"A Device for Testing Liquids"

The invention relates to a device for testing liquids and in particular to a testing device which makes use of the phenomenon of agglutination to detect the occurrence of an antibody/antigen reaction.

As is well known, various immunological tests may be carried out making use of this phenomenon. For example, blood group can be determined by applying appropriate antibodies to blood samples to see which antibody causes agglutination of the red blood cells, such agglutination being visible to the naked eye. Thus, if a sample agglutinates in the presence of "A" antibody (Anti-A) then the blood sample is of Group "A".

Various devices have been designed to facilitate the determination of blood group, or other immunological tests. Devices for this purpose generally comprise a structure providing a sample receiving location to which a sample of the liquid to be tested may be applied, an indicating location spaced from the receiving location, a pathway for the flow of liquid from the receiving location to the indicating location, and means for retaining in the pathway a reagent which will agglutinate with the substance to be detected. As the sample flows along the pathway from the sample receiving location, it contacts the reagent and agglutination may or may not occur depending on whether or not the substance is present in the sample. If agglutination occurs the flow of liquid is arrested or slowed so that it does not arrive at the indicating location. On the other hand, if agglutination does not occur then the sample fluid flows through to the indicating location. Thus, the presence of the substance being tested for can be

determined by whether or not the fluid reaches the indicating location.

European Patent No. 0456699 discloses a device of this general type for the determination of blood groups. In this device a covered panel is formed with a hollow into which a blood sample may be placed and a number of capillary passages lead from the hollow to respective chambers containing membranes impregnated with various reagents. Further elongate and tortuous capillary passages lead from these chambers to indicating chambers designed to display a particular symbol depending on whether or not a flow of blood reaches the indicating chamber.

In use, the separate flows of blood from the sample hollow are mixed with the respective reagents in the mixing chambers before flowing along the elongate capillary passages. If a particular reagent in a mixing chamber initiates agglutination of the sample, the sample will not be able to flow along the whole length of the associated tortuous capillary passage and there will be no change of appearance at the indicating chamber. However, if no agglutination occurs then the blood sample will continue to flow along the capillary passage to the indicating chamber and the appearance of the chamber will change as a result of the presence of blood in it. If the mixing chambers contain reagents causing agglutination with the common blood groups, the device as a whole may be arranged to indicate the blood group of a single sample placed in the sample receiving hollow.

The present invention sets out to provide various improvements to testing devices of the basic type mentioned above and particularly, but not exclusively, of the kind described in European Patent No. 0456699.

One problem with existing devices lies in ensuring that the occurrence of agglutination reliably prevents a blood sample flowing to the indicating location. Where the pathway between the sample receiving location and the indicating location is a simple capillary passage, it may occur that agglutination is not sufficient to prevent some of the sample reaching the indicating location, in which case a false reading, or contradictory readings, may be given by the device. According to one aspect of the invention, therefore, means are provided for reducing the likelihood of this occurring.

According to the first aspect of the invention, therefore, there is provided a device for testing the presence of a substance in a liquid, the device including a sample receiving location to which a sample of the liquid to be tested may be applied, an indicating location spaced from the receiving location, at least one pathway for the flow of liquid from the receiving location to the indicating location, and means for retaining in said pathway a reagent which effects agglutination in the liquid in the presence of the aforesaid substance, said pathway including a capillary passage in which there is at least one localised region of reduced cross-section to reduce the flow of liquid through that region.

The localised region of reduced cross-section tends to inhibit the flow of liquid if some agglutination has occurred and thus reduces the likelihood of such liquid passing through to the indicating location.

The capillary passage may include a plurality of said localised regions of reduced cross-section spaced apart along the length of said passage. Each localised region of reduced cross-section may be located nearer said indicating location than to said

receiving location. Each capillary passage may be substantially triangular in cross-section.

Said localised region of reduced cross-section may be provided by one or more baffles extending partly across the capillary passage. Each baffle may extend across a major portion of the cross-sectional area of the capillary passage.

