

[54] BLOOD TYPING SYSTEM

[76] Inventor: John J. McMorrow, Jr., 652 W.
170th St., New York, N.Y. 10032

[22] Filed: Nov. 26, 1971

[21] Appl. No.: 202,486

[52] U.S. Cl. 23/253 R, 23/259, 211/74,
233/26

[51] Int. Cl. B011 9/00

[58] Field of Search 23/253 R, 259;
424/11; 195/127; 211/71, 74; 233/26

[56] References Cited

UNITED STATES PATENTS

2,568,677	9/1951	Adelson	211/72
2,755,018	7/1956	Grela et al.	211/74 X
3,192,968	7/1965	Baruch et al.	23/259 X
3,327,535	6/1967	Sequeira	23/259 X
3,379,315	4/1968	Broadwin	211/74 X
3,480,152	11/1969	Walsh	211/74
3,522,011	7/1970	Sanderson	23/253 R X

3,604,566	9/1971	Rem et al.	211/74
3,649,462	3/1972	Jessup	23/259 X

FOREIGN PATENTS OR APPLICATIONS

1,117,601	6/1968	Great Britain	233/26
-----------	--------	---------------------	--------

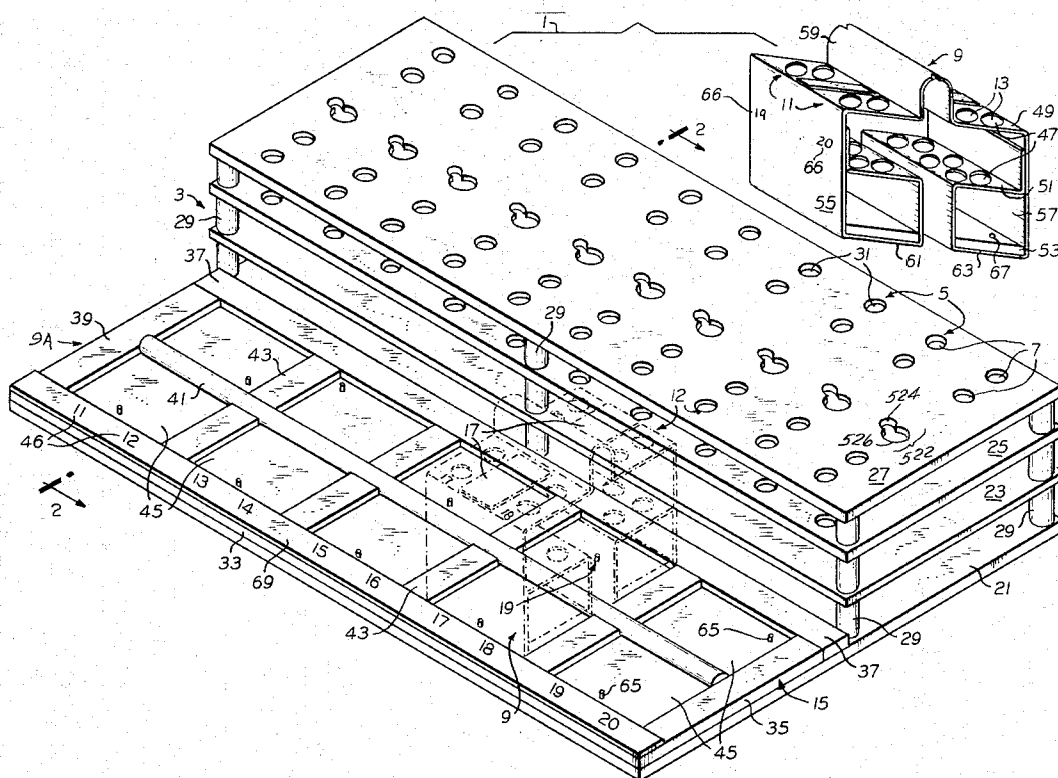
Primary Examiner—Robert M. Reese

Attorney—S. C. Yuter and Paul Fields

[57] ABSTRACT

A blood typing system comprises a first section having a plurality of lines of test tube holding means. A second section has a plurality of lines of test tube holding means, each line in said second section associated with only one line in said first section. Receiving means positively aligns each line in said second section with its associated line in said first section. Preferably said second section is a removable centrifuge carrier. Other additional means are disclosed which comprise a better blood typing system.

25 Claims, 13 Drawing Figures



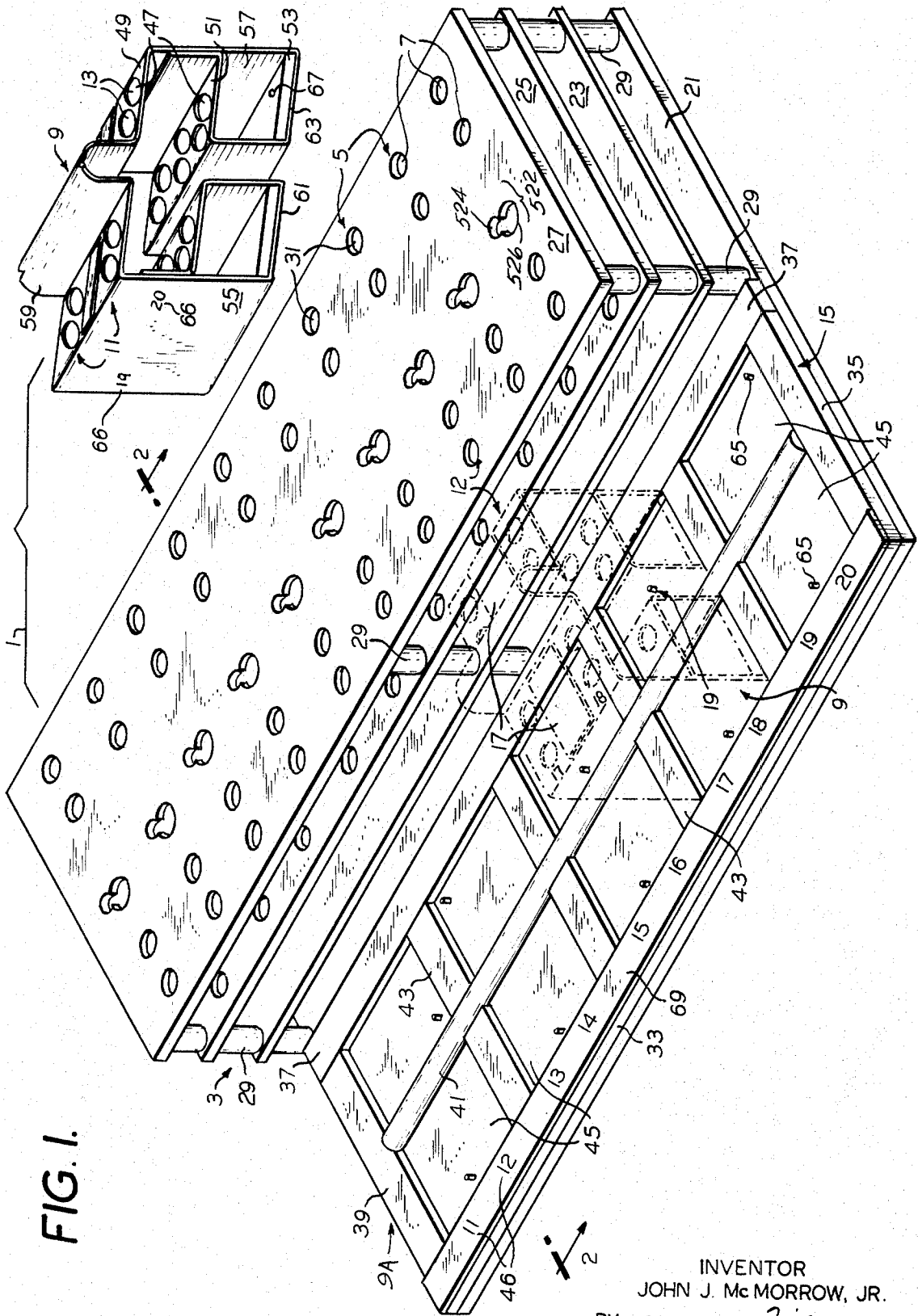


FIG. 1.

INVENTOR
JOHN J. Mc MORROW, JR.
BY *Yuter & Fields*
ATTORNEYS

FIG. 2.

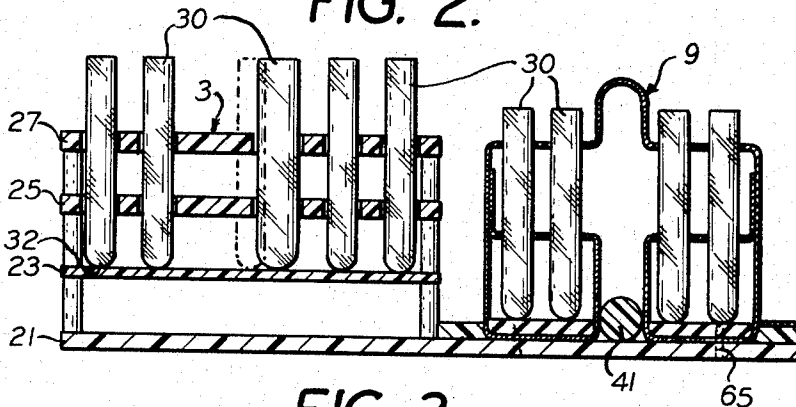


FIG. 3.

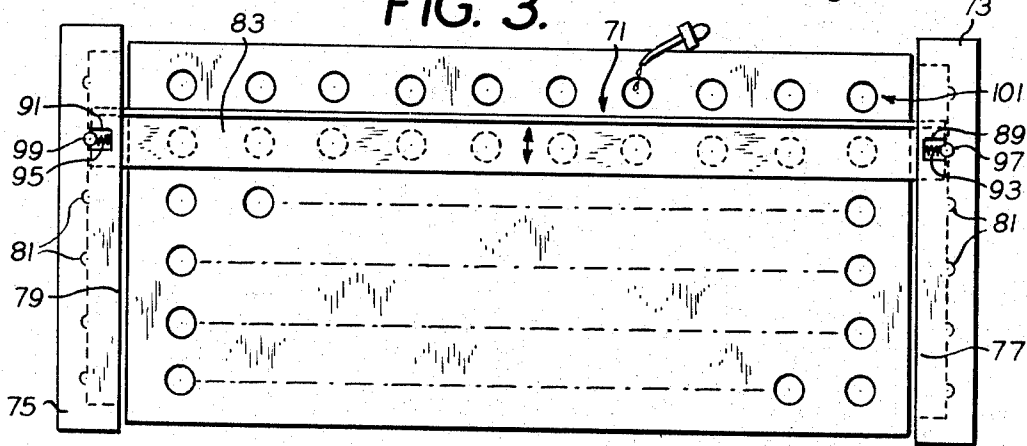


FIG. 4.

