

[54] **ELECTROPHORESIS SAMPLE APPLICATOR**

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[58] Field of Search **204/180 G, 180 S, 299**

[56] **References Cited**

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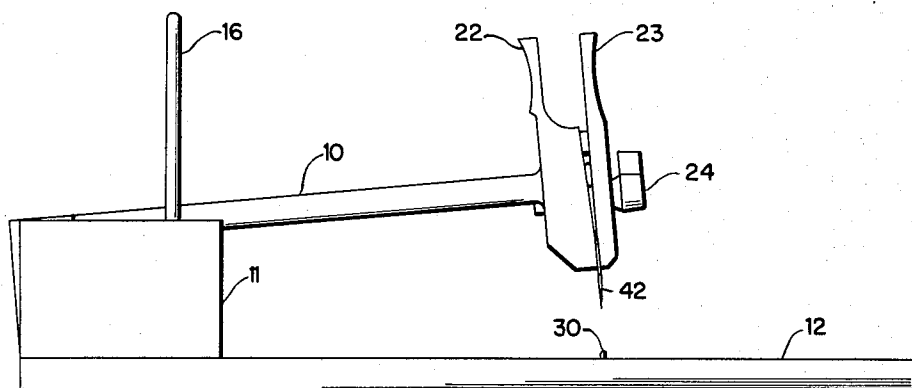
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[57]

ABSTRACT

This invention provides an apparatus and applicator for applying liquid sample to an electrophoretic membrane. The applicator comprises two parallel strips of flexible plastic film separated by a spacer along one edge. At the other edge the strips form fingers between which are suspended liquid samples. The applicator is gripped at the laminated edge by the apparatus at the end of an arm pivotally mounted on a base plate. The arm is connected by mechanical linkage to a handle which controls movement of the arm such that the applicator can be lowered to contact a membrane supported by the base plate with the correct amount of force to deposit the liquid samples cleanly and precisely on the membrane. The gripping element of the apparatus can be adjusted to control the spacing between the fingers and thereby control the amount of sample deposited.

14 Claims, 4 Drawing Figures



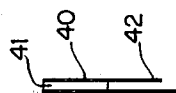


FIG. 4

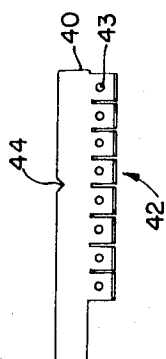


FIG. 3

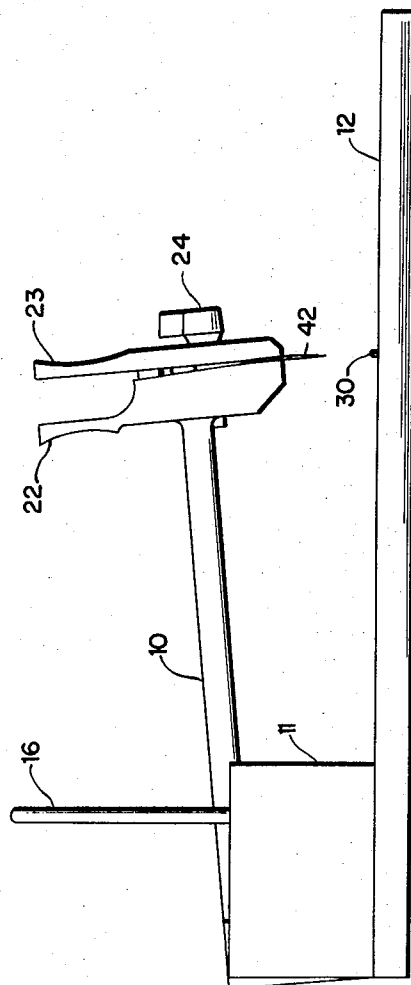


FIG. 1

ELECTROPHORESIS SAMPLE APPLICATOR

BACKGROUND OF THE INVENTION

Certain analytical procedures, such as electrophoresis, require the depositing of precise amounts of liquid sample, such as serum, at precise places on a gel or membrane resting on a carrier plate or slide. In the case of a gel, the sample is usually deposited manually, such as by pipetting the sample into preformed cavities or by applying the sample with a spatula (as described in U.S. Pat. No. 3,622,484) or other hand-held device. In either event, the operation is tedious, time consuming, requires manual skill, and is subject to operator error, with the result that frequently either too much or too little sample is deposited, or the sample is smeared or splattered on the gel or membrane. It is an object of this invention to provide an improved method, apparatus and applicator for applying liquid sample to a gel or membrane.