In a preferred form of device according to the invention said locations and the pathways between them are defined by recesses formed in a base plate, a cover plate being secured over the base plate to cover the recesses so as to convert them into closed chambers or passages, and each said localised region of reduced cross section comprises a baffle which extends partly across its associated passage and has an upper surface spaced from the cover plate so as to provide a gap between the baffle and the cover plate through which fluid may flow. Said gap may increase in area in the direction of fluid flow.

In devices of the kind first referred to the various locations and the pathways between them may be defined by recesses formed in a base plate, a cover plate then being secured over the base plate to cover the recesses so as to convert them into closed chambers or passages. The cover plate may, for example, be secured in position by means of thermal welding, ultrasonic welding or by an adhesive. However, problems may occur in securing the cover plate to the base plate. Difficulty may be experienced in ensuring that the adhesion of the cover plate reliably forms a liquid-tight seal along the boundaries of each recess. Also, the volume or cross-sectional area of at least some of the recesses may be extremely critical for the accurate and reliable operation of the

device. For example, the cross-sectional area of the capillary passages may need to be very accurately determined in order to ensure that the appropriate flow of liquid along the passages occurs in both the fluid state and the agglutinated state. It is found that the means used for securing the cover plate to the base plate, whether this be some form of welding or an adhesive, may cause variation in the cross-sectional area of the capillary passages or other forms of recess, either by the seal between the cover plate and base plate being spaced outwardly of the edge of the recess, or, on the other hand, encroaching into the recess itself. According to a second aspect of the invention, therefore, means are provided for securing the cover plate to the base plate in a manner which maintains the integrity of the recesses in the base plate.

According to this aspect of the invention there is provided a device for testing for the presence of a substance in a liquid, the device including a sample receiving location to which a sample of the liquid to be tested may be applied, an indicating location spaced from the receiving location, at least one pathway for the flow of liquid from the receiving location to the indicating location, and means for retaining in said pathway a reagent which reacts to the presence of the aforesaid substance, said device comprising a base plate in which is formed at least one capillary groove constituting a part of said pathway, and a cover plate which is secured in overlying relationship to the base plate to cover said capillary groove and thereby form a capillary passage, the base plate being formed with upstanding ribs extending along each side of the capillary groove and, the cover plate being bonded to said upstanding ribs.

The cover plate may be bonded to the upstanding ribs by thermal or ultrasonic

welding or by an adhesive. Ultrasonic welding is preferred since the heat generated in thermal welding may affect the reagents located in the device and, similarly, a chemical adhesive may also have some adverse chemical effect on the reagents.

Preferably an overflow groove is formed in the base plate alongside each capillary groove whereby, during welding of the cover plate to the base plate, molten material from said rib may flow into the overflow groove. Preferably overflow grooves are formed extending along both sides of the capillary groove.

The capillary groove may be generally V-shaped in cross-section, and each overflow groove may also be generally V-shaped in cross-section. The upstanding ribs may be of inverted V-shape, opposites of each rib forming one side of each of the capillary groove and adjacent overflow groove respectively.

Preferably a main undersurface of the cover plate is in abutting contact with portions of a main upper surface of the base plate.

In the case where the receiving location and/or indicating location are defined by recesses in the base plate, said location may be at least partly surrounded by an upstanding peripheral rib to which part of the cover plate is bonded. An overflow groove is preferably formed in the base plate outside and adjacent said upstanding peripheral rib.

In devices of the general kind first referred to, it is necessary to vent the indicating locations to atmosphere in order to permit the flow of liquid along the pathway to the indicating locations. Thus, in European Patent No. 0456699 short capillary passages lead from the indicating chambers to apertures in a side edge of the

device which are open to the atmosphere. However, in operation of the device blood, or other liquid being tested, will normally flow to at least one of the indicating chambers, and since there is likely to be some variation in the volume of the sample applied to the device, it may occur that blood actually flows along these further short capillary passages and is discharged from the edge of the device. In view of the possible risks of infection from blood, or other liquids being tested, this is undesirable and a third aspect of the invention provides means whereby the liquid being tested may be prevented from escaping from the device.