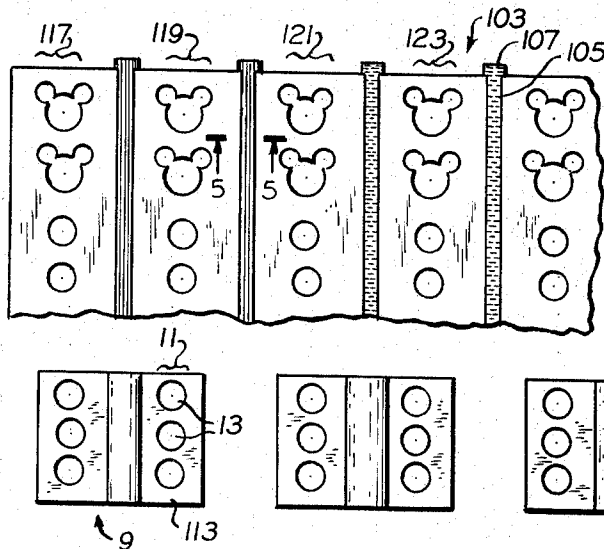
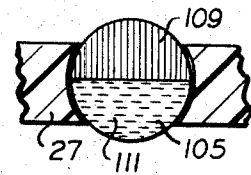


FIG. 5.



INVENTOR
JOHN J. Mc MORROW, JR.
BY *Yuter & Fields*
ATTORNEYS

FIG. 6.

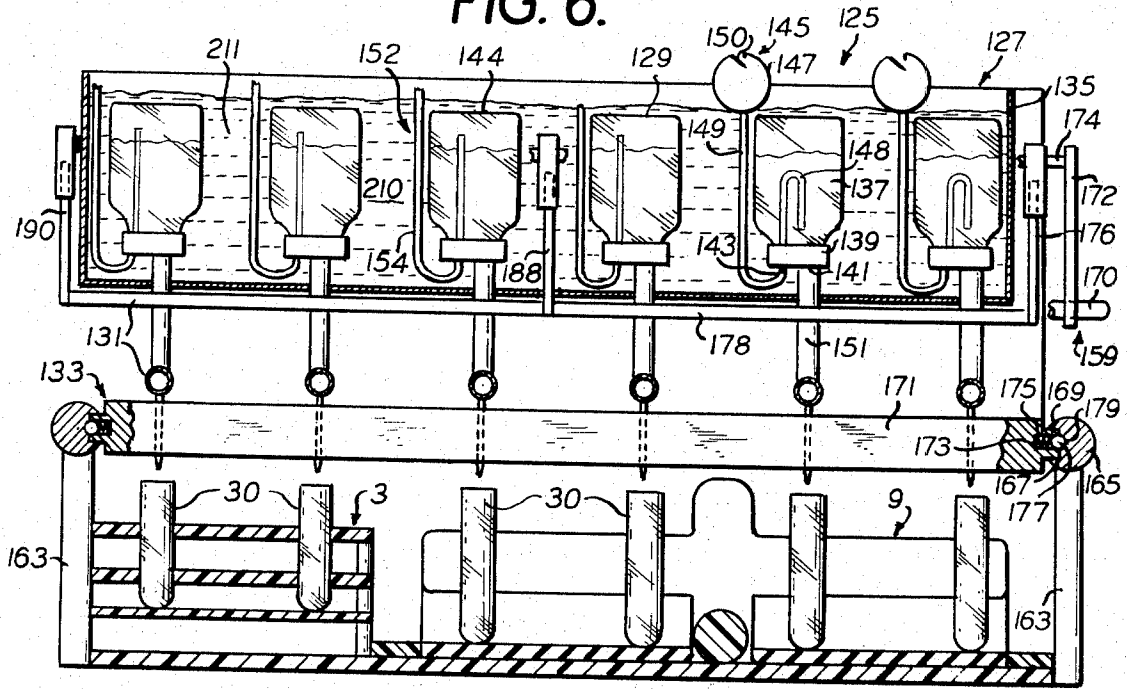
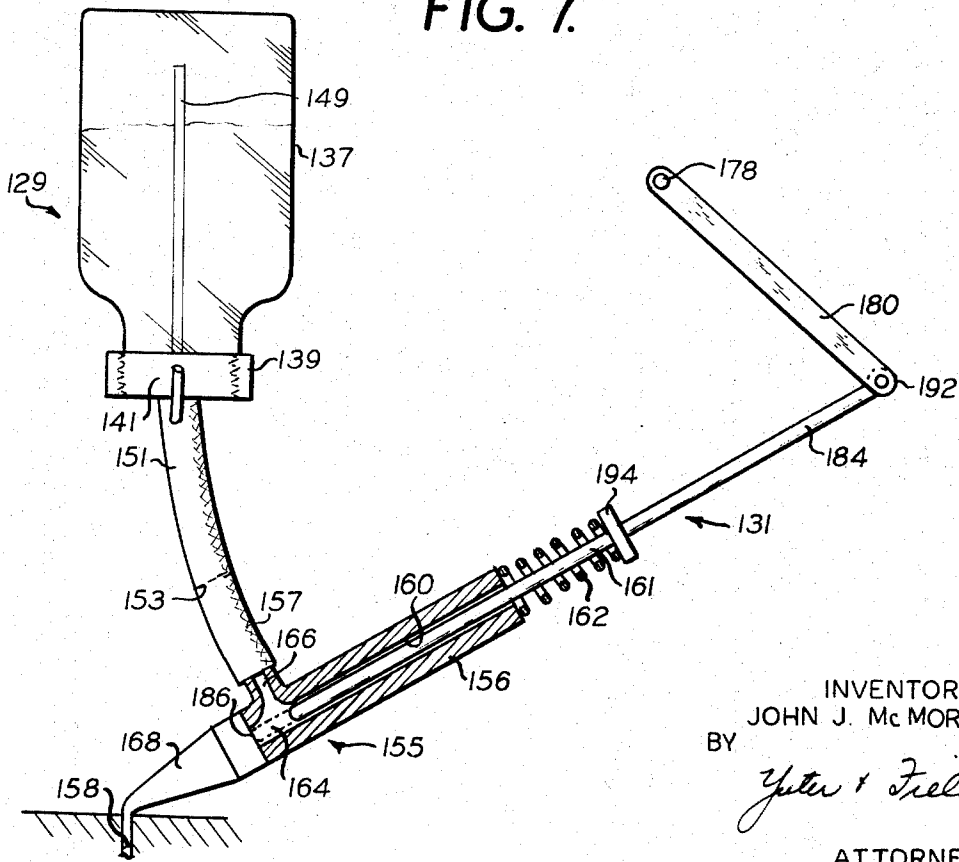


FIG. 7.



INVENTOR
JOHN J. Mc MORROW, JR.
BY

Yetter & Fields

ATTORNEYS

FIG. 8.

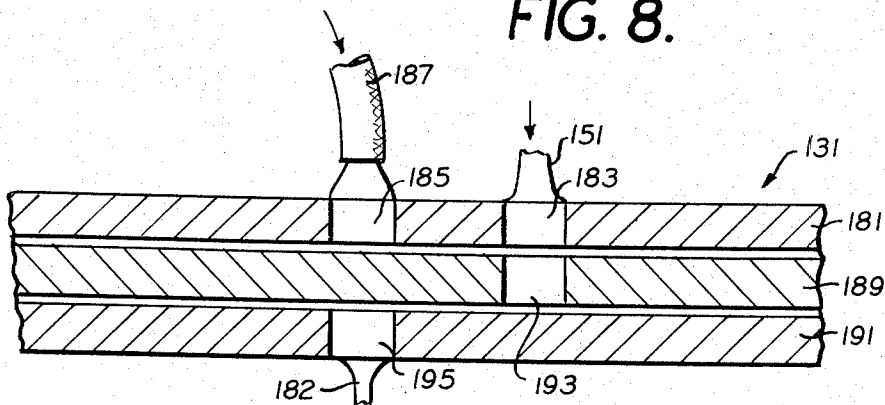


FIG. 9.

