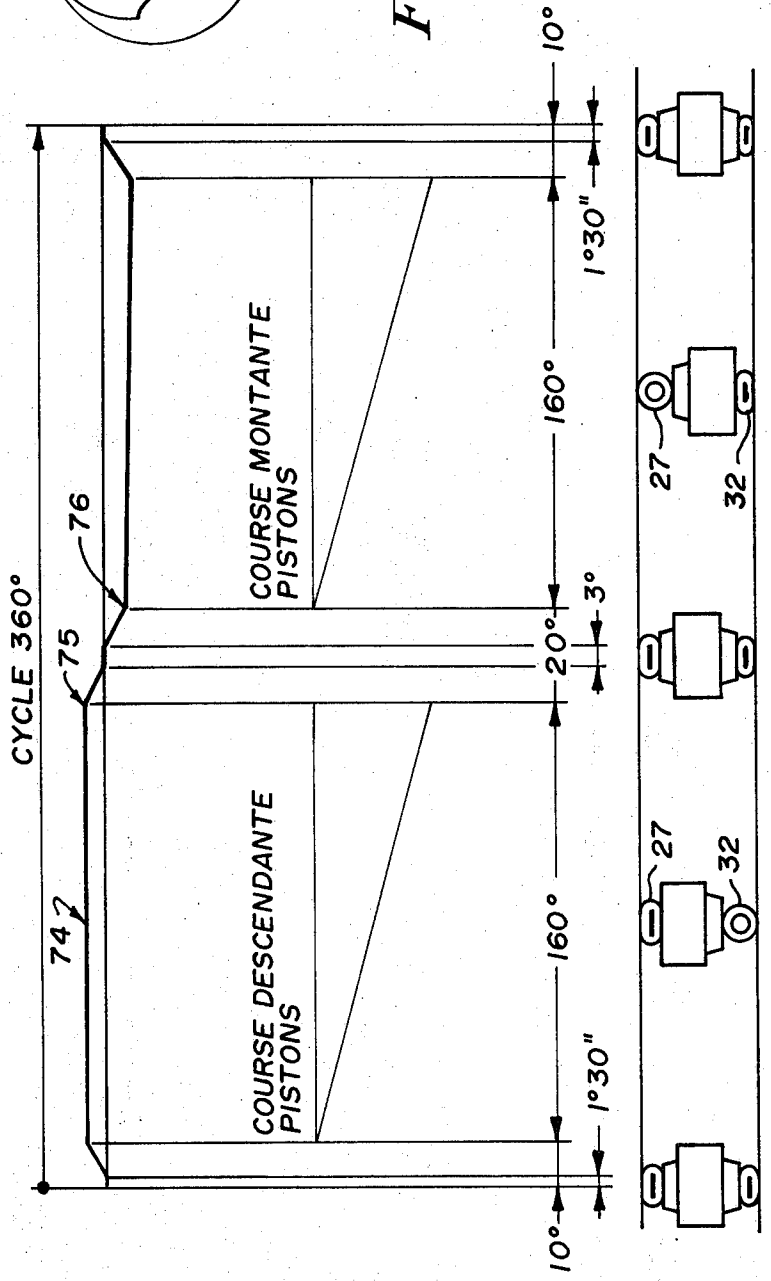
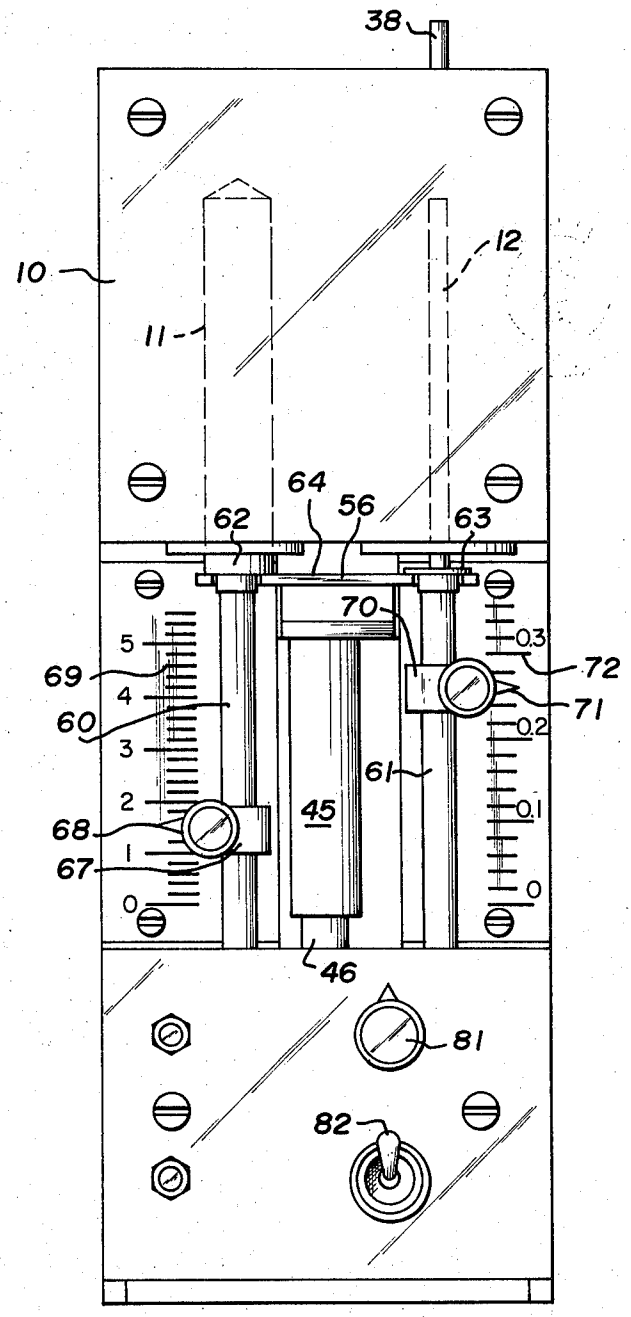