According to this aspect of the invention there is provided a device for testing for the presence of a substance in a liquid, the device including a sample receiving location to which a sample of the liquid to be tested may be applied, an indicating location spaced from the receiving location, at least one pathway for the flow of liquid from the receiving location to the indicating location, and means for retaining in said pathway a reagent which reacts to the presence of the aforesaid substance, a further pathway extending from the indicating location to a dumping location, said dumping location comprising a reservoir in the device. By providing a reservoir in the device for any liquid flowing beyond the indicating location, possible contamination of the exterior of the device is prevented.

In the case where a plurality of said pathways are provided, said dumping location preferably comprises a plurality of reservoirs with which the pathways communicate respectively.

As previously mentioned, the device may comprise a base plate formed with

recesses defining said locations and said pathway, and a cover plate which is secured in overlying relationship to the base plate to cover said recesses, and in this case the or each dumping reservoir may comprise a recess formed in the base plate and covered by a portion of the cover plate. The or each said recess may be at least partly surrounded by an upstanding peripheral rib to which part of the cover plate is bonded. An overflow groove is preferably formed in the base plate outside and adjacent said upstanding peripheral rib.

Said portion of the cover plate over the or each recess is preferably formed with an aperture for the escape of air from recess. A removable cover, such as a self-adhesive label, may be provided to close said aperture.

The cover plate may also include an aperture to provide access to the recess defining the sample receiving location, a removable cover, such as a self-adhesive label, being provided to close said aperture.

A single cover or self-adhesive label may be provided to close both the aperture to the receiving location and the aperture from the dumping location.

In European Patent No. 0456699 the reagents to cause possible agglutination in the fluid being tested are located in chambers from which capillary passages lead to the indicating chambers. Due to the comparatively large size of these chambers, it may be found that a large liquid sample is required, and that mixing of the sample with the reagent in the chamber may be less than complete. According to a fourth aspect of the invention there is provided an improved arrangement for mixing the reagent with the sample.

According to this aspect of the invention there is provided a device for testing for the presence of a substance in a liquid, the device including a sample receiving location to which a sample of the liquid to be tested may be applied, an indicating location spaced from the receiving location, at least one pathway for the flow of liquid from the receiving location to the indicating location, and means for retaining in said pathway a reagent which reacts to the presence of the aforesaid substance, said pathway including a capillary passage and at least a part of said capillary passage constituting said means for retaining said agglutinating reagent. Preferably said reagent is dispersed along a stretch of the capillary passage.

The internal surface of the capillary passage may be treated to enhance the retention of the reagent in the passage. The treatment may be mechanical and/or chemical. For example, the surface of the passage may be roughened, or it may be coated with a substance to which the reagent adheres.

In any of the above arrangements according to the invention there may be provided a plurality of pathways each leading from a sample receiving location to an indicating location. There may be provided a single sample receiving location from which all the pathways extend, or each pathway may extend from a different respective sample receiving location. Preferably the pathways lead to different respective indicating locations.

Where a plurality of pathways are provided said pathways are preferably all of the same length between said sample receiving location and indicating location.

The following is a more detailed description of an embodiment of the invention,

by way of example, reference being made to the accompanying drawings in which:

Figure 1 is a plan view of the base plate of a testing device according to the invention,

Figure 2 is a section through one of the capillary grooves of the base plate, prior to the fitting of the cover plate to the base plate,

Figure 3 is a similar view to Figure 2, but after fitting of the cover plate to the base plate,

Figure 4 is a section on the line 4-4 of Figure 1, after fitting of the cover plate,

Figure 5 is a section on the line 5-5 of Figure 1, after fitting of the cover plate,

Figure 6 is a section on the line 6-6 of Figure 1, after fitting of the cover plate and showing a baffle in the capillary groove,

Figure 7 is a longitudinal section through a capillary groove, showing the baffle of Figure 6,

Figure 8 is a similar view to Figure 6, showing an alternative form of baffle, and

Figure 9 is a plan view of a portion of a capillary groove, showing one arrangement of baffles of the kind shown in Figure 8.

Referring to Figure 1, the device comprises a rectangular base plate 10 which may be moulded from a suitable plastics material, for example it may be injection moulded from polystyrene.