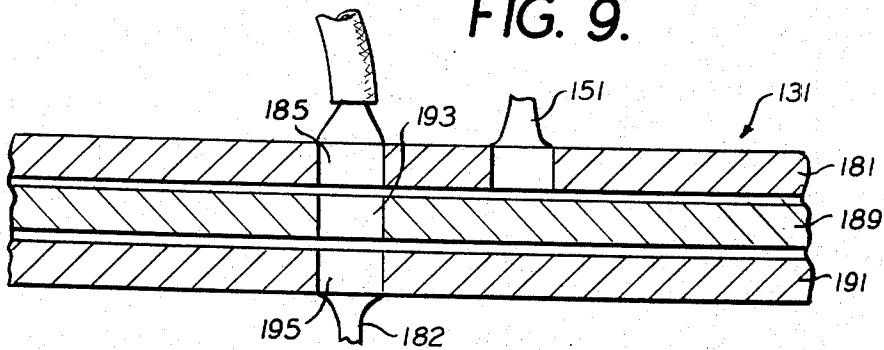
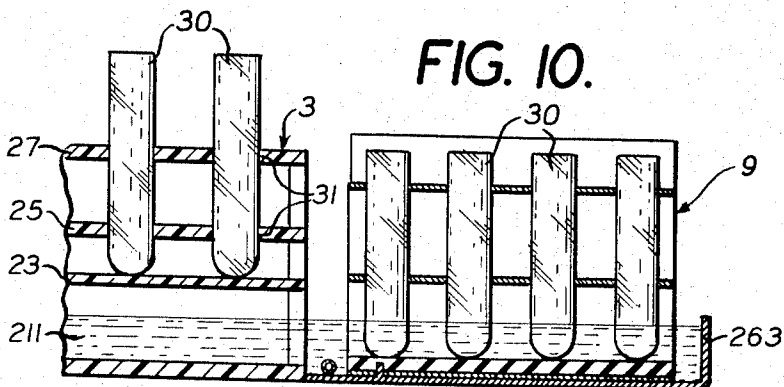
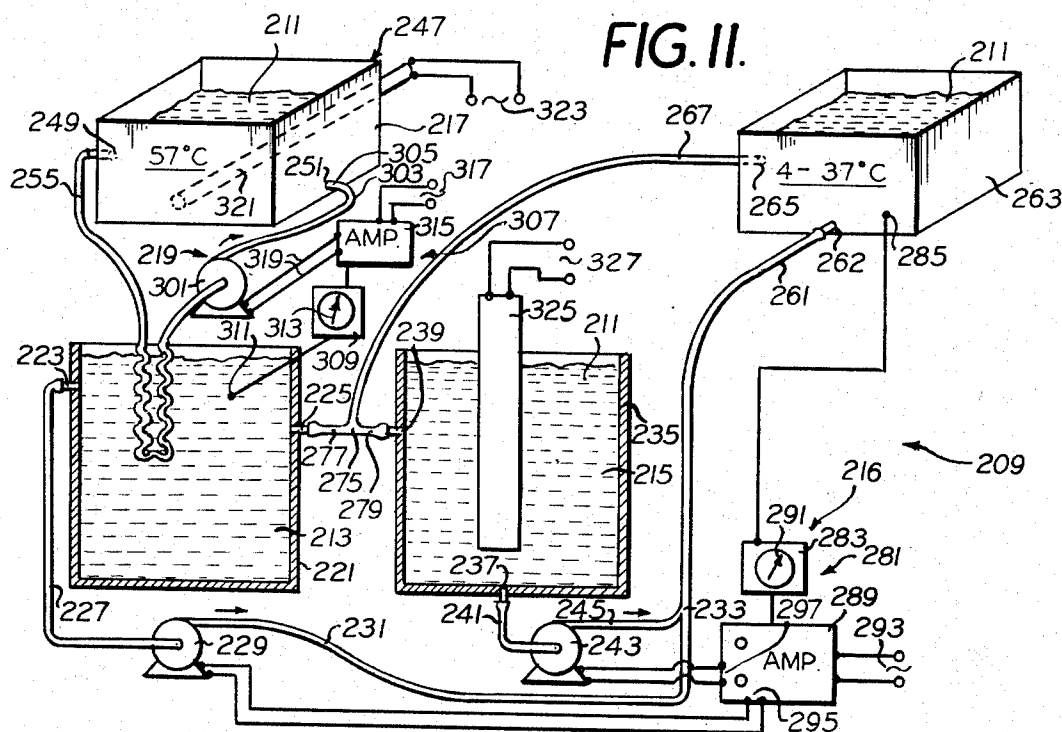
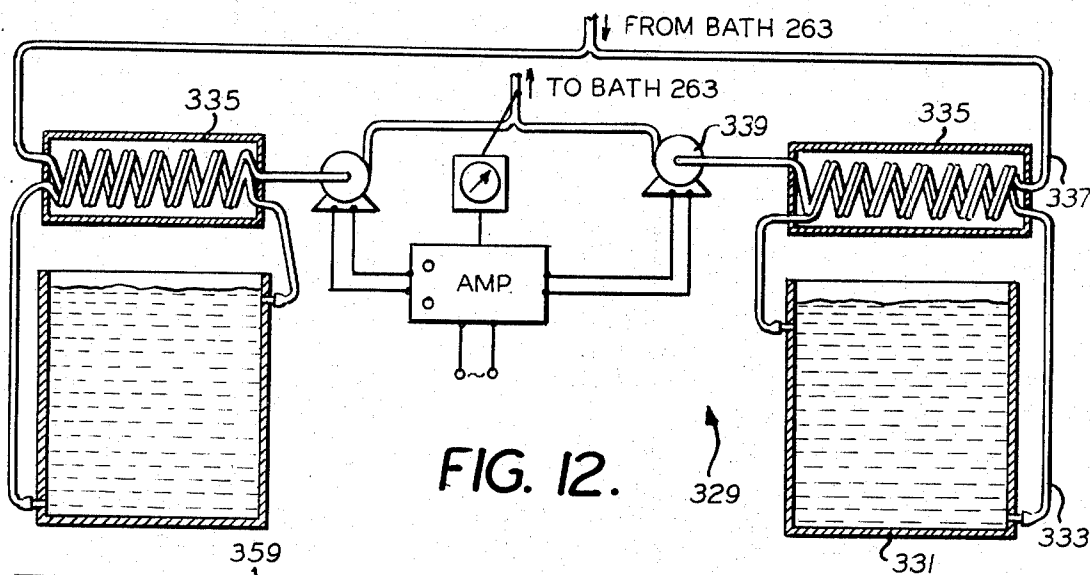
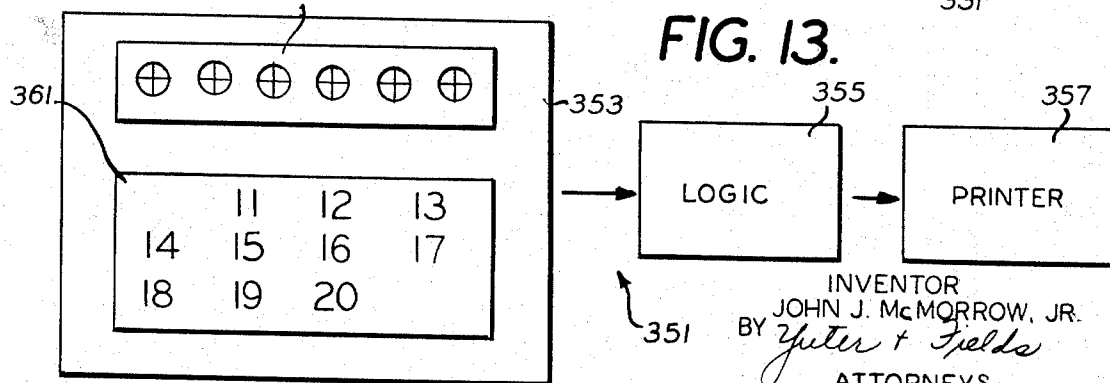


FIG. 10.



INVENTOR
JOHN J. Mc MORROW, JR.
BY *Yuter & Fields*
ATTORNEYS



BLOOD TYPING SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to the field of apparatus used during the analysis of the medical condition of patients and more specifically to tests relating to typing of blood.

2. Prior Art

In the standard typing of human blood in a clinical laboratory blood bank or donor processing laboratory at least five to eight test tubes are normally used. Though blood may be typed on a glass plate without centrifugation of the reactants, the test tube technique is generally considered to be the more acceptable method since centrifugation of reactants in the tubes enhances positive results.

For a patient or donor specimen to be typed by the standard test tube method, six test tubes at a minimum must be used.

TABLE I

Test Tube No.	Reagent	Specimen
1	anti-B serum	patient's cells
2	anti-A serum	patient's cells
3	albumin control	patient's cells
4	anti Rho	patient's cells
5	B cells	patient's serum
6	A cells	patient's serum

Test tubes No. 3, No. 4, No. 5, and No. 6 *must* be centrifuged to achieve optimum test results. Test tubes No. 1 and No. 2 *may* be centrifuged. Whether or not test tubes No. 1 and No. 2 are centrifuged does not alter the basic idea of this invention.

In order to associate with maximum assurity the test tubes No. 3, No. 4, No. 5 and No. 6 with the proper donor or patient specimen both before and after centrifugation, in the event that more than one patient or donor specimen is being typed at the same time, some method of notation must be made on each test tube. The notation must include two bits of information. The first bit of information must tell what reagents are in the test tubes; the second bit of information must tell the patient's identity. If only one patient is being typed, the notation must include at least the first bit of information on each test tube — that is, the reagent in the test tube.

On test tubes No. 1 and No. 2, coding with regard to reagents (the first bit of information) is less important since all commercially available anti-A serum and anti-B serum are coded blue and yellow respectively. But, if more than one patient is being typed at the same time, test tubes No. 1 and No. 2 of each patient must be clearly distinguished from the test tubes No. 1 and No. 2 of other patients.

Not only is it time consuming to write on test tubes but also it is difficult to do so clearly. Frequently in the process of loading and unloading test tubes from the centrifuge the writing becomes smudged and illegible. This is the inherent weakness of the standard method of assuring maximum quality control through the clear and distinct labeling of all test tubes used for testing.

Among the other problems complicating the job of the typing technician is that he must perform many tasks. For example, besides the straight typing of a patient's blood, it may be necessary to cross-match a particular patient's blood with that of a donor specimen.

Another problem for the technician is adding the reagents to the test tubes containing the blood to be typed. The reagents that are added are relatively expensive. Therefore, any waste presents an additional expense in the typing of blood. However, many of the reagents have red blood cells which settle. These cells must be agitated back into suspension before the reagent is added to the tube.

Another complication resides in the fact that many of the reactions must take place at specific temperatures. It is sometimes important to keep some reagents at 4°C. 4°C is also useful for cold-phase blood cross-matching (usually performed for special problems), typing where the patient's serum does not back-type strongly and "absorption" of cold agglutinins. Room temperature is useful for the regular typing of blood, a first phase of cross-matching (cross-matching may have many phases — the usual are room temperature, 22°C, 37°C, Coombs Phase, and possibly a 4°C phase). Actually some temperature control may be needed to reach "room temperature" in hot climates. Also necessary is a temperature of 37°C for cross-matching, typing with saline reacting serums, and keeping blood specimens warm to avoid coating cells with cold agglutinins 57°C would be useful for syphilis testing (complement deactivation) and elution of antibodies from cells.