CYCLE 360°
76
75
74
COURSE MONTANTE PISTONS
COURSE DESCENDANTE PISTONS
10°
1°30"
160°
3°
20°
160°
1°30"
10°
27
32
27
32

FIG. 9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10
12
11
64
56
62
63
70
0.3
72
69
5
4
71
60
3
0.2
61
2
45
0.1
68
1
67
0
0
46
81
82

FIG. 8

APPARATUS FOR TRANSFERRING LIQUIDS

DETAILED DESCRIPTION OF THE INVENTION

In chemical or biological analysis, it is often necessary to withdraw from different vessels predetermined amounts of different liquid media and then to combine the media in a single vessel. Particularly when analyzing a specimen sample such as urea, blood, sputa and the like to ascertain diagnostically significant indications, it is important that ready means be found for withdrawing from one container, a predetermined amount of a liquid designed to biochemically react with specimen sample and from another container predetermined amounts of said specimen sample and then combining the two in a single vessel. In this way, diagnostically significant indications can be revealed.

The apparatus which constitutes the present invention is adapted to perform such an operation or a succession of such operations. A particularly noteworthy feature of the apparatus of the present invention resides in its capability of permitting the amount of liquid medium that need be withdrawn from each vessel to be varied at will, in accordance with established criteria.

The apparatus according to the present invention is characterized in that it comprises two pumps provided by a piston means mounted in sequence in a system or circuit means. The circuit means is adopted during one phase of operation to withdraw liquid media contained in separate receptacles in communicating with the circuit means and in another phase of operation, to discharge all of the liquid media withdrawn from the separate receptacles into a single vessel. The amount of liquid drawn to the system or circuit means can be readily and conveniently varied depending upon the liquid medium utilized and the result sought.

With the latter end in view, the invention is further characterized in that means are provided for independently regulating the means which control the amount of liquid medium to be drawn into the system or circuit means from the container in which a particular medium is contained.

Thus, an object of the present invention is to provide a device which permits the ready and facile transfer of predetermined quantities of different liquid media contained in separate vessels into a single vessel. These and other objects will be apparent from the following drawings.

FIG. 1 is a diagram of apparatus according to the invention.

FIG. 2 is a partial rear view of the apparatus.

FIG. 3 is a view in vertical section of the apparatus according to the invention.

FIG. 4 is a plan view of a cam.

FIG. 5 is a view in section on the line 5—5 of FIG. 4.

FIG. 6 is a diagram of part of the apparatus.

FIG. 7 is a perspective view of a component of the apparatus.