Integrally moulded in the base plate are a circular recess 11, which constitutes a sample receiving location, and five capillary grooves 12, 13, 14, 15, 16 which follow tortuous paths from the recess 11 to five respective indicating recesses 17, 18, 19, 20

and 21. Each indicating recess is in the shape of a different symbol. The recesses 17, 18, 19 are in the shapes of the letters A, B and O respectively. The recess 20 is generally in the shape of a cross and part of the recess 21 is generally in the shape of a tick.

Further capillary grooves 22 lead from the indicating recesses to respective dumping recesses 23 which are formed side-by-side in the base plate adjacent the sample recess 11.

A cover plate 24 (see Figure 3) is secured over the face of the base plate 10 so as to cover and close the various grooves and recesses. The cover plate is formed with a circular aperture, shown dotted at 25 in Figure 1, which registers with the recess 11 so that a sample of liquid to be tested can be introduced into the recess 11. Further apertures 26 are formed in the cover plate over each dumping recess 23 to serve as air vents. A self-adhesive label (indicated at 27) is adhered over the cover plate 24 and a removable portion 27A of the label is positioned over the apertures 25 and 26 to prevent contamination before the device is used. The label portion 27A is simply stripped off the device when required to enable a sample to be introduced into the recess 11. The label portion 27A may be replaced after the device has been used, the device thereby being resealed to prevent contamination from the interior of the device to the exterior.

The dumping recesses may contain neutralising agents to render harmless any leakage from the vent holes. Although individual dumping recesses 23 are preferred, as shown, the capillary grooves 22 could lead to a single common dumping recess having a single vent hole.

The cover plate 24 could be slightly smaller in size than the base plate 10 and shaped to fit snugly within an upstanding peripheral wall extending around the outer periphery of the base plate 10.

In the present example the device is designed for determining blood group. For this purpose stretches of the capillary passages 12, 13, 14 and 15 are coated respectively with different mono-clonal antibodies, namely anti-AB, anti-A, anti-B and anti-D. The capillary passage 16 is uncoated. The capillary passages, or the desired stretches of the passages, may be pre-treated to allow the antibodies to bind to the surfaces of the passages. For example, the passages may be pre-coated with appropriate proteins, carbohydrates or other materials. The surfaces of the appropriate stretches of the passages may also be roughened.

The cover plate 24 is transparent and the label 27 applied to its outer surface has transparent portions corresponding to the shapes and locations of the indicating recesses 17, 18, 19, 20, 21 respectively. (The transparent portion of the label which overlies the recess 21 is shaped to reveal only the tick-shaped part of that recess). The portion of the label surrounding the transparent shapes A and B, as indicated in dotted lines at 29 in Figure 1, is blood red in colour as is also the portion 30 surrounding the cross-shaped area 20. The portions of the label surrounding the O-shaped and tick-shaped transparent areas are white or some other non-red colour. The label may also bear other printed matter both for advertising or information purposes. For example, the label may include regions where the name, date, blood group or other information may be marked.

Instead of the panels 29, 30 and other information being printed on a separate

self-adhesive label, they may be printed directly on the transparent cover plate 24 itself.

In use, the label portion 27A is removed and a blood sample is introduced into the recess 11. Capillary action causes the blood to pass from the recess 11 along each of the capillary passages 12, 13, 14, 15 and 16. As the blood flows along the coated part of each passage it mixes with the antibody with which the passage is coated. If the antibody in a particular capillary passage reacts with the blood flowing along that passage to cause agglutination, the agglutination causes the flow of blood in that passage to slow down and eventually stop so that blood does not reach the shaped indicating recess at the end of that passage. If no agglutination occurs, blood continues to flow along the capillary passage until it reaches and fills the shaped indicating recess at the end of that passage. Any further flow of blood along that capillary passage is then discharged to the dumping recess 23 by way of the related overflow passage 22. Each dumping recess 23 is of such a size that in normal use the recess will be big enough to contain any overflow blood from the capillary passage leading to it, thus preventing contamination of the exterior of the device with blood.