A further problem arises in the technician's determining the type of blood tested after all of the tests have been completed. Under present practice, blood typing relies on the technician remembering information stored in his head. Test tubes No. 1 and No. 2 are compared with test tubes No. 5 and No. 6. In effect, their patterns must be the mirror image of one another. Test tube No. 4 determines the Rho type per se and test tube No. 3 lends credibility to the result obtained by analyzing test tube No. 4. Test tube No. 3 also acts as a control tube to the testing being performed in test tubes No. 1, No. 2, No. 5, and No. 6. The technician must visually observe each reaction, draw a mental conclusion, and reduce that conclusion to writing. Thus, the accuracy of blood typing under this method relies highly on the technician's memory.

Therefore, it is an object of this invention to insure the typing of blood is both relatively safe and foolproof.

It is another object of this invention that such typing be performed using test tubes and a centrifuge.

It is a further object of this invention that such relatively safe and foolproof blood typing be available for the analysis of a plurality of patient's blood simultaneously.

It is another object of the invention to provide such relatively safe and foolproof blood typing without a technician having to write on any test tubes.

It is a further object of this invention to provide easy interchangeability between straight blood typing and cross-matching.

It is a further object of this invention to enable the addition of reagents to the test tubes containing the blood specimens without unnecessary loss of reagent.

It is a further object of this invention to provide for the loading of a reagent insuring that all the sediment of the reagent is truly in suspension.

It is another object of this invention to provide that the addition of the reagent through the test tubes should be relatively quick and easy.

Another object of this invention is to provide means for maintaining the test tubes containing the reacting blood specimens at the desired temperatures.

It is another object of this invention to provide more test tubes at one desired temperature and other test tubes at another temperature.

Another object of the invention is to provide means for insuring that the reading of the blood type is relatively foolproof by minimum reliance on the technician's memory.

SUMMARY OF THE INVENTION

The above and other objects of the invention are accomplished by providing a blood typing system including a blood typing rack comprising a first section having a plurality of lines of test tube-holding means. A removable second section having a second plurality of lines of test tube-holding means is also provided. In the second section each line is associated with one and only one line in the first section as a result of coded keying means positively associating each line in the second section with its associated line in the first section. The second section is a removable test tube-holding centrifuge carrier. The coded keying means is an extension of the first section. Differing keys in the second section align the centrifuge carrier with corresponding test tube-holding means in the first section thereby uniquely aligning each line of test tube-holding means in the centrifuge carrier with its associated line in the first section.

A feature of the invention is that test tube-holding means in the first section are supported at a higher level than the test tubes supported by the centrifuge carriers. This allows a temperature-controlled fluid to flow around and contact the test tubes in the centrifuge carriers and not those in the first section. Thus, the reagents in the test tubes in the centrifuge carriers have their temperature raised or lowered in accordance with the controlled temperature of the temperature control fluid, without affecting the temperature of the reagents in the test tubes in the first section.

The preferred embodiment also has indicating means for indicating whether adjacent lines of test tubes are related. The indicating means includes a rotatable axial bipartite cylindrical bar between adjacent lines of test tube-holding means in the first section. The technician can rotate the bipartite cylindrical bar to indicate whether the succeeding line is related to the line preceding.

Another inventive feature to accomplish the above objects is a loading means for adding predetermined quantities of material to test tubes in the test-tube holding means. The preferred embodiment of the loading means include support means for holding a plurality of material containers. Dispensing means are provided for simultaneously adding a predetermined quantity of material to a plurality of test tubes in a line. Transport means carry the support means from a positive position to another positive position with respect to each line.

The dispensing means of the loading means includes a first valve for preventing the flow of material back into the material containers. Ejecting means controls the flow of reagent material to the test tubes. Second valve means connected to said ejection means prevent the flow of atmospheric air into the ejection means. Control means operates said ejection means causing reagent material to be dispensed into said test tubes.

The ejection means of the preferred embodiment also measures the amount of reagent material dispensed.

Also provided is temperature control means for regulating the temperature of a temperature control fluid. In the preferred embodiment the temperature control means includes a first reservoir means maintaining the temperature control fluid at a high temperature. A second reservoir means maintains the temperature control fluid at a low temperature. First closed fluid means circulates said temperature control fluid from said first and second reservoir means to parts of said first and second sections and back to said first and second reservoir means for maintaining the temperature of the test tubes in said parts of said first and second sections at a predetermined temperature.

A third temperature reservoir for maintaining the temperature control fluids at a very high temperature is also provided. A second closed fluid-circulating means circulates said temperature control fluid from said third temperature reservoir through said first temperature reservoir and back to said third temperature reservoir for maintaining said first temperature reservoir at a high temperature. The third temperature acts as a test tube bath.

The blood typing rack in the preferred embodiment also includes means to aid the technician in typing the blood. Switch means for each test tube in a line for indicating either a positive or a negative reaction for that test tube is provided. Logic means decode the output from said switch means to indicate the blood type. Printing means print the decoded output of said logic means.

Other objects, features, and advantages of the present invention will become more obvious from a consideration of the following detailed specification of which the claims form a part, as illustrated in the attached drawings, which show, by way of example, and not by limitation, the principle of the invention in the preferred embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of the blood typing rack showing a centrifuge carrier removed from its dotted outline position.

FIG. 2 is a sectional side view of the blood typing rack shown in FIG. 1.

FIG. 3 is a plan view of a loading cursor over the blood typing rack for manual loading of reagents.

FIG. 4 is a plan view of the blood typing rack particularly showing the indicating means.

FIG. 5 is a side sectional view of the indicating means for indicating whether adjacent lines are related.

FIG. 6 is a side sectional view of the blood typing rack disclosing the simultaneous reagent dispensing means.

FIG. 7 is a side partially sectional, view of the dispensing means of FIG. 6.

FIG. 8 is a side sectional view of another embodiment of the simultaneous dispensing means.

FIG. 9 is a side sectional view of the dispensing means shown in FIG. 8 during operation.

FIG. 10 is a side, partially sectional, view of the blood typing rack of FIG. 1 illustrating the temperature control fluid.

FIG. 11 is a schematic representation of the temperature control means for controlling the temperature of the control fluid of FIG. 10.

FIG. 12 is a variation of the temperature control means.

FIG. 13 is a schematic representation of the blood typing logic for an electrical readout of the blood typing test.

DESCRIPTION OF THE INVENTION

Description of FIGS. 1 and 2

Referring to FIG. 1 the blood typing rack 1 is shown. A first section 3 has a plurality of lines (hereinafter sometimes termed rows) 5 of test tube-holding means 7. Blood typing rack 1 also has a second section 9A for receiving a plurality of centrifuge carriers 9 having a plurality of rows 11 of test tube-holding means 13. Each row 11 in the centrifuge carrier 9 is associated with only one row 5 in the first section 3. Also provided is coded connecting means 15 for positively aligning each row 11 in the centrifuge carrier 9 with its associated row 5 in the first section 3.

In the preferred embodiment the centrifuge carrier 9 is a standard centrifuge basket. For example, the standard Sorvell twelve test tube centrifuge basket can be utilized for the centrifuge carrier 9. From FIG. 1 it can be seen that the standard centrifuge basket 9 has been modified by covers 17. Covers 17 cover the center row on standard centrifuge basket 9. Covers 17 prevent the technician using blood typing rack 1 from mistakenly and accidentally placing test tubes in the center row of standard centrifuge basket 9. As seen, there is no row 5 in the first section 3 associated with the center row of standard centrifuge basket 9.

Coded connecting means 15 is an extension of the first section 3 and has coded keys 19 for aligning the rows 11 in the second section standard (centrifuge basket) 9 with their associated rows 5 in the first section 2 forming aligned row 12. A more detailed description will now be given.

The first section 3 has a bottom plate 21, a support plate 23, a middle plate 25, and a top plate 27. Plates 21-27 are held in a spaced parallel relationship by support pillars 29. Support pillars 29 are located at the four corners of plates 21-27 and in the middle of the long edge of plates 21-27.

Support plate 23, middle plate 25, and top plate 27 form the test tube-holding means 7 of the first section 3. The exact relationship of the test tube-holding means 7 can also be seen from FIG. 1 and FIG. 2 together, reference to which should be made for a fuller understanding of the following description. In middle plate 25 and top plate 27 are located holes 31 approximately the size of the test tubes 30 which are to be supported. Holes 31 are arranged in rows 5 to form with the support plate 23 a test tube-holding means 7. That is, the test tubes 30 are placed in holes 31 both through top plate 27 and middle plate 25 and are supported at their bottom edge 32 by support plate 23.

As a result of the spaced relationship between support plate 23 and bottom plate 21 the test tubes 30 supported by the tube-holding means 7 have their bottom edge 32 supported above the level of bottom plate 21. Thus, a temperature controlled fluid 211 (see FIG. 10) may circulate in and around the blood typing rack 1 up to the level of bottom plate 23 and still not substantially affect the temperature of any material held within the test tubes 30 supported in the first section 3.

Bottom plate 21 (FIG. 1) extends beyond the forward edge of plates 23-27 to form part of the coded

connecting means 15. Coded connecting means 15 has its area defined according to the demands of second section 9. As explained above second section 9 is preferably formed of a plurality of standard centrifuge baskets, also given the designation 9. Thus, coded connecting means 15 has a plurality of cavities of substantially the same shape as the base of centrifuge basket 9. On the bottom of plate 21 there are laid out four rectangular bars 33, 35, 37, 39 forming a large rectangular cavity. Dividing this cavity lengthwise is a spherical bar 41 and dividing the cavity widthwise is a plurality of rectangular bars 43 running from either rectangular bar 33 or 37 to spherical bar 41. Thus, there are formed a plurality of rectangular cavities 45. Each rectangular cavity 45 is of the proper size to receive the double bases of each centrifuge basket 9 as more fully described below.

Each pair of cavities 45 associated with one centrifuge basket 9 is assigned two reference numbers 46, each of which identifies an aligned row 12. Reference numbers 46 for the embodiment shown in FIG. 1 are eleven through twenty.

