

Dec. 1, 1970

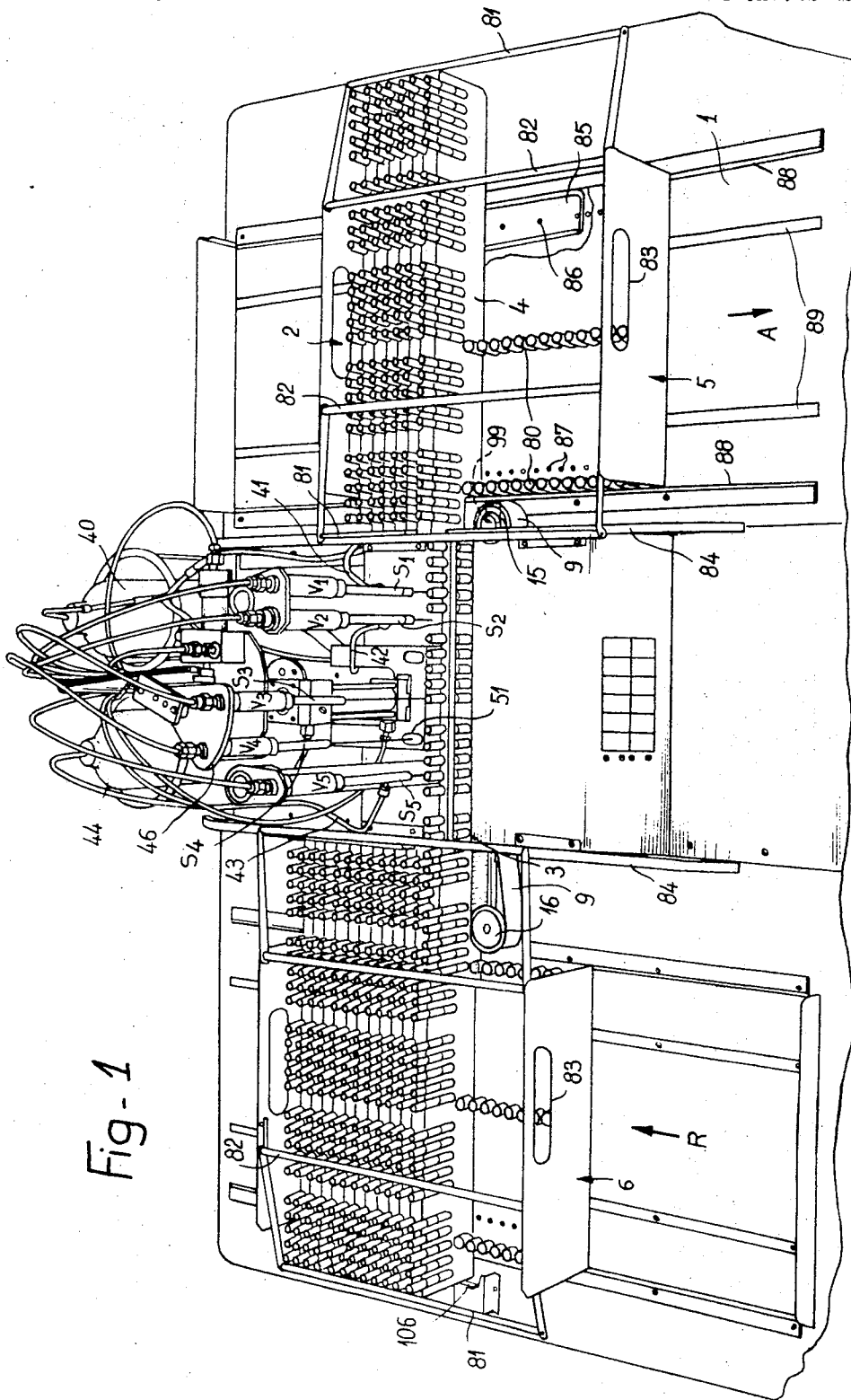
L. M. VAILLS

3,544,272

MACHINES FOR MAKING LABORATORY ANALYSES

Filed Jan. 2, 1968

4 Sheets-Sheet 1



Dec. 1, 1970

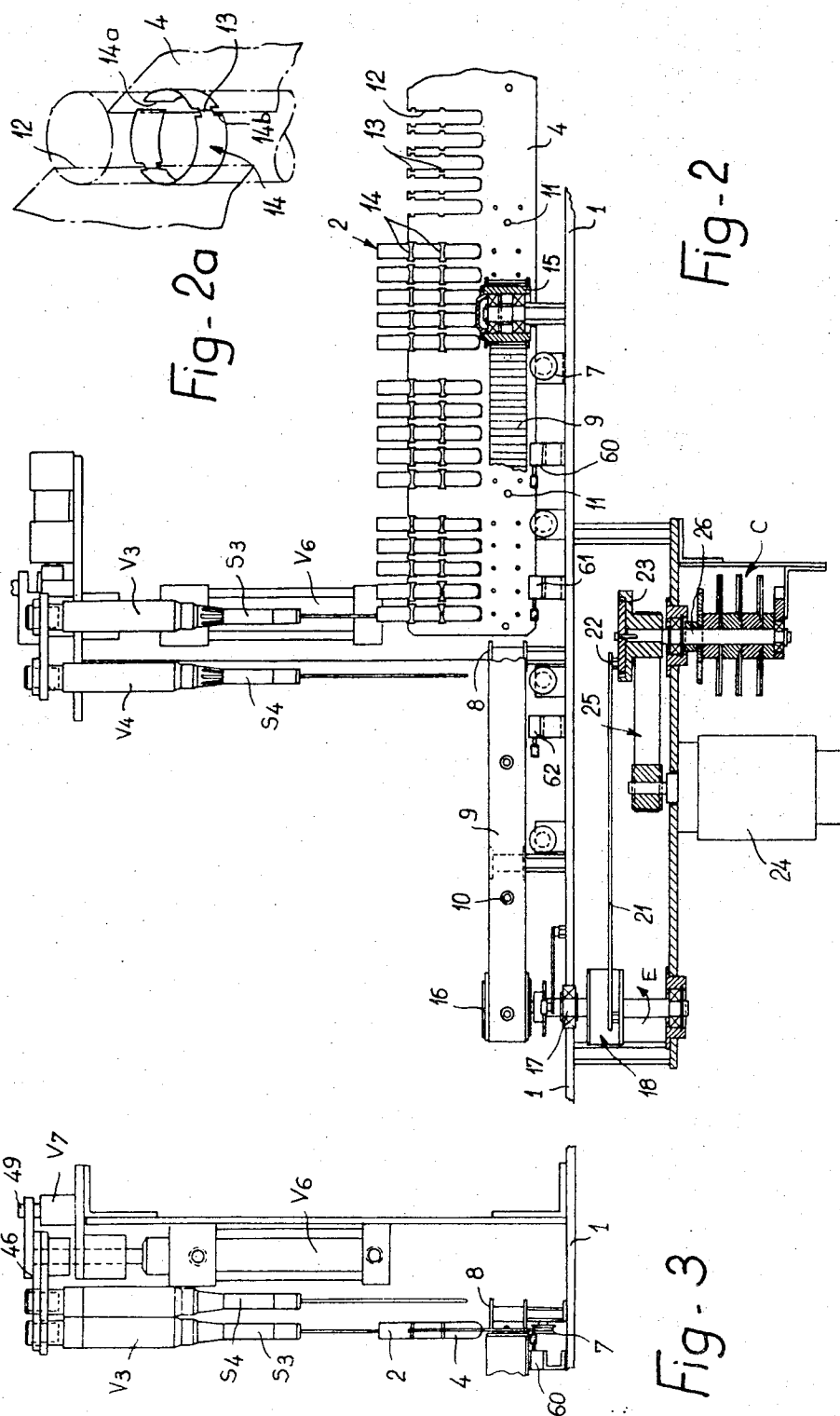
L. M. VAILLS

3,544,272

MACHINES FOR MAKING LABORATORY ANALYSES

Filed Jan. 2, 1968

4 Sheets-Sheet 2