The capillaries 12, 13, 14 and 15 are coated with anti-A, anti-B, anti-AB and anti-D antibodies respectively.

The capillary passage 16 and tick-shaped indicating recess 21 act as a control. Since no antibody is located within the capillary 16 there should be a free flow of blood along the capillary 16 from the recess 11 to the recess 21. The tick-shaped visible portion of the recess should therefore turn red, indicating that the device is operating correctly.

If the blood sample is Group A it will react with the anti-A antibody in capillary 12 causing agglutination to occur in that capillary. The sample will also react with the anti-AB antibody in capillary 14 causing agglutination to occur in that capillary also. Consequently the indicating recesses 17 and 19 will remain empty, as a result of the agglutination, but the indicating recesses 18 and 20 will become filled with blood. The B, O and + will thus be of the same colour as the surrounding surface whereas the A will remain of a light colour contrasting with its surrounding red surface. The letter A along will therefore stand out, indicating the A blood group.

If the sample is Group B agglutination will occur in capillaries 13 and 14 while free flow will occur along the capillaries 12 and 15. As a result, the letter B will stand out in contrast to its surrounding surface.

If the blood sample is Group O no agglutination will occur in any of the capillaries so that all of the indicating recesses 17, 18, 19 and 20 will become filled with blood. However, only the O-shaped recess 19 will then contrast with its surrounding surface so that the O stands out as indicating that blood group.

Finally, if the blood type is positive, reaction with the anti-D antibody will cause agglutination in the capillary passage 15 and the cross-shaped indicating recess 20 will remain unfilled with blood, indicating that the blood sample is positive.

Although the resistance provided by the capillary passages alone may be sufficient to prevent flow of blood into the indicating recesses if agglutination occurs, it may occur that the resistance to flow is not sufficient and some blood may flow into the indicating recesses even though agglutination has occurred, giving rise to false or

misleading readings. Accordingly, in order to ensure that flow is prevented once agglutination has occurred, specific locations in each of the capillary passages are reduced in cross-section so as to provide greater resistance to the through flow of agglutinated blood. In the present case two such regions of reduced cross-section are provided in each capillary passage as indicated, for example, at 31 and 32 in capillary passage 12.

As best seen in Figures 6 and 7, the reduction in cross-section of each capillary passage, such as passage 12, is effected by locating in the passage a baffle 33 which blocks most of the passage but leaves a gap 34, for the flow of blood, between the top of the baffle and the underside of the cover plate 24. The upper surface 35 of the baffle 33 is inclined, as shown in Figure 7, so that the gap 34 widens in the direction of flow, as indicated by the arrow 36.

Figure 8 shows an alternative arrangement where the baffle 37 extends only partly across the width of the capillary passage, leaving a triangular gap 38 between the side edge of the baffle and the adjacent wall of the passage. In this case there may be provided a number of baffles 37, spaced apart longitudinally of the capillary passage, alternate baffles projecting from opposite sides of the passage so as to provide a tortuous flow path for blood along the passage, around the baffles 37. Such an arrangement is shown in Figure 9, where three baffles 37 are provided.

Other baffle arrangements may be employed and different numbers and combinations of baffles may be used. For example, the baffles may be in the form of convex projections extending from one side wall of the passage towards the opposite

side. Other forms of reduction in cross-section may be employed. For example, the passage 12 itself may be necked so as to reduce in cross-section at a specific location.

Alternatively, the effective cross-section may be locally reduced by the use of fixed particles, lengths of materials and absorbents. The use of inert materials and active materials may also be of benefit.

Instead of, or in addition to, the physical barrier to flow provided by the baffles 33, there may be provided a region of each capillary which is coated with a chemical which reacts with agglutinated blood, but not with unagglutinated blood, so as to block the capillary and prevent further flow of blood to the relevant indicating recess.