SUMMARY OF THE INVENTION

This invention provides an apparatus and applicator for applying liquid sample, such as blood serum, to a membrane, such as an agarose gel electrophoretic membrane. The applicator is gripped by the apparatus at the end of an arm pivotally mounted on a base plate. The arm is mechanically connected to a handle such that rotation of the handle results in rotation of the arm, whereby, when a membrane is placed on the base plate, rotation of the handle causes the applicator to contact the membrane and release sample contained by the applicator. In a preferred embodiment, the means for gripping the applicator includes means for adjusting the horizontal alignment of the applicator and means for adjusting the sample holding capacity of the applicator. The applicator comprises two strips of flexible film separated at one edge by a spacer laminated between the strips, with each strip having a plurality of fingers at the opposite edge which define capillary spaces between the strips for containing liquid sample. The apparatus and applicator of the invention overcome the problems inherent in the prior art methods of applying sample manually.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side view of the apparatus of this invention showing the arm in a slightly raised position with the applicator gripped at the end of the arm.

FIG. 2 is an exploded view of the apparatus of this invention.

FIG. 3 is a front view of an applicator used with the apparatus.

FIG. 4 is a side view of the applicator.

DETAILED DESCRIPTION

The apparatus comprises an arm 10 pivotally mounted between two support blocks 11 secured to a base plate 12 by screws 13. The arm 10 pivots on bushings 14 about pins 15. Also pivotally mounted between the support blocks 11 is a handle 16, which pivots on bushings 17 about pins 18. The handle 16 is connected to the arm 10 through a link 19. The link 19 is secured to the handle 16 by pin 20 and to the arm 10 by pin 21 at places offset from the axes of rotation such that as the arm 10 approaches a horizontal position, a large angular movement of the handle 16 results in a correspondingly smaller angular movement of the arm 10.

This ensures that the applicator enters and leaves the gel in a slow, deliberate motion so that even an untrained operator can make a precise application of sample each time.

One end of the arm 10 terminates in a face 22. A jaw 23 contacts the face 22 and is held in place by an adjusting knob 24 which threadedly engages a screw 25 passing through the face 22. The knob 24 has a spherical base which engages a spherical depression in the jaw 23. The lower edge of the jaw 23 forms a lip 26. A spring 27 biases the upper portion of the jaw 23 away from the face 22. A fin extending from the jaw 23 engages a slot 28 in the face 22 and thereby limits the rotational freedom of the jaw 23. However, the jaw 23 is free to rotate in a plane perpendicular to the surface of the face 22 about an axis passing through the knob 24.

The applicator comprises two strips 40 of flexible film, such as plastic (e.g., polyester) film, separated at the top by a spacer 41 laminated between the strips. The inner surfaces of the strips are preferably coated with a hydrophilic material, such as gelatin. The outer surfaces are preferably hydrophobic. Each strip 40 has a plurality of fingers 42 which define capillary spaces between the strips for containing the liquid samples, which are released when the fingers contact the gel. The fingers of one strip are preferably slightly longer than the fingers of the other strip so that the fingers cut and enter the gel cleanly. If the fingers were the same length, they would tend to crush the gel rather than pierce it. The shorter fingers preferably have holes 43 in them to facilitate loading of sample.

The applicator is positioned between the jaw 23 and the face 22 by pushing the upper portion of jaw 23 toward the face 22 to move the lip 26 away from the face, and then inserting the applicator such that a notch 44 in the top of the applicator engages a protrusion 29 on the face 22, followed by releasing the upper portion of jaw 23 to secure the applicator between the lip 26 and the face 22. The protrusion 29 fixes the lateral position of the applicator while permitting it to rotate so that it can be aligned horizontally.

The applicator is aligned horizontally by lowering the arm 10 until the tips of the fingers 42 touch a slide (not shown) resting on the base plate 12. As the fingers 42 touch the slide, the grip on the applicator is relaxed briefly by squeezing the upper portion of the jaw 23 toward the face 22, which permits the tips of the fingers to align horizontally on the surface of the slide.