Dec. 1, 1970

L. M. VAILLS

3,544,272

MACHINES FOR MAKING LABORATORY ANALYSES

Filed Jan. 2, 1968

4 Sheets-Sheet 3

Fig- 5

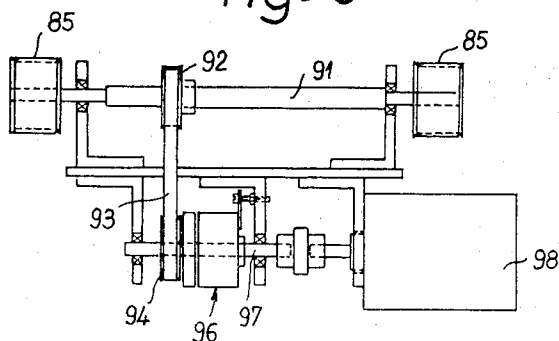


Fig- 7

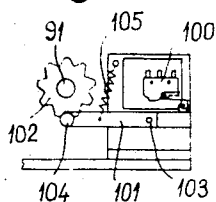


Fig- 4

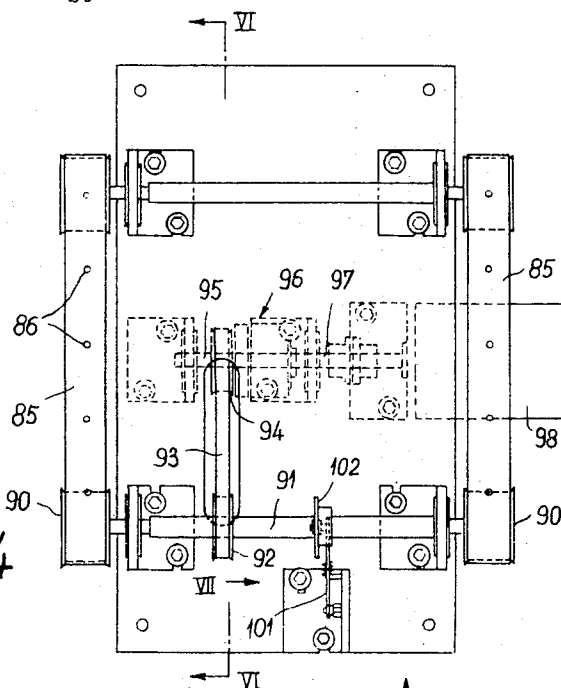
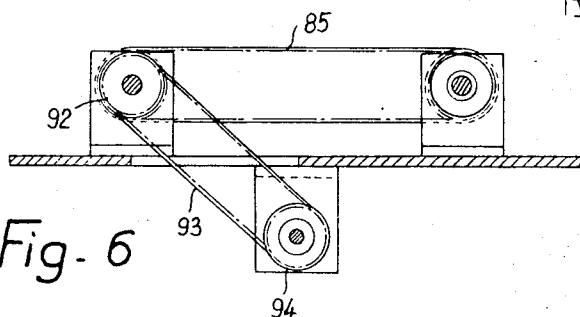