To ensure that the device will operate properly with a given volume of a blood sample, it is important that the cross-sectional area of each of the capillaries 12, 13, 14, 15, 16 is accurately determined and that blood cannot leak from the capillaries. It is also important that the capillaries should be of essentially the same length. For the latter purpose it will be seen from Figure 1 that the stretch of each capillary close to its respective indicating recess is tortuous in shape. This not only increases the resistance to flow of agglutinated blood through the stretches of the passages, but each passage may be readily preformed of a required length by selecting the dimensions of the tortuous parts of the passage. Thus the tortuous design readily enables the passages to be made of the same length.

As previously mentioned, the cover plate 24 may be secured to the base plate 10 by an adhesive or by thermal or ultrasonic welding, the latter being preferred. In the prior art arrangements there may be regions of the device where there is a narrow gap

between the undersurface of the cover plate 24 and the upper surface of the base plate 10. If such gaps occur adjacent a capillary passage this may effectively increase the cross-sectional area of the passage, and blood may also leak from the capillary into the gap. In the above described device, therefore, means are provided to ensure that the welding process preserves the integrity and dimensions of the capillary passages. This is shown in Figures 2 and 3.

Referring to Figure 2: each capillary groove, such as groove 12, is generally V-shaped in cross-section. Running alongside each side of the groove, and parallel to it, are two overflow grooves 39 which are of generally similar cross-sectional shape to the groove 12. However, the top portions 40 of the inverted V-shape ribs 41 thus formed between each overflow groove 39 and the capillary groove 12 project slightly above the level of the surrounding surface 42 of the base plate 10.

When the cover plate 24 is first placed over the base plate 10, therefore, the tops of the ribs 41 hold it a short distance above the upper surface 42 of the base plate 10. However, when thermal or ultrasonic welding is then effected, the tops 40 of the ribs 41 melt and collapse. By providing the overflow grooves 39 along each side of the capillary groove 12, the melting material can flow outwardly into the overflow grooves as well as inwardly into the capillary groove 12 itself, as indicated at 40A and 40B in Figure 3. This enables the cover plate to be pressed firmly into abutting engagement with the upper surface 42 of the base plate 10, regardless of any slight variation in the volume of rib material upstanding above the level of the surface 42, and no molten material can prevent the two plates coming into contact by becoming trapped between them. Since

the cover plate is thus always pressed hard against the base plate, there is little likelihood of leakage of fluid between the two plates, and also the capillary passages will always be of substantially the same cross-sectional area.

In prior art arrangements, where molten material can only flow towards or into the capillary groove itself, some of the molten material may remain on the top surface of the base plate, thus holding the cover plate out of contact with the base plate. This may allow leakage of blood from the capillary passage into the gap between the cover plate and base plate. Also, the depth of the gap is likely to vary, both between different devices and between different regions of the same device, so that the effective cross-sectional area of the capillary passage also varies. This will affect the flow and may lead to unreliable and inconsistent results from the device.

In the arrangement described above, only about half of the molten material flows into the capillary groove itself, and since the cover plate always finishes in the same position with respect to the base plate, the amount of molten material flowing into the capillary groove is substantially consistent and can therefore be allowed for when calculating the effective cross-sectional area of the capillary passages, which will be consistent between different devices and between different regions of the same device.

Similar overflow grooves are formed on the base plate around the sample receiving recess 11, each of the indicating recesses 17, 18, 19, 20 and 21 (as shown in Figure 4), the capillary grooves 22 and the dumping recesses 23 (as shown in Figure 5).

Although the described device is for use in determining blood group, it will be appreciated that similar devices, incorporating features of the invention, may be used for

carrying out other diagnostic tests. Although the reaction in the blood group test is an antibody reaction, in other tests the reagent might be antigen. The device according to the invention could, for example, be used in tests for the presence of infectious diseases, such as measles, mumps or rubella.

In some tests it may be desirable to provide enlarged further reaction chambers in the capillary pathways, each reaction chamber containing one or more reagents which may be suitable to create agglutination, and hence the visualisation of a symbol. The reagents in such further reaction chambers may be instead of reagents located in the capillary passages themselves, or in addition to such reagents. Additional enlarged chambers may be provided for reaction transfer or reactions alone.