After the fingers 42 have been aligned, the spacing between the strips may be adjusted to control the amount of sample contained between the fingers. The spacing is adjusted by rotating the adjusting knob 24. When the knob 24 is rotated completely in one direction, the surface of the jaw 23 is parallel to the surface of the face 22. The strips 40 of the applicator are then parallel and the space between them is equal to the thickness of the spacer 41. When the knob 24 is rotated in the other direction, the jaw 23 becomes angular with respect to the face 22. Since the front fingers rest against the lip 26 of the jaw 23, while the back fingers rest against the surface of the face 22, as the jaw becomes angular the front fingers become bent toward the back fingers. Thus, the lower edges of the strips 40 may be made closer or farther apart depending on the setting of the knob 24, with the result that a repeatable

amount of sample can be deposited in the gel with a minimum of operator skill.

After the fingers 42 have been aligned and the space between them adjusted, liquid sample is introduced into the space between the fingers of the adjacent strips. A particularly convenient method of introducing sample is to dip the fingers into a trough divided into compartments corresponding to the fingers. Each compartment contains a separate sample for each pair of fingers. The trough is placed on the base plate 12 and the arm 10 is lowered so that each finger enters its respective compartment of the trough. The samples flow into the spaces between the fingers by capillary action. Alternatively, sample may be introduced into the spaces by using a pipette.

The samples are deposited into a gel by placing the membrane on a slide resting on the base plate 12, and lowering the arm 10 by rotating the handle 16 until the fingers 42 contact the gel. As the fingers contact the gel, the sample is released.

The base plate 12 has two keypins 30 for accurately positioning the slide by engaging holes in the bottom of the slide. As a result, the samples are automatically deposited precisely where desired in the gel. Slides with different keyhole patterns can be used for various application requirements. The keypins can also be used to position the sample trough.

The applicator illustrated herein is especially suitable for zone electrophoresis. However, other applicators, such as for immunoelectrophoresis, can also be employed in accordance with this invention. The jaw and face of the apparatus can, of course, be modified as necessary to accommodate other applicators. Similarly, the apparatus of this invention can be used to apply samples in applications other than electrophoresis, such as paper chromatography.

What is claimed is:

1. Apparatus for applying liquid sample to a membrane, comprising
 - a base plate,
 - an arm pivotally mounted on one end and supported by the base plate,
 - means at the other end of the arm for gripping a sample applicator,
 - a handle connected by a mechanical linkage to the arm such that rotation of the handle results in rotation of the arm, whereby, when a membrane is placed on the base plate, rotation of the handle causes the applicator to contact the membrane and release sample contained by the applicator.
2. The apparatus of claim 1 wherein the gripping means includes means for adjusting the horizontal alignment of the applicator.

3. The apparatus of claim 1 wherein the gripping means includes means for adjusting the sample holding capacity of the applicator.

4. The apparatus of claim 1 wherein the mechanical connection between the handle and the arm is such that a large rotation of the handle results in a correspondingly smaller rotation of the arm as the arm approaches a horizontal position.

5. The apparatus of claim 1 wherein the base plate includes keypins for accurately positioning the membrane.

6. The apparatus of claim 1 wherein the gripping means comprises

a face at the end of the arm,

an adjusting knob threadedly engaged to the face, a jaw between the face and the knob, the jaw being free to rotate in a plane perpendicular to the surface of the face about an axis passing through the adjusting knob,

means biasing the upper portion of the jaw away from the face.

7. The apparatus of claim 6 wherein the face includes a protrusion for fixing the lateral position of the applicator.

8. The apparatus of claim 1 in combination with a sample applicator comprising two substantially parallel strips of flexible film separated at one edge by a spacer laminated between the strips, each strip having a plurality of fingers at the opposite edge which define capillary spaces between the strips for containing liquid sample.

9. The combination of claim 8 wherein the applicator has a notch at the laminated edge for engaging a protrusion in the gripping means for fixing lateral motion of the applicator.

10. A sample applicator comprising two substantially parallel strips of a flexible film separated at one edge by a spacer laminated between the strips, each strip having a plurality of fingers at the opposite edge which define capillary spaces between the strips for containing liquid sample.

11. The applicator of claim 10 wherein the fingers of one strip are slightly longer than the fingers of the other strip.

12. The applicator of claim 11 wherein each shorter finger has a hole in it to facilitate loading of sample.

13. The applicator of claim 12 wherein the inner surfaces of the strips are hydrophilic.

14. The applicator of claim 13 having a notch at the laminated edge adapted to engage a protrusion for fixing lateral motion of the applicator.

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