Fig- 6



Dec. 1, 1970

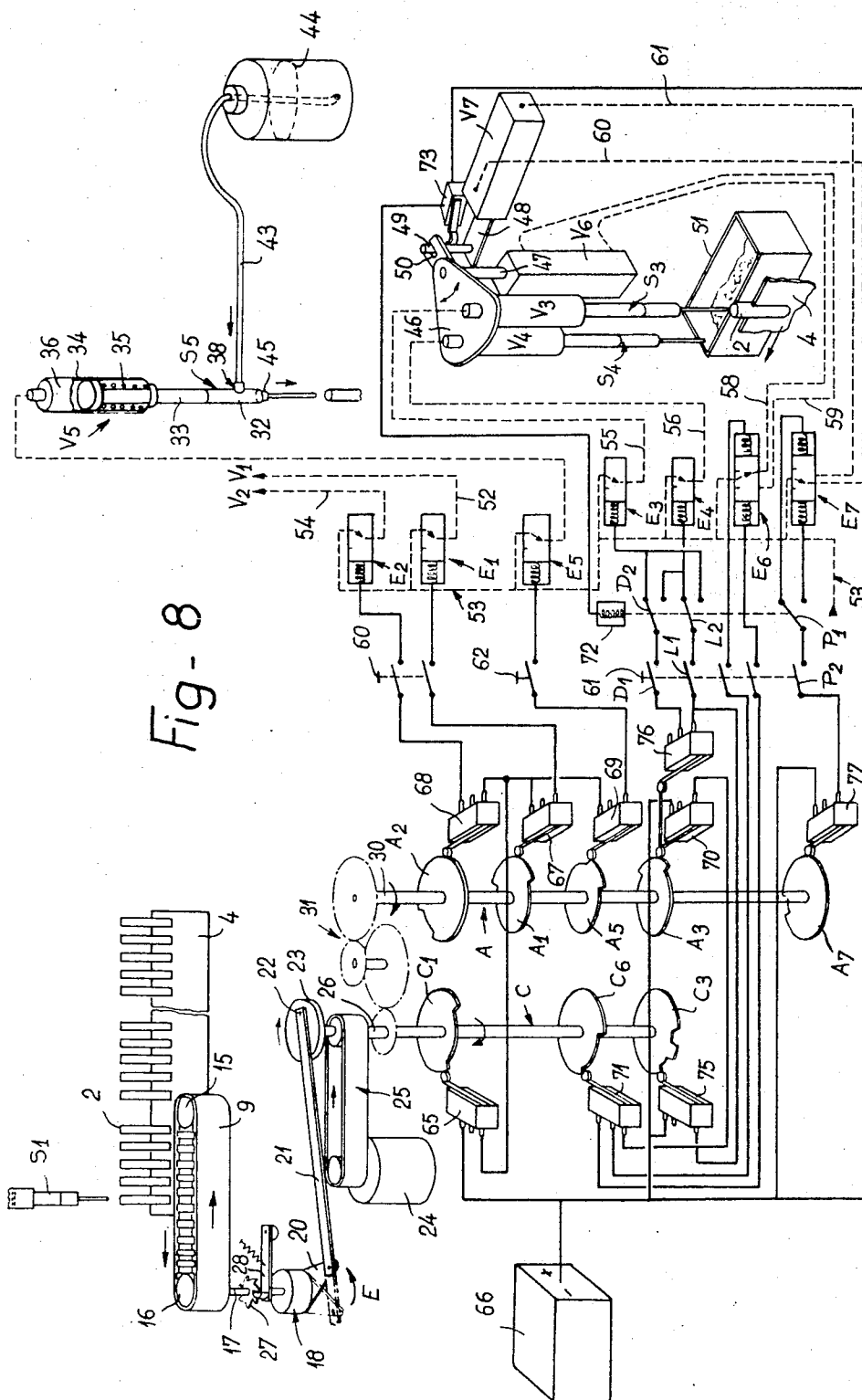
L. M. VAILLS

3,544,272

MACHINES FOR MAKING LABORATORY ANALYSES

Filed Jan. 2, 1968

4 Sheets-Sheet 4



1

3,544,272

MACHINES FOR MAKING LABORATORY ANALYSES

Laurent M. Vaills, Perpignan, France, assignor to Ministère de l'Agriculture-Servise Veterinaire, Paris, France
Filed Jan. 2, 1968, Ser. No. 695,000

Claims priority, application France, Jan. 12, 1967, 90,860

Int. Cl. G01n 1/00

U.S. Cl. 23—253

7 Claims

ABSTRACT OF THE DISCLOSURE

A machine for performing laboratory analyses involving fluids to be mixed in test tubes, characterised in that it comprises syringes for delivering said fluids, said syringes having a pneumatically-operated piston, the test tubes being disposed on supports responsive to step-by-step driving means, the length of each feed step corresponding to the relative spacing between adjacent test tubes, so that the test tubes are caused to move and stop under said syringes, the pneumatic syringe actuating means being timed with said step-by-step drive. At least two syringes have a common pivot, permitting one syringe to change fluid in a test tube while the other co-acts with its test tube and a rinsing vessel.