FIG. 8 is a front elevation of the apparatus according to the invention; and

FIG. 9 is a diagram of the operation sequence of the apparatus.

The device as shown in FIG. 1 comprises a block 10 advantageously formed from a transparent plastic. Block 10 is provided with two cylindrical bores 11 and 12. In the embodiment shown, the longitudinal axis of bores 11 and 12 are parallel and of the same length, while the transverse axis of each of bore 11 and bore 12 are different. It is, of course, to be understood that the dimensions of bores 11 and 12 can be varied.

Disposed slidably in bores 11 and 12 are plungers or cylinders 13 and 14 respectively which comprises a first and second pump means. Each plunger 13 and 14 is closely fitted in bores 11 and 12. Preferably a gap of the order of a millimeter exists between the pistons, and the walls (e.g. wall 15), in block 10 which define bores 11 and 12. While this value is preferred, it is not to be deemed limitative. A seal, advantageously, a removable sealing ring 17 provides sealing tightness when the plunger 13 is disposed in the bore 11 in accordance with conventional practice.

Chamber 21 of the first pump means is provided by the space in bore 11 not occupied by the piston 13. Chamber 21 is in communication with chamber 24. Chamber 24 is provided by the space in bore 12 left vacant by piston 14. Communication between chambers 21 and 24 is provided by a conduit 22 extending from the top part 23 of chamber 21 to an orifice 27 formed in the bottom part of the wall defining bore 12. Piston 14 has disposed about the lower portion thereof a sealing means 26 which may be a removable ring similar to removable ring 17.

Conduit 22 which may be any suitable hollow flexible tube means includes a flexible portion 27 which is capable of being deformed or crimped whereby the opening in the conduit 22 may be closed.

A crimping or pressing means 44 is provided for closing conduit 22. Means 44 comprises a block portion 84 formed with an internal open portion 85. Crimping or pressing means 44 is received in an opening in block 10 for vertical sliding movement. Movement of means 44 in a vertical direction is controlled by means of a stud 80 which is received in a longitudinal slot 81 in means 44. Stud 80 is secured to with block 10.

At its upper end, crimping means 44 is provided with a triangular portion 28; the rounded apex of which extends downwardly into the open portion of the means 44. A second triangular-shaped portion 41′ is also provided. The rounded apex of portion 41′ extends upwardly into the said open portion of means 44. Disposed between the apexes of portions 28 and 41′ is a rigid member 83. The upper and lower faces of rigid member 83 has formed thereon two dish-shaped members 29 and 31. The dish-shaped members face in opposite directions.

Flexible portion 27 is positioned in the open portion of crimping means 44 between members 28 and 29.

A second deformable conduit 32 is positioned in crimping means 44 between portions 31 and 41′. Conduit 32 (FIG. 1) is securely received in an opening on the bottom part 34 of the wall which defines bore 10. The other end of conduit 32 comprises a hollow needle 35 for withdrawing a liquid diluent, e.g. a specimen sample in solution form, from a vessel 36.

An additional conduit 38 extends from the top of bore 12. Conduit 38 comprises any suitable tube means for a major part of its length. At its free end, conduit 38 comprises a hollow needle means 39 and the conduit 38 is movable advantageously so that needle 39 can occupy either of the two positions 39_1 or 39_2 whereby it can be received in either a first vessel 40 or

a second vessel 41 depending upon the phase of operation of the device.

The movement of members 28 and 41' in order to effect closure of the conduits 22 or 32 is effected by a cam 42 (FIGS. 4 and 5) in cooperation with a roller means 43 which is rotably secured to rod 82. Rod 82 comprises a part of means 44 and is fixedly secured to member 84. Surrounding rod 82 is a biasing means 30. Biasing means 30 biases means 44 in a downward vertical direction.

Cam 42 comprises a part of a disc 51 (FIGS. 4–6) in which a stud 54 is mounted. Thus, the cam disc 51 has integral therewith at its upper end, the cam 42 and the stud 54. On stud 54, is a roller 54' (FIGS. 3 and 6). Roller 54' is disposed in a horizontal slot in a member 55 secured to a sleeve 45. Sleeve 45 is slidably positioned on a vertical shaft 46 secured to the apparatus frame 47. A plate member 56 is integrally connected to sleeve 45. Plate member 56 is adopted to move sleeve 45 along its vertical axis.