Referring to FIG. 1 the details of the centrifuge basket 9 can be seen. As described above, centrifuge basket 9 is the standard Sorvell centrifuge basket which can be readily removed with the test tubes 30 from the blood typing rack 1 and put into a standard centrifuge. Centrifuge basket 9 is made of metal. It has a plurality of test tube-holding means 13 comprising a plurality of holes 47. These holes are located in the top plate 49 and the middle plate 51. The test tubes 30 themselves are supported by the bottom plate 53 which is composed of a soft material capable of absorbing slight impacts without breaking the glass test tubes 30. Centrifuge basket 9 has two portions 55 and 57 joined by a hump 59. Bottom surfaces 61 and 63 of portions 55 and 57, respectively, have dimensions slightly smaller than the inside dimensions of rectangular cavities 45. Thusly, portions 55 and 57 nestle snugly in rectangular cavities 45. This can be seen clearly from the dotted centrifuge basket 9 inserted in cavities 45 at positions 17 and 18 in FIG. 1.

An important aspect of the invention is that coded connecting means 15 has coded keys 19 for positively aligning each row 11 in the second section 9 with its associated row 5 in first section 3 to form an aligned row 12. Keys 19 take the form of pins 65 in rectangular cavities 45. That is, each rectangular cavity 45 has one pin 65. Pins 65 align with and fit into keyholes 67 in bottom surfaces 61 and 63 of centrifuge baskets 9. Pins 65 are arranged so that the combination of pins 65 associated with each centrifuge basket 9 form a unique arrangement. Further, pins 65 are not symmetrically placed. Therefore, not only will centrifuge basket 9 fit into only one pair of rectangular cavities 45, but they will fit into that particular pair of rectangular cavities 45 in a unique orientation. Thusly, centrifuge baskets 9 cannot be placed "backward" in their proper location.

Etched below each row 11 on centrifuge baskets 9 is a reference number 66 identical to reference number 46 associated with aligned row 12 of which row 11 forms a part. This aids the technician to visually locate the correct location for that centrifuge basket.

Operation of FIGS. 1 and 2

Blood typing rack 1, among other advantages, makes it possible to type a patient's blood by the test tube

method simultaneously without the need to write on any tubes in order to achieve maximum quality control. Proper reassociation of test tubes containing donor and patient's specimens after centrifugation is achieved by making the centrifuge basket a "keyed" extension of the blood typing rack 1.

The blood typing rack in FIG. 1 is loaded with centrifuge baskets 9 and test tubes 30 which will hold the reagents. For the embodiment shown in FIG. 1, five centrifuge baskets 9 are needed which hold a total of 56 test tubes 30. Similarly, if the five test tube-holding means 7 in rows 5 of the first section 3 are all filled with tubes, fifty additional test tubes are needed.

First section 3 of the blood typing rack 1 holds a total of 80 tubes in which reactions (tests) are performed. Row 522 running the length of the rack is for patient specimens. A total of 10 patient specimens can be held in blood typing rack 1. Each of the 10 places for patient specimen tubes in row 522 is composed of two holes. One hole, smaller hole 524, is bored in the plastic eccentric to larger hole 526. This permits a smaller (10 × 75 mm) satellite serum tube, containing a fraction of the primary patient specimen which has been separated from the primary patient specimen tube, to be attached to the primary patient specimen tube with a rubber band and the two tubes to be stored in the holes of row 522. Thus, one section of the blood typing rack 1 holds a total of 80 tubes for reactions and 10 larger patient specimen tubes. Each patient specimen tube can have a removably attached serum satellite tube.

The blood typing rack 1 has ten aligned columns 12 allowing the blood typing of ten individual donors. Each aligned column 12 holds nine test tubes 30 for each blood specimen. The patient or donor specimen that is being tested is loaded into test tubes 30 held in each aligned column 12. The reagents are then added to the donor specimens. Centrifuge baskets 9 are removed from the blood typing rack 1 and placed into the centrifuge (not shown). At the end of centrifugation each centrifuge basket 9 is returned to the same numbered position in the typing rack 1 from which it was removed. The technicians accomplish this by matching reference numbers 66 on the rows 11 of each centrifuge basket 9 with reference number 46 associated with the row 5 on first section 3. However, the technician cannot misplace the centrifuge basket 9. A centrifuge basket 9 will not sit in rectangular cavities 45 unless the keying means, pins 65, match and penetrate into keyholes 67. Otherwise, centrifuge basket 9 will be held above the level of rectangular cavities 45 by pins 65 contacting lower surfaces 61 and 63.

Each centrifuge basket 9 is thus guaranteed to be returned to its proper position connecting means 15. The reference numbers 46 and 66 aid in the repositioning of centrifuge baskets 9 after centrifugation. The "keying" pins 65 insure that the repositioning is done properly. That is, since pins 65 are not symmetrically placed, centrifuge basket 9 cannot be placed "backwards." These means reassociate physically the reaction test tubes 30 with the patient's specimen test tubes 30.

As with other aspects of the preferred embodiment the coded keys 19 shown, pins 65 associated with keyholes 67, can be done in various ways. For example, rectangular cavities 45 may have irregular shapes carved into rectangular bars 43. These shapes would key into similar shapes carved into bottom surfaces 61

and 63 of centrifuge baskets 9. Pins 65 and keyholes 67 are shown merely to illustrate the invention.

Similarly, each centrifuge basket on the preferred embodiment has two rows 11 of test tube-holding means 13, i.e., test tubes to type the blood of two different patients. One skilled in the art could easily vary this number and use other means than a centrifuge basket for the second section 9.

DESCRIPTION OF FIG. 3

Illustrated in FIG. 3 is loading cursor 71 for enabling the test tubes 30 to be loaded accurately by hand. Loading cursor 71 includes two base rails 73 and 75. Base rails 73 and 75 have path ways 77 and 79, respectively. On the vertical wall of path ways 77 and 79 are hemispherical detents 81. Riding on and supported by the horizontal walls of pathways 77 and 79 is horizontal cursor bar 83 having cylindrical cavities 89 and 91, respectively. In cylindrical cavities 89 and 91 are springs 93 and 95. One end of springs 93 and 95 bears against the end wall of cylindrical cavities 89 and 91, respectively. The other ends of springs 93 and 95 bear against balls 97 and 99. Balls 97 and 99 engage hemispherical detents 81 and 83 when horizontal crossbar 83 is appropriately aligned.

Operation of FIG. 3

Loading cursor 71 enables the filling of the test tubes to be accomplished by hand insuring that the same reactant is not accidentally placed in an incorrect test tube. For example, assume that the technician wanted to add anti B reagent to the rearmost column of test tubes, labeled column 101 in FIG. 3. The horizontal cursor bar 83 would be moved to the location illustrated in FIG. 3 so that balls 97 and 99 engage hemispherical detents 81 and 83, respectively, as shown. Drops of anti B reagent would be added to the test tubes just behind the cursor using the cursor as a guide. Thusly, it would be difficult, if not impossible, for the technician to accidentally place anti B reagent in a row of tubes other than row 101.

Description of FIGS. 4 and 5

The preferred embodiment also includes a plurality of indicating means 103 for indicating that adjacent rows of test tubes are related. This is extremely useful when blood typing rack 1 is used in a cross-match version. The indicating means 103 includes a rotatable axial bipartite cylindrical bar 105 in the first section 3 of blood typing rack 1. Cylindrical bar 105 is located between adjacent rows 5 (FIG. 1) of test tube-holding means 7. Cylindrical bar 105 is rotatably embedded in top plate 27 (see FIG. 5). Cylindrical bar 105 can be rotated from its end 107 by a technician. Axial bipartite cylindrical bar 105 is formed by joining two differently colored hemispherical bars 109 and 111 by a suitable binding agent. As shown in FIGS. 4 and 5, one color is indicated by vertical lines and the other color indicated by horizontal lines.

Also seen in FIG. 4 is the different configuration of second section 9. Here, second section 9 has centrifuge baskets 113 which have only three test tube-holding means 13 in each row 11. This arises from the fact that only three test tubes need be centrifuged in cross-matching operations.

Operation of FIGS. 4 and 5

The operation of FIGS. 4 and 5 is described in conjunction with a "cross-match" operation. Any number of blood specimens (up to 9 in the embodiment shown in FIG. 1) may be cross-matched with a patient's specimen. For example, assume that a patient's specimen is to be cross-matched with two donor specimens. The patient's specimen is placed in row 117. The donor specimens would be placed in rows 119 and 121. The cylindrical bars 105 between rows 117 and 119 and rows 119 and 121 are rotated by their ends 107 so that the color represented by hemispherical bar 109 is visible. Contrarywise, indicator bar 105 between rows 121 and 123 is rotated by its end 107 as that the color represented by hemispherical bar 111 is visible. Thus, the technician can readily tell by the color of cylindrical bar 105 whether a particular row or test tube-holding means 7 is associated with the following or previous rows 5.

Again, the specified embodiment shown and described in FIGS. 4 and 5 is only by way of example. Each laboratory could standardize on its own convention as to how many test tubes should be available in each row 11 of test tube-holding means 13 in second section 9. If the suggested embodiment shown in FIG. 4 is utilized, three test tube-holding means 13 in each row 11, the standard Sorvell basket could still be utilized. By rotating the centrifuge basket 9 shown in FIG. 1 90° from the orientation utilized in FIG. 1 and removing covers 17 from the second row 11 of test tube-holding means 13, three test tube-holding means 13 would be associated with each row 5 of test tube-holding means 7. Of course, one skilled in the art would readily recognize that rectangular bars 33, 35, 37, and 39, rectangular bars 43 and spherical bar 41 will have to be rearranged and that other changes made including the moving of pins 65 to accommodate the new orientation of centrifuge basket 9.

Description of FIGS. 6 and 7

Shown in FIG. 6 is the loading means 125 for adding predetermined quantities of reagent materials to an aligned row 12 of test tubes 30. Loading means 125 includes support means 127 for holding a plurality of material containers 129. Also included are dispensing means 131 (also seen in FIG. 7) for simultaneously adding predetermined quantities of reagent material to test tubes 30. Transport means 133 carry support means 127 to a positive position with respect to each aligned row 12.

Referring to FIG. 6 support means 127 can be seen in detail. Support means 127 includes an outer case 135. Outer case 135 is capable of holding a temperature controlled fluid 211 at a level above the top of material containers 129. That is, outer case 135 is watertight on the four sides and bottom. Although the support means 127 includes outer case 135, capable of holding a temperature control fluid 211, and thus comprises a temperature bath for material container 129 one skilled in the art might prefer to avoid any chances of contamination of the reagent material by use of a water jacket. For ease of illustration and simplification the means by which support means 127 carries material containers 129 is not shown in detail. One skilled in the art can easily devise numerous methods by which this can be accomplished. Similarly, other details of the

construction that one skilled in the art would readily recognize to be necessary and could as readily provide are not shown. The material containers 129 in the preferred embodiment include ordinary bottles 137. Also included are reagent caps 139. Reagent caps 139 have two orifices 141 and 143. 141 is used to allow the reagent to leave reagent bottles 37. 143 is used as the entry means for agitating means 145 or venting means 152.