The present invention relates to machines for making laboratory analyses and has specific reference to an improved machine of this type, for performing laboratory analyses involving the cyclical mixing of fluids in test tubes, this machine being designed for performing this cycle automatically while increasing the performance rate in comparison with manual processes and eliminating any risk of errors.

Basically, the machine according to this invention is characterised in that it comprises fluid-delivering syringes having a pneumatically controlled piston, the test tubes being disposed on supports driven step-by-step, each feed step corresponding to the relative spacing between the test tubes so that the test tubes are caused to move and stop under the aforesaid syringes, the pneumatic means for controlling said syringes being operated in synchronism with said step-by-step driving means.

This invention is also concerned more particularly with an arrangement of the machine which is intended for carrying out successive dilutions by a series of test tubes, and characterised on this specific point in that said dilutions are effected by using at least one syringe mounted for vertical movement and a pneumatically operated piston in order to pick up and transfer the fluid from one test tube to another. Preferably and advantageously the aforesaid dilutions are carried out by using two syringes mounted on a pivoting support whereby these syringes are brought alternatively, upon each change of test tube series, the one in the dilution position and the other in a position in which it co-acts with a rinsing vessel by being immersed into said vessel while the dilution syringe is immersed into the test tubes.

Other features and advantages of this invention will appear as the following description proceeds.

A specific form of embodiment of a machine according to this invention is described hereinafter by way of example with reference to the accompanying drawing, in which:

FIG. 1 is a perspective view showing the upper portion of the machine;

FIG. 2 is a fragmentary front elevational view of the machine, showing the means for driving the test tube supports;

2

FIG. 2a shows details of the resilient test tube retaining rings;

FIG. 3 is a fragmentary side elevational view of the assembly shown in FIG. 2;

FIG. 4 is a plan view of a device for driving one of the baskets of FIG. 1 which carries the test tube supports;

FIG. 5 is an elevational view taken in the direction of the arrow V of FIG. 4;

FIG. 6 is a fragmentary view taken in the direction of the arrows VI—VI of FIG. 4;

FIG. 7 is a detail view taken in the direction of the arrow VII of FIG. 4; and

FIG. 8 is a diagrammatic view illustrating the machine driving system.

The machine illustrated in FIG. 1 comprises at its upper portion a table 1 for handling the test tubes 2; overlying this table are syringes S1 to S5 disposed above a test tube transfer path 3, the test tubes being divided in this example by groups or series of five and mounted on supporting plates 4 adapted to travel successively along said transfer path 3. These supporting plates 4 are transferred from a feed basket 5 to said transfer path 3, said basket 5 being adapted to receive a relatively great number of test tube supporting plates 4 and to bring these plates in succession to a position in which they are aligned or co-planar with the inlet of said transfer path, these plates 4 being delivered from the transfer path outlet to a similar basket 6 constituting a receiving basket.

To this end, the baskets 5 and 6, as will be explained presently, are each equipped with drive means adapted to move the relevant basket in a direction transverse to said path 3, that is, in the direction of the arrows A and R, respectively, as the plates 4 travel along said transfer path 3.

The plates are driven step by step along this path 3, as will be seen in the following description, from means so designed that each step corresponds to the relative spacing of the test tubes on the plates 4.

The transfer path 3 consists at its bottom of grooved rollers 7 adapted to be engaged by the lower edge of said plates 4, and laterally of belt rollers 8 rotatably mounted on vertical shafts, and receiving a plate-driving endless belt 9 provided to this end with studs 10 adapted to engage corresponding holes 11 disposed at spaced intervals in the plates 4. These studs 10 and holes 11 are equally spaced so that they lie at the same level or height when the corresponding supporting plate 4 is being transferred along and by the path 3.

Each plate has its upper marginal portion, which is to emerge above the path 3, formed with cutouts 12 corresponding in shape to the vertical axial section of the test tubes, the side edges of these cutouts being formed with two pairs of registering and vertically spaced notches adapted to receive test tube retaining resilient rings 14 split at 14a and notched at 14b so as to resiliently engage the cutouts 12 and lock the test tubes in the notches 13 (FIG. 2a).

The endless belt 9 is internally notched or toothed and mounted on a loosely rotating pulley 15 and on a driving pulley 16 driven intermittently by adequate means.