Plate member 56 has formed therein two indentations 57 and 58, which have arcuately shaped bottoms 59 and 59'. Rods 60 and 61 as seen in FIG. 8 are fixedly secured, respectively, to piston means 13 and 14. Rods 60 and 61 are slidably disposed in the indentations 57 and 58 on plate means 56. Rods 60 and 61 are respectively provided with shoulders 62 and 63 which bear upon the top surface 64 of plate member 56 in one position of operation.

On rod 60, a stop 67 comprising a pointer means 68 is slidably disposed. Also on rod 61, a similar stop 70 provided with a pointer means 71 is disposed. Each pointer 68 and 71 is associated with an indicia or scale means. As should be apparent from the drawings, stops 67 and 70 may include bands about rods 60 and 61 which bands when loosened by the knurled knob shown in FIG. 3 can be moved upwardly or downwardly on rods 60 and 61. When a desired position is reached as indicated on the scale or indicia means, the band is tightened about rods 60 and 61. Then relative sliding movement between respectively rods 60 and 61 and stops 67 and 70 is precluded. Of course, it should be apparent other arrangements can also be employed in lieu of the aforementioned bands.

The apparatus additionally comprises an electric motor M, the shaft of which forms the input of a coupling and breaking device and also comprises means which via an electric signal provided by a programmer or any logic device actuates the coupling and breaking device under the influence of a current impulse. Actuation of motor means M initiates rotation of disc 51 in accordance with conventional practice. Means are provided for stopping the device, which means are controlled by the programmer or logic device.

A button 81 can be used for switching over from automatic operation to manual operation, in which the starting and stopping are under manual control.

A switch 82 (FIG. 3) is provided to initiate operation of the apparatus when its moving parts are in a predetermined position in accordance with conventional procedures.

The operation of the device is as follows. The hydraulic circuit assembly including the pump chambers is first filled with liquid, e.g. a physiological solution, eg. sterile water and the like. When an electrical impulse is received from the programmer, member 56 which initially is in the uppermost position thereof is driven downwardly in a vertical direction by means of roller 54'. Roller 54' which is fixedly secured to disc 51 moves as a consequence of disc 51 being rotated under the influence of the shaft of the motor means M. The movement of member 56 in a vertical direction is controlled by the sliding movement of sleeve 45 on shaft 46. During this phase of operation, cam 42 on disc 51 moves out of engagement with roller 43. Pressing or crimping means 44 is then biased downwardly under the influence of the spring means 30. The apex portion of member 28 in cooperation with member 29 presses upon or squeezes member 27. The conduit 22 of which flexible member 27 forms a part is then closed. Thus, the pump chamber 24 is no longer in communication via conduit 22 with chamber 21. However, conduit 32 is not closed as it is not forced into closed position by the cooperation of portions 31 and 41'.

When plate member 56 meets the stop means secured to rod 61, piston 14 is driven downwardly. As a consequence of this downward movement, a vacuum is created in chamber 24 which progressively increases and liquid is sucked from vessel 40 through conduit 38 into chamber 24. During this stage, chamber 24 is isolated from chamber 21 due to the fact that flexible tube 27 is crimped. Thus, liquid cannot pass through conduit 22. By proceeding accordingly, it is assured that the quantity of liquid drawn into chamber 24 is dependent precisely on the distance of travel of piston 14. As plate member 56 moves downwardly after engagement with the stop 70 on piston rod 61, it comes into engagement with stop 67 secured to piston rod 60. During this stage, chamber 21 is in communication with vessel 36 via conduit 32. When plate 56 engages stop 67, the piston means 13 is moved downwardly while piston means 14 moves concurrently therewith and liquid from receptacle 36 is drawn into the chamber 21.

By adjusting the stops to appropriate gradiations on the indicia means, the amount of movement of pistons 13 and 14 and hence the amount of liquid taken into each chamber, can be controlled. The importance of this should be readily apparent to one skilled in the diagnostic art, because when doing analysis for diagnostically significant indications, for example, it is often desirable that a certain aliquot of specimen sample should be combined with a certain aliquot of reagent medium in order to assure that diagnostically significant indications be observed.

After the cam 51 has rotated through a predetermined angle, the rotation of cam 51 is stopped. The stopping is such that the amount of liquid drawn into the chambers is the amount indicated on the indicia or scale means by the pointer before operation.