Although in blood group testing it has been found desirable for all the pathways to be of the same length, the lengths of the pathways may be required to vary if, for example, different types of reactions and different reaction chamber configurations cause the reactions to occur over different periods. Thus in a multi-test situation, the pathway lengths could be adjusted so that all the results are obtained at about the same time.

Although the provision of shaped indicating recesses 17, 18, 19, 20 and 21 is a convenient way of indicating to the user that agglutination has occurred, other forms of indicator may be employed. For example, the arrival of blood at an indicating recess may be arranged to trigger a colour change at that recess or to trigger some other visible reaction. For example, latex particles of different colours may be used, as well as immunogold and other visualisation media currently in use in immunoassays.

In the example described, the indicating recesses may be treated with an

appropriate chemical, either before or after use, to "fix" the image provided by the flow of blood into some of the recesses.

In the device specifically described above, the cross-sectional shapes and sizes of the capillary passages and chambers are determined by the shapes of grooves and recesses in the base plate 10 alone. However, it is also possible for the underside of the cover plate 24 to be formed with grooves and/or recesses which cooperate with grooves and/or recesses in the base plate to define the necessary passages and chambers. This may allow a standard base plate to be used with different cover plates to provide passages and chambers of different flow characteristics.

In a further modification, not shown, some of the passages and/or chambers in the device may be formed solely by grooves or recesses in the underside of the cover plate alone, such grooves or recesses being closed by flat portions of the upper surface of the base plate.

Although pathways in the form of capillary passages are preferred, the invention does not exclude other forms of pathway for the passage of liquid from the sample receiving location to the indicating locations. For example, the pathways may be in the form of printed liquidic circuits of the kind described in U.S. Patent No. 5198193 and British Patent Specification No. 2231150, as well as other related patents and patent applications.

CLAIMS

1. A device for testing the presence of a substance in a liquid, the device including a sample receiving location to which a sample of the liquid to be tested may be applied, an indicating location spaced from the receiving location, at least one pathway for the flow of liquid from the receiving location to the indicating location, and means for retaining in said pathway a reagent which effects agglutination in the liquid in the presence of the aforesaid substance, characterised in that said pathway includes a capillary passage in which there is at least one localised region of reduced cross-section to reduce the flow of liquid through that region.

2. A device according to Claim 1, wherein the capillary passage includes a plurality of said localised regions of reduced cross-section spaced apart along the length of said passage.

3. A device according to Claim 1 or Claim 2, wherein the localised region of reduced cross-section is located nearer said indicating location than to said receiving location.

4. A device according to any of the preceding claims, wherein the capillary passage is substantially triangular in cross-section.

5. A device according to any of the preceding claims, wherein said localised region of reduced cross-section is provided by one or more baffles extending partly across the capillary passage.

6. A device according to Claim 5, wherein each baffle extends across a major portion of the cross-sectional area of the capillary passage.

7. A device according to Claim 5 or Claim 6, wherein said locations and the pathways between them are defined by recesses formed in a base plate, a cover plate being secured over the base plate to cover the recesses so as to convert them into closed chambers or passages, and wherein each said localised region of reduced cross section comprises a baffle which extends partly across its associated passage and has an upper surface spaced from the cover plate so as to provide a gap between the baffle and the cover plate through which fluid may flow.

8. A device according to Claim 7, wherein said gap increases in area in the direction of fluid flow.

9. A device for testing for the presence of a substance in a liquid, the device including a sample receiving location to which a sample of the liquid to be tested may be applied, an indicating location spaced from the receiving location, at least one pathway for the flow of liquid from the receiving location to the indicating location, and means for retaining in said pathway a reagent which reacts to the presence of the aforesaid substance, said device comprising a base plate in which is formed at least one capillary groove constituting a part of said pathway, and a cover plate which is secured in overlying relationship to the base plate to cover said capillary groove and thereby form a capillary passage, characterised in that the base plate is formed with upstanding ribs extending along each side of the capillary groove, the cover plate being bonded to said upstanding ribs.

10. A device according to Claim 9, wherein the cover plate is bonded to the

upstanding ribs by thermal or ultrasonic welding.