To this end the mechanism driving the pulley 16 comprises a unidirectional coupling device 18 mounted on the pulley shaft 17 extending downwards under the table 1, this device 18 consisting for example of a freewheel of the wedging type adapted to drive the shaft 17 in the direction of the arrow E of FIGS. 2 and 8, the driving member of this wheel being solid with a radial arm 20 connected via a link 21 to the crankpin 22 mounted on a rotary wheel 23. This wheel 23 is driven continuously from an electric motor 24 by means of a transmission belt 25, and the shaft

26 carrying said wheel 23 has keyed thereon a plurality of control cams C for a purpose to be explained presently.

From the onset it will be seen that the rotary motion of the motor 24 is thus converted into a reciprocating motion of arm 20 which, during each half-revolution of wheel 23 which causes said arm to rotate in the direction of the arrow E, drives the freewheel device 18 of the belt-driving pulley 16, the other half-revolution of wheel 23 being inoperative as far as the driving of belt 9 is concerned. To prevent any residual friction in the free-wheel device 18 from driving the belt 9 in the opposite direction a non-return device is associated with shaft 17 in the form of a ratchet wheel 27 engaged by a spring-urged pawl 28 thus positively preventing any rotation of said shaft 17 in the direction opposite to the direction shown by the arrow E and holding the belt 9 against motion during the inoperative half-revolution of wheel 23, whereby this endless belt 9 and therefore the test tube supporting plates 4 will be driven step-by-step, since the length of each operative stroke of the endless belt 9 corresponds to the relative spacing of the test tubes in a same series. At the same time the above-mentioned cams C perform one complete revolution each time the endless belt 9 is driven by one step, and another series of control cams A is carried by a shaft 30 parallel to shaft 26 and operatively connected thereto through a train of reducing gears 31 such that the shaft 30 will complete a revolution each time five test tubes have been fed, taking due account of the fact that the successive test tube series are separated by two steps. In the above-described example the analysis process comprises both the delivery of fluids into the test tubes and the successive dilutions thereof, the first function being effected by the syringes S1, S2 and S5 mounted in fixed positions vertically above the test tube stopping positions, the other function being performed by the syringes S3 and S4 of which the specific mounting will be explained presently.

Each fixed syringe S1, S2 and S5 comprises a syringe body 32 in which a piston 33 is slidably mounted, as usual, this piston however having the additional function of the piston of a pneumatic actuator in a cylinder 34 formed integrally with the syringe body, the corresponding actuators being designated by the reference symbols V1, V2 and V5.

Each actuator aforesaid is of the single-acting type in that it comprises a spring 35 normally urging the piston 33 to its suction position, and a control chamber 36 connected through duct means to a compressed-air distributing electromagnetic valve. Moreover, each syringe body is connected via a suction valve 38 and a feed pipe to a fluid reservoir; thus, syringe S1 is connected through pipe 40 to a bottle 40, like syringe S2 (through pipe 42), and syringe S5 is connected via a pipe 43 to another bottle 44. Each syringe body further comprises a delivery valve 45 incorporated in the union receiving the needle thereof.

The syringes S3 and S4 like the above-described syringes are associated with single-acting piston-cylinder actuators designated by the reference symbols V3 and V4 but, furthermore, these actuators are mounted on a support 46 to which the following motions can be applied:

On the one hand, a vertical reciprocating motion produced by a double-acting pneumatic actuator V6, the support 46 being connected to the piston-rod 47 of this actuator;

On the other hand, a pivotal motion about the rod 47 produced by another double-acting pneumatic actuator V7 of which the piston-rod 48 carries a pin 49 engaging an elongated hole formed in a lug rigid with said support 46.

The purpose of this two-syringe combination S3, S4 is to permit an alternative operation of these syringes, such that one syringe located vertically above the path 3 will be used to make the successive dilutions between the test-tubes of a same series by picking up and transferring fluid from one test tube to another (as a consequence of the vertical movement and of the operation of the correspond-

ing syringe), while the other syringe is caused to dip into a washing vessel 51 for undergoing an internal rinsing operation, whereby the permutation of syringes S3 and S4 takes place each time a fresh series of test tubes is substituted for the preceding one, as a consequence of the pivotal movement of the common support 46 of these syringes.

The pneumatic actuator V1 is connected via a pipe line 52 to a single-acting electromagnetic valve E₁ supplied with compressed air from a main line 53 connected to the source (not shown) and to the other electromagnetic valves to be mentioned presently.

Actuator V2 is connected through a pipe line 54 to a single-acting electromagnetic valve E₂.

Actuator V3 is connected via a pipe line 55 to a single-acting electromagnetic valve E₃.

Actuator V4 is connected via a pipe line 56 to a single-acting electromagnetic valve E₄.

Actuator V5 is connected via a pipe line 57 to a single-acting electromagnetic valve E₅.

Actuator V6 is connected via a pair of pipe lines 58 and 59 to a double-acting electromagnetic valve E₆.

Actuator V7 is connected via a pair of pipe lines 60 and 61 to a double-acting electromagnetic valve E₇.

The function of cams C and A consists in controlling electric contacts for energizing the aforesaid electromagnetic valves and therefore the syringes associated therewith as a function of the feed movement of the test tube supporting plate 4 along the path 3 and also of the mixing and dilution program common to all the series of test tubes to be processed in the machine.