The next stage of the operation of the device which is initiated by a signal from the programmer causes roatation of disc 51 which in turn brings cam 42 into engagement with roller means 43. Pressing means 44 moves upwardly. Thus, the apex of portion 41' moves upwardly in cooperation with member 31 causes conduit 32 to close. Concurrently, member 28 which bore upon the flexible portion 27 moves upwardly and pressure on tube 27 is released. Thus, conduit 22 is opened. Concurrently, member 56 is driven in an upward direction under the influence of roller 54' and disc 51. As plate member 56 moves in a vertical direction upwardly, it first engages shoulder 63 and then shoulder 62 formed integral respectively with pistons 14 and 13. Thereafter, the pistons rise simultaneously and since

the orifice in conduit 32 is closed, all of the liquid contained in the chambers 21 and 24 is forced via conduits 22 and 38 into receptacle 41 which has now taken the place of vessel 40. The liquid medium withdrawn from vessel 40 during the first stage is first transferred into vessel 41. Its entry into vessel 41 is followed by a predetermined amount of liquid medium equal to the quantity withdrawn from vessel 36 during the first stage. Accordingly, the liquid medium in vessel 41 comprises both the liquid which has been withdrawn from vessel 40 and from vessel 36, e.g. centrifuged total blood, some globuals of which are withdrawn for dilution with physiological serum in a proportion defined by the positions of stops 70 and 67. Liquid flows in both chambers during the suction and delivery stages.

The link cooperating with roller 54' insures that the conduits which include pipes 27 and 32 are moved into engagement with portions 28 and 41' only when the pistons are stationery. The device which closes tubes 27 and 32 by squeezing or crimping them, using the spring 30, enables the pipes or conduits to operate repeatedly without damage. The tubes comprising the conduit may be formed of any elastomeric material suitable for the purposes of the present invention. The bottom part of FIG. 9 shows valves V_1 and V_2 when open and closed respectively. The diagram 74 at the top part of FIG. 9 shows how valve operation is controlled. Positions 75 and 76 corresponding to the bottom and top dead center positions respectively of roller 54'. The angle between positions 75 and 76 correspond to the movement of roller 54'.

Each operating cycle is initiated by a signal from the programmer which may be any suitable logic device. In order to wash the device, knob 81 is set to manual operation resulting in the continuance sequence of operating cycles in which valves V_1 and V_2 successfully take up the position shown in the bottom of FIG. 9. The apparatus operates without damage even in the absence of liquid. The volume of either pump may be modified by replacing the pistons and the corresponding ring seals.

We claim:

1. An apparatus for transferring quantities of different liquid media contained in separate liquid receiving vessels into a single vessel which comprises a conduit system having open ends, two piston pump means, each including a plunger portion and a pump casing in which the plunger portion is slidably received, disposed sequentially in the conduit system between the open ends, a first conduit portion of said conduit system connecting said pump means, a first valve means in the conduit system between the said two pump means for opening and closing the first conduit portion, a second conduit portion in the conduit system being secured to one of said pump means, said second conduit portion including one of said open ends of the conduit system, a third conduit portion in the conduit system secured to the other of said pumps, said third conduit portion including the other of said open ends of the conduit system, second valve means in the conduit system positioned in the conduit system between one of said pump means and said one of said open ends for cooperation with the second conduit portion whereby said second valve means can effect the opening and closing of said second conduit portion and means movable by a motor means operatively connected to the piston pumps and the first and second valve means for controlling the opening and closing of the first and second conduit portions and the movement of the plunger portions of the piston pumps, a portion of said first valve means and a portion of said second valve means being integrally connected for concurrent movement in response to movement of the means movable by said motor means.

2. An apparatus as in claim 1 wherein removable seal means is positioned between each plunger portion and its associated pump casing.

3. An apparatus as in claim 2 wherein the pistons are driven via two abutments, adjustably secured thereto.

4. An apparatus as in claim 1 wherein the first and second conduit portions are formed from an elastomeric material and the opening and closing thereof by the first and second valve means, respectively, is effected by crimping the said conduit portions.

5. An apparatus according to claim 4 wherein each of the valve means comprises a stationary support member and a movable portion, each of said conduit portions being disposed between a stationary support member and a movable portion.

* * * * *