11. A device according to Claim 10, wherein an overflow groove is formed in the base plate alongside each capillary groove whereby, during welding of the cover plate to the base plate, molten material from said rib may flow into the overflow groove.

12. A device according to Claim 11, wherein overflow grooves are formed extending along both sides of the capillary groove.

13. A device according to any of Claims 9 to 12, wherein the capillary groove is generally V-shaped in cross-section

14. A device according to any of Claims 9 to 13, wherein each overflow groove is generally V-shaped in cross-section.

15. A device according to Claim 14, wherein the upstanding ribs are of inverted V-shape, opposite sides of each rib forming one side of each of the capillary groove and adjacent overflow groove respectively.

16. A device according to any of Claims 9 to 15, wherein a main undersurface of the cover plate is in abutting contact with portions of a main upper surface of the base plate.

17. A device according to any of Claims 9 to 16, wherein the receiving location and/or indicating location are defined by recesses in the base plate, and said location is at least partly surrounded by an upstanding peripheral rib to which part of the cover plate is bonded.

18. A device according to Claim 17, wherein an overflow groove is formed in the base plate outside and adjacent said upstanding peripheral rib.

19. A device for testing for the presence of a substance in a liquid, the device including a sample receiving location to which a sample of the liquid to be tested may be applied, an indicating location spaced from the receiving location, at least one pathway for the flow of liquid from the receiving location to the indicating location, and means for retaining in said pathway a reagent which reacts to the presence of the aforesaid substance, a further pathway extending from the indicating location to a dumping location, characterised in that said dumping location comprises a reservoir in the device.

20. A device according to Claim 19, wherein a plurality of said pathways are provided, and said dumping location comprises a plurality of reservoirs with which the pathways communicate respectively.

21. A device according to Claim 19 or Claim 20, comprising a base plate formed with recesses defining said locations and said pathway, and a cover plate which is secured in overlying relationship to the base plate to cover said recesses, the or each dumping reservoir comprising a recess formed in the base plate and covered by a portion of the cover plate.

22. A device according to Claim 21, wherein the or each said recess is at least partly surrounded by an upstanding peripheral rib to which part of the cover plate is bonded.

23. A device according to Claim 22, wherein an overflow groove is formed in the base plate outside and adjacent said upstanding peripheral rib.

24. A device according to any of Claims 21 to 23, wherein said portion of the

cover plate over the or each recess is formed with an aperture for the escape of air from recess.

25. A device according to Claim 24, wherein a removable self-adhesive cover is provided to close said aperture.

26. A device according to Claim 25, wherein the cover plate also includes an aperture to provide access to the recess defining the sample receiving location, a removable cover also being arranged to close said aperture.

27. A device according to Claim 26, wherein a single self-adhesive label is provided to close both the aperture to the receiving location and the aperture from the dumping location.

28. A device for testing for the presence of a substance in a liquid, the device including a sample receiving location to which a sample of the liquid to be tested may be applied, an indicating location spaced from the receiving location, at least one pathway for the flow of liquid from the receiving location to the indicating location, and means for retaining in said pathway a reagent which reacts to the presence of the aforesaid substance, said pathway including a capillary passage, characterised in that at least a part of said capillary passage constitutes said means for retaining said reagent.

29. A device according to Claim 28, wherein said reagent is dispersed along a stretch of the capillary passage.

30. A device according to Claim 28 or Claim 29, wherein the internal surface of the capillary passage is treated to enhance the retention of the reagent in the passage.

31. A device according to Claim 30, wherein the surface of the passage is

roughened.

32. A device according to Claim 30, wherein the surface of the passage is coated with a substance to which the agglutinating reagent adheres.

33. A device according to any of the preceding claims, wherein there are provided a plurality of pathways each leading from a sample receiving location to an indicating location.

34. A device according to Claim 33, wherein there is provided a single sample receiving location from which all the pathways extend.

35. A device according to Claim 33 or Claim 34, wherein the pathways lead to different respective indicating locations.

36. A device according to any of Claims 33 to 35, wherein said pathways are all of substantially the same length between said sample receiving location and indicating location.