From the onset it will be noted that the timing between the cam controlling the cycle of operation of the syringes and the test tube supporting plates 4 is of positive nature since the internally notched belt 9 angularly connected to the cams will drive the plates 4 only as a consequence of the engagement of said studs 10 into the holes formed in these plates, by reason of one per test tube series; in other words, there is a constant, predetermined relationship between the cam positions and the test tube positions on path 3.

Moreover, although only one series of cams performing one complete revolution each time a test tube series is fed could be provided, such as series A, the drawings illustrate an exemplary form of embodiment comprising two series of cams which is preferred for producing a more positive actuation of the electric contacts controlling the energization of the electromagnetic valves; otherwise stated, as the cams A perform one complete revolution per test tube series, every six steps, their only function during the cycle is to validate the pulses controlling said electromagnetic valves which are delivered by the other cams C making a complete revolution at each step.

The analysis process governing the cycle of operation of this machine, in the example illustrated and described herein, corresponds to Wright's veterinarian serodiagnosis applied to cows, 0.2 cubic centimeter of serum to be analysed being placed, manually, for each cow in the first test-tube of each series.

In this case the various syringes have the following specific functions:

Syringe S₁: introducing 0.5 cc. of physiological serum into the last four test tubes of each series.

Syringe S₂: introducing 0.8 cc. of physiological serum into the first test tube.

Either of the alternately used syringes S₃ and S₄: picking up 0.5 cc. of serum from the first test tube and transfer it into the second test tube;

Picking up from said second test tube 0.5 cc. of the dilution just created therein, and subsequently transfer same into the third test tube; and so forth from the third test tube into the fourth one, and from the fourth one into the fifth one. In other words, there will remain 0.5 cc. in each one of the five test tubes after their

passage under the dilution syringe, the serum to be analysed being gradually and increasingly diluted, the dilution syringe completing its cycle with 0.5 cc. of the last dilution which are eliminated in the washing vessel 51, after the syringes S_3 and S_4 have been exchanged for making the dilutions in the next test tube series (on the contrary the syringe being rinsed must be emptied into the washing vessel before exchanging the syringes, thus introducing a differentiation in their control as will be explained presently).

Syringe S_5 : introducing 0.5 cc. of antigen into each test tubes.

The arrangement of cams C and A and of the electric contacts inserted in the circuits of the aforesaid electromagnetic valves is illustrated in FIG. 8 and will be described presently in conjunction with the operation of the machine in order to simplify the disclosure.

It will be seen, beforehand, that various electric contacts signalling the presence of the test tube supporting plates 4 engaged in the transfer path 3 are provided, these contacts being adapted to co-act with the lower edge of said plates 4, and comprising a presence contact 60 disposed beneath and between the syringes S_1 and S_2 , another presence contact 61 located beneath the dilution syringe S_3 or S_4 , and a third presence contact 62 underlying the syringe S_5 . The operation of this machine, from the time a test tube supporting plate 4 is engaged in the path 3 of which the belt 9 is started by energizing the motor 24, takes place as follows:

Assuming that the timing of cams C and of the supporting plate 4 engaged in the path 3 is set as explained hereinabove by engaging the studs 10 into holes 11, the supporting plate 4 will close a presence contact 60 when the first series of test tubes is positioned under the syringes S_1 and S_2 .

From the syringe arrangement illustrated in FIG. 1 it will be seen that the first actuator to be operated is actuator V_1 and therefore its electromagnetic valve E_1 so that this syringe S_1 will deliver 0.5 cc. of physiological serum into the second test tube. This desired result is obtained by virtue of cams C_1 and A_1 , and it will be seen that cam C_1 is adapted to close an electric contact 65 having its input connected to one terminal of a suitable source of current 66 and its output connected to the input of three electric contacts 67, 68 and 69. The other terminal of said source of current is connected to the electromagnetic valves and to a relay 72.

Contact 67 responsive to cam A_1 has its output connected to electromagnetic valve E_1 via contact 60.

Thus, in the specific case of syringe S_1 , the presence contact 60 being closed, cam A_1 will enable the control of electromagnetic valve E_1 during the four steps out of six of the cycle which corresponds to the passage of the last four test tubes of each series under the syringe S_1 , and cam C_1 making one revolution per step will deliver each time the positive pulse for controlling the actual operation of this electromagnetic valve E_1 through one fraction of the half-revolution of this cam which corresponds to the short pause observed by the test tubes at each step.

In the case of syringe S_2 , actuated thereafter, as the presence contact 60 is closed, it is cam A_2 that will enable the control of electromagnetic valve E_2 during the desired step fraction which is the fraction corresponding to the pause of the first test tube of each series under the corresponding syringe S_2 , and it is still cam C_1 that will deliver the positive pulse for controlling the actual operation of electromagnetic valve E_2 .

In the case of syringe S_5 disposed near the outlet of transfer path 3, it is necessary firstly that the test tube supporting plate 4 actuates the presence contact 62 to permit the operation of electromagnetic valve E_5 via contacts 65 and 69. The control of electromagnetic valve E_5 is enabled by cam A_5 during the five steps of the cycle corresponding to the

passage of the five test tubes of each series under the syringe, and it is cam C_1 that delivers at each step the positive pulse for controlling this electromagnetic valve (considering the positions of the syringes and test tubes shown in FIG. 2 it will be noted that cam A_5 must be shaped to enable the control of said electromagnetic valve one step before the validation pulse delivered by cam A_1).