Some reagent bottles 137 include agitating means 145 for suspending red blood cells in the reagent material. Valve 150 on air bulb 147 allows atmospheric air to enter compressible air bulb 147 when the air pressure in the compressible air bulb is less than surrounding atmospheric pressure. This occurs after compressible air bulb 147 is squeezed or reagent has been removed from reagent bottles 137. Valve 150 prevents air from leaving compressible air bulb 147 into the atmosphere through its one way action. If temperature variations of the reagent material in reagent bottles 137 causes a pressure increase from reagent material expansion, to avoid forced leaking of dispensing means 131, an additional air vent similar to venting means 152 can be supplied. Attached to compressible air bulb 147 is air tube 149. Air tube 149 extends from compressible air bulb 147 through orifice 143 into the reagent material. Air tube 149 has bend 148 and terminates near reagent cap 139. Compressible air bulb 147 is located at least partially outside outer case 135 to allow easy access by the technician.

A reagent tube 151 extends from orifice 141 to dispensing means 131.

Referring to FIG. 7 the details of dispensing means 131 can be seen. The dispensing means 131 includes first valve means 153 for preventing the flow of reagent material back into material containers 129. Also included is injection means 155 for controlling the flow of reagent material to the test tubes. Second valve means 158 connected to injection means 155 prevents the flow of atmospheric air into injection means 157. Control means operate said injection means 157 dispensing reagent material into the test tubes 30.

More specifically, dispensing means 131 includes first valve means 153 which allow reagent material to flow out of but not into reagent bottle 137. Although first valve means 153 is illustrated by a flap valve, as with other specific means shown in this specification, other means could be used to the same advantage. For example, first valve means 153 could be the well-known spring-loaded ball and seat valve.

First valve means 153 is located in reagent tube 151. Reagent tube 151 extends from orifice 141 to injection means 155. Injection means 155 has an outer body 156 having a cylindrical passage 160. Riding in cylindrical passage 160 is plunger 161. Plunger 161 is normally biased so that it does not completely fill cylindrical passage 160 by spring means 162. That is, portion 164 of cylindrical passage 160 is normally not occupied by plunger 161. When plunger 161 extends into cylindrical passage 160 and fills portion 164, the reagent material held in portion 164 is displaced. The amount of reagent material that is displaced is predetermined by the distance plunger 161 is extended to cylindrical passage 160. Connected to portion 164 of cylindrical passage 160 is reagent passage 166. Reagent passage 166 is connected to reagent tube 151 at a point below first valve means 153. Connected to the open end 186 of cy-

lindrical passage 160 is spout 168. Located at the other end of spout 168 is second valve means 158.

Also shown in FIG. 7 is the preferred embodiment of second valve means 158, i.e., a flap valve allowing reagent material to be ejected from spout 168, but prevents atmospheric air from flowing into spout 168. Spout 168 directs the predetermined quantities of reagent material to the test tube 30 directly below.

Control means 159 operates said injection means 155. That is, control means 159 includes handle 170 (FIG. 6). Connected to handle 170 is crank 172. Crank 172 is attached to and causes to rotate axle 174. In turn, crank 176 is rotated by axle 174. Crank 176 is in turn connected to axle 178. Axle 178 is also supported by crank-bearing assemblies 188 and 190. Periodically spaced along axle 178 are levers 180 (see FIG. 7). At end 192 of levers 180 are push rods 184. Push rod 184 bears against the cap 194 of plunger 161.

Transport means 133 includes bases 163 (see FIG. 6). Mounted on top of bases 163 are rails 165. Rails 165 have longitudinal grooves 167. Riding in grooves 167 are guides 169 of horizontal bar 171. Within each guide 169 is cylindrical cavity 173. Against the end of cylindrical cavity 173 is biased a spring 175. A ball 177 rides against the other end of spring 175 and bears against the vertical wall of groove 167. Located periodically along the vertical wall of groove 167 are detent depressions 179. Detent depressions 179 are aligned with aligned rows 12. That is, when balls 177 are engaged in detent depressions 179 dispensing means 131 is aligned to dispense reagent material into test tubes 30 in an aligned row 12 (FIG. 1).

Operations of FIGS. 6 and 7

Loading means 125 is located over the aligned row 12 of test tubes 30 into which the reagent material is to be added. This is accomplished by moving support means 127 over the aligned row 12 so that transport means 133 assumes a positive position by balls 177 engaging detent depressions 179.

After transport means 133 is properly positioned, handle 170 is turned causing crank 172 to rotate. That in turn causes axle 174 to rotate crank 176. Crank 176 rotates axle 178 causing lever 180 to push push-rod 184. The movement of push-rod 184 causes plunger 161 to bear against spring means 162 and extend into portion 164 of cylindrical passage 160. The reagent material in passage 160 is forced by plunger 161 into spout 168 and from there into the appropriate test tubes. Thus, injection means 155 controls the flow of reagent material to the test tubes.

Upon the technician releasing handle 170 spring means 162 biases plunger 161 out of cylindrical passage 160. Receding plunger 161 creates a vacuum in portion 164. Thus, the air pressure in portion 164 causes second valve means 158 to close preventing atmospheric air from entering spout 168 and portion 164. Similarly, the lower pressure in portion 164 causes valve means 153 to open, drawing into portion 164 reagent material from reagent bottle 137. The air pressure is equalized in reagent bottle 137 through venting means 152 or agitating means 145.

Contrarywise when plunger 161 was penetrating deeper into cylindrical passage 160 to eject the reagent material from portion 164, the higher pressure in portion 164 caused first valve means 153 to close preventing the flow of reagent material back into reagent bot-

ties 137 and caused second valve means 158 to open allowing the reagent material to flow into the reagent tubes.

The amount of reagent material ejected by plunger 161 is directly proportional to the distance plunger 161 extends into portion 164. Thus, plunger 161 forms a measuring means for the amount of reagent material dispensed to each test tube.

Agitating means 145 causes any settled deposit in reagent bottle 137 to be dispersed throughout the reagent material in that bottle. The technician squeezes compressible air bulb 147. The air forced out of compressible air bulb 147 travels through air tube 149 and enters the reagent material in reagent bottle 137. This air agitates the reagent material causing any settled material (blood cells) to become suspended in the reagent material. When the technician releases compressible air bulb 147, air re-enters compressible air bulb 147 through one-way flap valve 150. This allows the compressible air bulb 147 to regain its normal shape without drawing the reagent material from reagent bottle 137.

Outer case 135 of loading means 125 is adapted to hold temperature control fluid 211. Thus, the reagent material in reagent bottles 137 may be maintained at a predetermined temperature by the temperature control fluid 211. See the Description and Operation of FIGS. 11 and 12 for the temperature control of temperature control fluid 211.

Although the above description in operation of FIGS. 6 and 7 is basically schematic in operation, one skilled in the art could easily modify the specific means disclosed without departing from the spirit of the invention. For example, other valves could be substituted for the illustrated flap valves and other dispensing means could be utilized. For example, reference should be made to FIGS. 8 and 9 for another embodiment of dispensing means 131.

Description of FIGS. 8 and 9

Referring to FIGS. 8 and 9, an alternative embodiment of dispensing means 131 can be seen.

Dispensing means 131 includes a first pipe means, reagent tube 151, connected to the material containers 137. A movable chamber, cavity 193, normally aligned with first pipe means, reagent tube 151, accepts reagent material from material containers 137. Second pipe means, delivery tube 182, adds predetermined quantities of reagent material to the test tubes 30. Conveying means, middle bar 189, moves the movable chamber, cavity 193, out of flowable alignment with the first pipe means, reagent tube 151, and into flowable alignment with the second pipe means, delivery tube 182.

That is, dispensing means 131 of FIG. 8 comprises a top bar 181. Periodically located along top bar 181 are a set of two cavities 183 and 185 (only one set is shown). Feeding cavity 183 is reagent tube 151 extending from reagent bottle 137. A short distance displaced along horizontal bar 181 is second cavity 185. Connected to second cavity 185 is air tube 187. The other end of air tube 187 is connected to a steady supply of air pressure greater than atmospheric pressure. This source of air pressure is not shown. Displaced below and parallel to top bar 181 is middle bar 189. Middle bar 189 is sandwiched to top bar 181 by bottom bar

191. That is, middle bar 189 can slide in the plane of the paper between top bar 181 and bottom bar 191.

Periodically located along middle bar 189 are cavities 193. Cavities 193 are normally located below cavities 183. However, when middle bar 189 is slid, cavity 193 can be brought below cavity 185.

Located in bottom bar 191 directly below cavity 185 in top bar 181 is cavity 195. When cavity 193 of middle bar 189 is slid below cavity 185 of top bar 181 the three bars, 181, 189 and 191 are as shown in FIG. 9.

Operation of FIGS. 8 and 9

The dispensing means 131 of FIGS. 8 and 9 is normally in the configuration shown in FIG. 8. That is, cavity 193 is located directly below and in line with cavity 183. The reagent material therefore flows through reagent tube 151 and cavity 183 into cavity 193. Cavity 193 becomes loaded with the reagent material. When middle bar 189 is slid to place cavity 193 under cavity 185, the reagent material contained in cavity 193 is blown out of cavity 193 by the air pressure supplied through air tube 187 and cavity 185. The reagent material blown out of cavity 193 is blown into cavity 195 and from there into test tubes 30. As one skilled in the art will recognize, the cavity pair 183 and 185 is duplicated for each test tube 30 in an aligned row 12 which is to receive reagent materials.