Syringes S_3 and S_4 operated by actuators V_3 , V_4 , V_6 and V_7 comprise specific circuits for controlling the electromagnetic valve E_6 of the actuator for the up- and downward movements of syringes V_6 , the electromagnetic valves E_3 and E_4 of pumping cylinders V_3 , V_4 and the electromagnetic valve E_7 controlling the syringe exchange actuator.

The syringes S_3 and S_4 must perform five times the descending and ascending strokes at each cycle, since the dilution syringe must operate in all the test tubes. Therefore the control circuit of electromagnetic valve E_6 is responsive to a cam A_3 co-acting with a contact 70 for validation during five steps of the cycle, this contact 70 being connected on the one hand to the source of current and on the other hand to the input terminal of a contact 71 controlling the descending and ascending movements.

This contact 71 has two output terminals connected respectively to the two solenoids of the double-acting electromagnetic valve E_6 , the alternate energization of one or the other of these two output terminals depending on the engagement of the control arm of this contact with a cam C_6 performing a complete revolution during each step and delivering through this contact a down-stroke control pulse slightly inferior to the half-revolution corresponding to the stoppage of the test tubes, the remaining fraction of the revolution corresponding to an up-stroke control pulse.

Of course, this circuit is operative, i.e. a down-stroke can take place, only if the two corresponding blades of the presence contact 61 are in their closed position.

The electromagnetic valves E_3 and E_4 controlling the pumping cylinders V_3 and V_4 must be controlled differently accordingly as the corresponding syringe is operated for diluting or washing. In fact, the dilution syringe is raised, at the end of the cycle of a series, with 0.5 cc. of the last effective dilution which, for the sake of convenience, will be rejected into the washing vessel 51 in which continuous water flushing is maintained, but only after the syringe permutation, while the washing syringe proper contains at the end of the cycle 0.5 cc. of rinsing water which must be discharged into the vessel before exchanging the syringes for the next series.

As a result the washing syringe will be actuated as a pump six times per cycle, by effecting the syringe permutation during the feed corresponding to the first step of the cycle of each test tube series, whereas the dilution syringe will be actuated as a pump only five times per cycle. This difference in the control of electromagnetic valves E_3 and E_4 is obtained firstly with the assistance of a relay 72 comprising two control reversing blades inserted in the energizing circuit of these electromagnetic valves, the energization of the relay being controlled by a contact 73 responsive to the syringe positions, and actuated for example by the control arm 49 when the syringe S_3 is in its dilution position (see FIG. 8).

A cam C_3 driven through one revolution during each step is provided for delivering pumping control pulses in conjunction with an electric contact 75, and it will be seen that in this arrangement two pulses per cam revolution are delivered in order to double the pumping action (and thus improve the dilution and rinsing effects), these pulses being produced during the half-revolution of the cam which corresponds to the pause in the test tube step-by-step movement. These pulses issuing from contact 75 are fed directly via blade L_1 of contact 61 and blade L_2 of relay 72 to the electromagnetic valve E_3 or E_4 , according as the syringe being washed is S_3 or S_4 , so that the wash pumping takes place six times per cycle as mentioned hereinabove.

7

Since the dilution syringe must be actuated only five times per cycle as already explained, the pumping pulses produced by cam C₃ and transmitted from contact 75 are also applied to this end to a contact 76 mechanically connected to said contact 70 and actuated by cam A₃ enabling these pulses to be effective during only five steps of the cycle, as already explained. These validated pulses are then fed to electromagnetic valve E₃ or E₄, according as the syringe performing the dilution is S₃ or S₄, via blade D₁ of presence contact 61 and blade D₂ of relay 72.

Finally, the electromagnetic valve E₇ controlling the syringe exchange actuator V₇ is actuated in this case simply by means of an electric contact 77 responsive to a cam A₇ revolving by reason of one revolution per cycle, this cam A₇ being shaped and timed to cause said contact 77 to deliver a control pulse to the electromagnetic valve E₇ at the beginning of the feed movement of the first step of each cycle, whereby the syringe exchange is completed at the end of this first step. This pulse is delivered alternatively to one and to the other solenoids of said double-acting electromagnetic valve E₇, as a function of the position of a reversing blade P₁ or relay 72, and also via the blade P₂ of presence contact 61.

The test tube supporting plates 4 are conveniently introduced into the transfer path 3 and received at the outlet end thereof by means of feed baskets 5 and receiving baskets 6 comprising each on their bottom vertical guide rollers 80 for guiding and properly spacing the test tube supporting plates 4. These baskets are also provided with lateral rods 81 pivotally mounted on arms fulcrumed on shafts 82 and adapted to retain the supporting plates 4 on the relevant basket when the latter is being handled by means of the handles 83. In FIG. 1 it will be seen that when a basket is brought to its operative position on the machine its pivotally mounted rod 81 is raised automatically on the transfer path side by engaging a ramp 84 provided to this end on the machine.

The baskets 5 and 6 are further driven in the direction of the arrows A and R by means of respective devices illustrated in FIGS. 5, 6 and 7; each device comprises two driven endless belts 85 having their top run flush with the table surface provided to this end with a corresponding aperture, these belts being provided with driving studs 86 adapted to engage holes 87 formed in the bottom of each basket, these studs being aligned with these holes when the basket is engaged between guide members 88 secured on the machine, the weight of the basket also bearing against slide members 89 secured to the table of the machine.