Description of FIG. 11

The preferred embodiment of blood typing rack 1 includes a temperature control means 209 for regulating the temperature of a temperature control fluid 211. In the preferred embodiment the temperature control means 209 includes a first reservoir means 213 maintaining the temperature control fluid 211 at a high temperature. A second reservoir means 215 maintains the temperature control fluid 211 at a low temperature. In addition, first closed fluid means 216 circulates temperature control fluid 211 from said first and second reservoir means 213 and 215 to parts of said first and second sections 3 and 9 (also see FIGS. 1 and 2) and back to said first and second reservoir means 213 and 215 for maintaining the temperature of test tubes 30 in said parts of said first and second sections 3 and 9 at a predetermined temperature.

A third reservoir means 217 maintains temperature control fluid 211 at a very high temperature. Second closed fluid circulating means 219 circulates temperature control fluid 211 from third reservoir means 217 through first reservoir means 213 and back to third reservoir means 217 for maintaining first reservoir means 213 at the high temperature.

More particularly, temperature control fluid 211 can be any temperature variable fluid which is unaffected by the range of temperatures from the temperature maintained in second reservoir means 215 to the temperature maintained in third reservoir means 217. For example, second reservoir means 215 may be maintained at 4°C and third reservoir means 217 may be maintained at 57°C. Therefore, water would be an acceptable temperature control fluid 211.

First reservoir means 213 in the illustrated embodiment is a vat 221. Vat 221 has an outlet 223 and inlet 225. Connected to outlet 223 is tube 227. The other end of tube 227 is connected to the suction inlet of pump 229. The output of pump 229 is connected to

tube 231. The other end of tube 231 is connected to one inlet of tube junction 233.

Similarly, second reservoir means 215 is a vat 235 having an outlet 237 and an inlet 239. Connected to outlet 237 is a tube 241. The other end of tube 241 is connected to the suction input of pump 243. The outlet of pump 243 is connected to one end of tube 245. The other end of tube 245 is connected to another input of tube junction 233.

The output of tube junction 233 is connected to tube 261. The other end of tube 261 is connected to the parts of first section 3 and second section 9 (also see FIGS. 1 and 2) which are to have their test tubes maintained at the predetermined temperature. In the embodiment as illustrated in FIG. 10 only second section 9 receives temperature control fluid 211. As described above, this is accomplished by first section 3 maintaining its test tubes 30 at a higher level than the test tubes maintained by second section 9.

As shown in FIGS. 1 and 11, tube 261 is connected to bath 263. The temperature control fluid 211 is maintained at a level lower than that assumed by bottom plate 23 when blood typing rack 1 is put into bath 263. Bath 263 has input 262 which receives the end of tube 261 and output 265. Connected to output 265 is tube 267. Tube 267 branches into tubes 277 and 279 at tube junction 275. Tube 277 returns temperature control fluid 211 to the first reservoir means 213, vat 221. Tube 279 returns the temperature control fluid 211 to second reservoir means 215, vat 235.

First closed fluid means 216 also includes temperature control means 281. Temperature control means 281 includes temperature sensor 283. Temperature sensor 283 has its sensing element 285 embedded in bath 263. Temperature sensor 283 has a manually set indicator 291. Indicator 291 is set by the technician to the temperature desired to be maintained in bath 263. Temperature sensor 283 produces a difference voltage representative of the difference between the temperature sensed in bath 263 and that set into indicator 291. This difference voltage is fed to amplifier 289. Amplifier 289 has a bias voltage input 293 and outputs 295, 297. Output 295 controls pump 229 and output 297 controls pump 243. That is, the respective pump will energize to pump the correct temperature control fluid 211 to bath 263 to properly modify bath 263 to the predetermined temperature set into indicator 291. One skilled in the art can easily supply the specific details not disclosed herein.

Third reservoir means 217 is bath 247. Bath 247 has outlet 249 and inlet 251. Connected to outlet 249 is tube 255.

Second closed fluid circulating means 219 includes pump 301. The suction input of pump 301 is formed by tube 255. Tube 255 has a substantial part of its length immersed in temperature control fluid 211 contained in vat 221. The output of pump 301 is connected to tube 303. The other end of tube 303 is connected to input 305 of vat 247.

Also included in the second closed fluid circulating means is second temperature control 307. Second temperature control 307 comprises a temperature sensor 309 whose sensing element 311 is immersed in temperature control fluid 211 in vat 221. Temperature sensor 309 has indicator 313 which is set to a predetermined temperature at which temperature control fluid 211 in vat 221 is to be maintained. Temperature sensor 309

produces a voltage difference representative of the difference between the temperature of temperature control fluid 211 in vat 221 and the temperature set in indicator 313. This voltage difference is fed to amplifier 315. Amplifier 315 has line voltage input 317. Amplifier 315 also has an output 319 which controls pump 301.

Other details of the temperature control means 209 shown in FIG. 11 include heater 321 for temperature control fluid 211 in bath 247. Heater 321 is powered by line voltage through line voltage input 323. Heater 321 may be of any type commercially available such as that known as a self contained temperature controlled immersion heater.

Another detail shown is that of immersion cooler 325 in vat 235. Immersion cooler 325 is powered by line voltage through line voltage input 327. As with immersion heater 321, immersion cooler 325 has a self contained temperature control element.

Operation of FIG. 11

The limits of temperature normally employed in red cell testing for both typing and cross-matching are 4°C to 37°C. Reagent storage is 4°C. The goal is to maintain bath 263 at a predetermined temperature within the range 4°C through 37°C by temperature control means 281. That is, the predetermined temperature is set into indicator 291. By properly controlling the flow through junction 233 by the action of pumps 229 and 243, temperature control 281 can vary the temperature in vat 263.

The temperature in vat 235 is controlled by immersion cooler 325. The temperature in vat 221 is controlled by temperature control means 219 circulating temperature control fluid 211 from bath 247 through tube 255. That is, the temperature of temperature control fluid 211 within vat 221 should be the same as that set into indicator 313 on temperature sensor 309.

The temperature within bath 247 is controlled by immersion heater 321.

In use, blood typing rack 1 is placed into bath 263 for desired temperatures 4°C through 37°C. For complement deactivation (part of syphilis test), serum-containing tubes are placed into bath 247 for temperatures around 57°C. The reason two baths are used is that if the 57°C temperature were to be available in the same bath as a 4°C, the supply vats 221 and 235 would be subject to extremely wide variations in temperature from the temperature control fluid 211 returned from bath 263. Thus, vats 221 and 235 would either have to be extremely large to absorb the wide variation in temperatures of the temperature control fluid returned or have heating and cooling mechanisms of enormous capacity. Rather than opt for either of those alternatives, the preferred embodiment of the invention utilizes a second bath 247 maintained at 57°C. An additional advantage is that this bath 247 can be used to heat high temperature vat 221. Thusly, vat 221 is maintained at 37°C and vat 235 is maintained at 4°C.

Temperature control fluid 211 is also supplied to support means 127 (FIG. 6) to regulate the temperature of the reagent material as described above in conjunction with FIG. 6.

Description of FIG. 12

Shown in FIG. 12 is a variation on the temperature control means of FIG. 11. This variation is shown as a

separate Figure for ease of illustration, but easily could be incorporated into temperature control means 209 of FIG. 11 by one skilled in the art. Since FIG. 12 is basically self explanatory and is symmetrical around its center, only one half of FIG. 12 will be described in detail.

Assuming that vat 331 is the cold water vat of the temperature control means 329 of FIG. 12, cooling means is provided (not shown). The temperature control fluid 211 is withdrawn from vat 331 through tube 333. Tube 333 winds through heat exchanger 335 in close proximity to tube 337. From there tube 333 goes to pump 339. The temperature control fluid is then pumped from there to bath 263. Temperature control means 329 operates in the same manner as temperature control means 281 of FIG. 11. The returning temperature control fluid 211 from bath 263 comes through tube 337. As explained above, tube 337 is in close proximity to tube 333. After winding through heat exchanger 335, tube 337 returns the temperature control fluid 211 to vat 331.

Operation of FIG. 12

Assuming that vat 331 is the cold temperature vat for temperature control fluid 211, temperature control fluid 211 passing through tube 333, i.e., that going to bath 263, is at a lower temperature than that returning from bath 263 to vat 331 through tube 337. Thus, where tubes 333 and 337 pass in close proximity in heat exchanger 335, the temperature of temperature control fluid 211 in tube 333 is raised and that in tube 337 is lowered. This has the desirable effect of moderating the temperature of temperature control fluid 211 closer to the temperature of the bath or vat into which it is about to enter. Thus, the system approaches a higher efficiency than that shown in FIG. 11 without heat exchanger 335.

One skilled in the art will readily recognize that heat exchanger 335 as illustrated in FIG. 12 may not be the most efficient. For example, many heat exchangers using baffles have been found to have a higher efficiency than those using coils. However, for purposes of illustration, and not by way of limitation, heat exchangers 335 of FIG. 12 has been presented.

Description of FIG. 13

FIG. 13 is blood typing means 351. Blood typing means 351 comprises switch means 353 for each test tube in aligned rows 12 (also see FIG. 1) for indicating either a positive or negative reaction. Logic means 355 decodes the output from switch means 353 to indicate the blood type. Print means 357 print the decoded output of logic means 355.

Switch means 353 includes a plurality of positive indicating switches 359. There is one positive indicating switch 359 associated with each reagent tube in an aligned column 12. Thus, in the embodiment shown in FIG. 10 there are necessary six positive indicating switches 359. Also, switch means 353 include row indicating switches 361. Depression of a row indicating switch 361 represents through logic 355 that the positive indicating switches 359 that are being depressed are being depressed for the aligned column 12 associated with the reference number inscribed on that depressed row indicating switch. That is, the reference numbers inscribed on row indicating switches 361 correspond to reference numbers 46 and 66 in FIG. 1.

Operation of FIG. 13

In blood typing six tubes may be used to do a routine typing. The following table assigns a number to each test tube in an aligned row 12 and details its contents.

TABLE II

Tube 30.....	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
Reagent.....	anti B sera.....	anti A sera.....	5% Bovine albumin (control tube).	anti RHO (anti D).	Known B cells.....	Known A cells.
Specimen.....	Pt's cells.....	Pt's cells.....	Pt's cells.....	Pt's cells.....	Pt's serum.....	Pt's serum.