These endless belts 85 are also of the internally notched type and therefore positively driven by means of toothed drive wheels 90 keyed on a shaft 91 carrying another toothed wheel 92 connected via an endless, internally notched transmission belt 93 to a toothed wheel 94 keyed on the output shaft 95 of an electromagnetic clutch designated generally by the reference numeral 96. The input shaft 97 of this clutch is constantly driven from an electric motor 98 when the machine is in operation.

In the case of the feed basket 5 the feed thereof in the direction of the arrow A may also be responsive to an end switch 99 provided at the inlet end of the transfer path 3, under the belt thereof, this switch controlling the energization of the aforesaid electromagnetic clutch 96 for feeding the basket 5, provided that no supporting plate 4 abuts thereagainst. This end switch may also be used for releasing only the basket feed, in combination with a cutout switch causing the basket to stop in successive predetermined positions, such as a switch 100 responsive to an arm 101 co-acting with a toothed cam 102 keyed to the drive shaft 91. This arm 101 is fulcrumed at 103 and carries a roller or follower 104 constantly urged against the teeth of cam 102 by a spring 105, so that this arm will control the final positioning of the basket each time the latter is fed, in addition to the operation of said switch 100.

8

A similar device is provided for driving the receiving basket, except that the stop switch controlling the basket feed is located at a position 106 on the table of the machine, in alignment with the transfer path 3, so that it is actuated by the supporting plate 4 at the end of the travel thereof in the basket (FIG. 1).

Of course, the above-described form of embodiment lends itself to many modifications and variations without departing from the spirit and scope of the invention as set forth in the appended claims.

What is claimed is:

1. A machine for performing laboratory analyses involving successive dilution to be carried out by series of test tubes, said machine comprising a plurality of syringes for making said dilutions, each one of said plurality of syringes having a pneumatically operated piston, supports for the test tubes, step-by-step driving means operatively connected to drive said supports with the stroke of each feed step corresponding to the relative spacing between adjacent test tubes so that the test tubes are caused to sequentially move and stop under said syringes, a rinsing vessel, a common pivoting support for at least two syringes mounted for vertical movement, vertical control means and pivoting control means for said common support, syringe-piston control means, all said control means being timed in response to said step-by-step drive so that one of said syringes can pick up fluid and transfer same from one test tube to another, whereas the other of said two syringes co-acts with said rinsing vessel in which it is immersed while the other syringe is immersed in the test tubes, said common pivoting support being actuated upon each substitution of one series of test tubes by another so that said syringes are alternatively brought one in the dilution position and the other in the rinsing position.

2. A machine according to claim 1 wherein the test tube supports consist of plates disposed in a vertical plane with their lower edge engaged in a transfer path formed under the syringes, said transfer path consisting on one side of an endless belt driven in a step-by-step manner, said belt being provided with driving studs adapted to engage corresponding holes formed in each plate.

3. A machine according to claim 2, wherein said step-by-step driving means comprises a toothed driving wheel co-acting with said endless belt formed with internal notches adapted to engage the wheel teeth, said wheel being operatively connected to a shaft driven through a unidirectional coupling device responsive to a reciprocating angular motion of which each cycle corresponds to one step of said shaft, a pawl-and-ratchet device mounted on said shaft for positively positioning said belt during its pauses at each step of the driving means.

4. A machine according to claim 3, wherein said unidirectional coupling device is actuated by a connecting rod and crank mechanism comprising a rotary shaft driving cam means of said syringe piston control means, said cam means controlling electric contacts in energizing circuits of electromagnetic valves controlling in turn the pneumatic actuation of said syringes, further contacts responsive to the presence of test tubes under the corresponding syringes making said circuits operative.

5. A machine according to claim 2, further comprising means for feeding test tube supporting plates to said transfer path by means of a basket guided in a transverse direction with respect to said path and carrying said supporting plates in the form of rows parallel to said path, said basket being responsive to intermittent drive means adapted to engage said plates into the inlet end of said path, these plates being received at the outlet end of the path by a similar basket also driven intermittently in timed relationship with the plate reception.

6. A machine according to claim 5, wherein said basket drive means comprises an endless belt operatively connected to a driving motor and formed with driving studs

adapted to engage corresponding holes formed in the bottom of the basket.

7. A machine according to claim 5, wherein said test tube supporting plates are formed with test tube receiving cutouts in which the test tubes are retained by means of split rings resiliently engaging notches formed in the side edges of said cutouts and being resiliently locked therein by mutual engagement of notches.

References Cited

UNITED STATES PATENTS

3,188,181 6/1965 Peterson et al. ----- 23—253 X

3,193,359	7/1965	Baruch et al. -----	23—253 X
3,269,800	8/1966	Lukrec -----	23—253 X
3,302,452	2/1967	Leslie -----	73—423
3,327,535	6/1967	Sequevia -----	23—259 X
3,350,946	11/1967	Isreeli -----	73—423

JOSEPH SCOVRONEK, Primary Examiner

U.S. Cl. X.R.

10 23—259; 73—423