It may be assumed that a reaction in each test tube 30 can either be a positive or negative. Further, there are only eight reaction patterns that are "meaningful." All others are special cases. The eight reaction patterns correspond to exactly eight possible typing results. If a plus sign represents a positive reaction and a minus sign represents no reaction, the following table indicates the possible patterns:

TABLE III

Reaction in Test Tube No.						Blood Type
1	2	3	4	5	6	
-	-	+	+	+	+	O+
-	-	-	-	+	+	O-
-	+	-	-	-	-	A-
+	-	-	-	-	-	B+
+	-	-	-	+	+	B-
+	+	-	-	-	-	AB+
+	+	-	-	-	-	AB-

Another fact is that test tubes No. 1 and No. 2 compared with test tubes No. 5 and No. 6 must be the mirror image of one another. If this is not the case, an error has occurred. That is, if test tubes No. 1 and No. 2 are +, -, then test tubes No. 5 and No. 6 must be -, +. Rather than rely on the technician's concentration, blood typing means 351 of FIG. 13 relies on electronic logic.

The exact logic needed in logic means 355 is not detailed. Any technician skilled in the art could easily design many arrangements of logic to accomplish the desired functions. After introducing the proper reagent materials into the test tubes 30 for blood typing and performing any needed centrifugation, the technician depresses a row indicating switch 361 representative of the aligned row of test tubes 30 which he is then about to read. Since the same reagent material is always introduced into the test tubes 30 in the same positions by loading means 125 (FIG. 6), there can be no mistake as to which reaction is which to logic means 355, i.e., there is no worry that the test tube No. 2 has the anti B sera and not test tube No. 1. The technician then presses the appropriate positive indicating switches 359. That is, he depresses a switch if a positive reaction occurred in the associated test tube 30. If no reaction occurred in that test tube 30 he does not depress that switch. For example, the left-most positive indicating switch 359 in FIG. 13 represents the row of test tubes 30 shown in FIG. 10. Assume that row is in the left-most row of test tubes in blood typing rack 1, i.e., the row assigned the numeral 11 in FIG. 1, he depresses that row indicating switch 361. If a reaction occurred in the left-most test tube as shown in FIG. 10, the technician depresses the left-most positive indicating switch 359. He then proceeds with the remaining test tubes 30 and positive indicating switches left to right.

The switch means 353 is connected to logic means 355. Logic means 355 examines the combination of depressed positive indicating switches 359. By means of a table look-up or other logic means, logic means 355 determines which of the possible combinations in Table

III has occurred. Logic means 355 then indicates to printer 357 what the blood type is. Also indicated to printer 357 is which row indicating switch 361 was depressed. Printer 357 then prints out the row number and the blood type.

If the combination of positive indicating switches 359 that were depressed is not one of the permissible combinations shown in Table III, logic means 355 so detects and printer 357 so indicates.

The contribution of blood typing means 351 is further insurance that an error does not occur to a technician misreading the reactions occurring in the test tubes 30.

In addition to the suggestions immediately noted above, there will be obvious to those skilled in the art many other modifications and variations which attain many or all of the objects of the invention and to which accrue many or all of its advantages. However, these modifications and variations will not depart from the spirit of the invention.

What is claimed is:

1. A blood typing system comprising:

a rack;

a first section of said rack having a plurality of test tube-holding means, each of said test tube-holding means being adapted to hold a blood specimen of a particular patient;

a second section of said rack having a plurality of lines of removable test tube-holding means, each line in said second section being associated with only one test tube-holding means in said first section and being removable from said second section separate from other lines in said second section; coded keying means in said rack for positively receiving and aligning each line in said second section with its associated test tube-holding means in said first section so that when a line of test tube-holding means in said second section is removed it can be returned only to a position in said second section of said rack which is associated with the same test tube-holding means in said first section.

2. A blood typing system as in claim 1 including: indicating means for indicating that adjacent rows of test tubes are related.

3. A blood typing system as in claim 1 including: switch means for each test tube in a row for indicating either a positive or negative reaction; logic means for decoding the output from said switch means to indicate the blood type; printing means for printing the decoded output of said logic means.

4. A blood typing system as in claim 1 including a loading cursor for enabling the test tubes to be loaded accurately.
5. A blood typing system as in claim 1 wherein: said second section is a centrifuge carrier.
6. A blood typing system as in claim 5 wherein: said keys include pins to align with holes in said centrifuge carriers.
7. A blood typing system as in claim 5 wherein: said coded keying means is an extension of said first section and includes keys associated with said coded keying means for aligning said centrifuge carriers.
8. A blood typing system as in claim 7 wherein: each of said keys aligns only one of a plurality of said centrifuge carriers.
9. A blood typing system as in claim 1 including: loading means for adding predetermined quantities of reagent material to test tubes in said tube-holding means.
10. A blood typing system as in claim 9 wherein said loading means includes:
 - support means for holding a plurality of reagent holding bottles in a row and upside down;
 - dispensing means for simultaneously adding predetermined quantities of reagent material from said reagent holding bottles to a plurality of test tubes in a row;
 - transport means for carrying said support means to a positive position with respect to each row.
11. A blood typing system as in claim 10 including agitating means for suspending red blood cell in the reagent material.
12. A blood typing system as in claim 10 further comprising agitation means associated with some of the reagent holding bottles to agitate the contained reagent.
13. A blood typing system as in claim 1 wherein: said first section supports the test tubes at a higher level than said second section allowing temperature control fluid to contact said second section only.
14. A blood typing system as in claim 13 including: a temperature control fluid to control the temperature of the test tubes in said second section, and temperature control means for regulating the temperature of said temperature control fluid; said temperature control means comprising first reservoir means for holding fluid at a temperature higher than a predetermined temperature, second reservoir means for holding fluid at a temperature lower than the predetermined temperature, and mixing means for mixing the two fluids together for obtaining temperature control fluid at the predetermined temperature.
15. A blood typing system as in claim 14 further comprising a third reservoir means containing fluid at a temperature higher than the temperature of the fluid in said first reservoir means, and tube means immersed in said first reservoir means for conducting the fluid in said third reservoir means from and back to said third reservoir means for controlling the temperature of the fluid in said first reservoir means.
16. A blood typing system as in claim 15 wherein the temperature of the fluid in said third reservoir means is about 57° C.
17. A blood typing system as in claim 14 wherein said temperature control means includes:

- a first reservoir means maintaining the temperature control fluid at a high temperature;
- a second reservoir means maintaining the temperature control fluid at a low temperature; and
- first closed fluid means circulating said temperature control fluid from said first and second reservoir means to parts of said first and second sections and back to said first and second reservoir means for maintaining the temperature of the test tubes in said parts of said first and second sections at a predetermined temperature.
18. A blood typing system as in claim 17 including: a third reservoir means maintaining the temperature control fluid at a very high temperature;
- second closed fluid circulating means circulating said temperature control fluid from said third reservoir means through said first reservoir means and back to said third reservoir means for maintaining said first reservoir means at the high temperature.
19. A blood typing system as in claim 18 wherein said third temperature reservoir is a test tube bath.
20. A blood typing system comprising:
 - a first section having a plurality of rows of test tube-holding means;
 - a second section having a plurality of rows of test tube-holding means, each row in said second section associated with only one row in said first section;
 - connecting means for positively aligning each row in said second section with its associated row in said first section;
 - indicating means for indicating that adjacent rows of test tubes are related;
 - said indicating means including a rotatable axial bipartite cylindrical bar between adjacent rows of test tube-holding means in said first section.
21. A blood typing system comprising:
 - a first section having a plurality of rows of test tube-holding means;
 - a second section having a plurality of rows of test tube-holding means, each row in said second section associated with only one row in said first section;
 - connecting means for positively aligning each row in said second section with its associated row in said first section;
 - loading means for adding predetermined quantities of reagent material to test tubes in said tube-holding means;
 - said loading means including
 - support means for holding a plurality of material containers;
 - dispensing means for simultaneously adding predetermined quantities of reagent material to a plurality of test tubes in a row;
 - transport means for carrying said support means to a positive position with respect to each row;
 - said dispensing means including
 - first valve means for preventing the flow of reagent material back into the material containers;
 - open injection means for controlling the flow of reagent material to the test tubes;
 - second valve means connected to said injection means for preventing the flow of atmospheric air into said injection means; and
 - control means for operating said injection means dispensing reagent material into the test tubes.

21

22. A blood typing system comprising:

a first section having a plurality of rows of test tube-holding means;

a second section having a plurality of rows of test tube-holding means, each row in said second section associated with only one row in said first section;

connecting means for positively aligning each row in said second section with its associated row in said first section;

loading means for adding predetermined quantities of reagent material to test tubes in said tube-holding means;

said loading means including

support means for holding a plurality of material containers;

dispensing means for simultaneously adding predetermined quantities of reagent material to a plurality of test tubes in a row;

transport means for carrying said support means to a positive position with respect to each row;

said injection means measuring the reagent material dispensed.

23. A blood typing system comprising:

a first section having a plurality of rows of test tube-holding means;

a second section having a plurality of rows of test tube-holding means, each row in said second section associated with only one row in said first section;

connecting means for positively aligning each row in said second section with its associated row in said first section;

loading means for adding predetermined quantities of reagent material to test tubes in said tube-holding means;

said loading means including

22

support means for holding a plurality of material containers;

dispensing means for simultaneously adding predetermined quantities of reagent material to a plurality of test tubes in a row;

transport means for carrying said support means to a positive position with respect to each row;

said dispensing means including

first pipe means connected to the material containers;

a movable chamber normally aligned with said pipe means accepting reagent material from said material containers;

second pipe means for adding predetermined quantities of reagent material to the reagent tubes;

conveying means for moving said movable chamber out of flowable alignment with said first pipe means and into flowable alignment with said second pipe means.

24. A blood typing system comprising a rack having means for holding a plurality of test tubes each containing a mixture of blood specimens of a particular patient and a predetermined reagent, a switch means associated with each of said test tube-holding means having a position for indicating a positive reaction, logic means connected to said switch means for decoding the pattern of positive indications to determine the type of blood of the particular patient, and display means connected and responsive to said logic means to visually display the patient's blood type.

25. The blood typing system of claim 24 further comprising patient indicating means associated with each grouped plurality of test tube-holding means, said logic means and said display means being responsive to said patient indicating means to identify the patient in the visual display of the patient's blood type.

* * * * *

40

45

50

55

60

65