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(71) Applicant *(for all designated States except US)*: ROBBINS SCIENTIFIC CORPORATION [US/US]; 1250 Elko Drive, Sunnyvale, CA 95089–2213 (US).

(71)(72) Applicants and Inventors: DEGRAAFF, David [US/US]; 800 Arbor Road #3, Menlo Park, CA 94025 (US). HEYES, Kevin [US/US]; 15729 Pasco Largavista, San Lorenzo, CA 94580 (US). WRIGHT, David, J. [US/US]; 3431 Foxtail Terrace, Fremont, CA 94536 (US). ROBBINS, Paul, B. [US/US]; 866 Miranda Green, Palo Alto, CA 94306 (US).

(74) Agents: GUERNSEY, Larry, B. et al.; IPLO of Michael J. Hughes, Suite 295, 1171 Homestead Road, Santa Clara, CA 95050–5478 (US).

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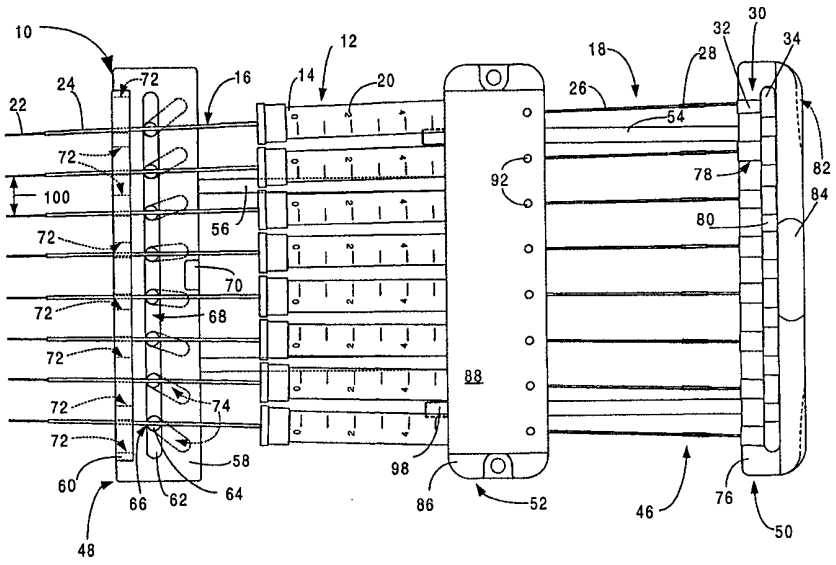

(57) Abstract

A syringe array (10) for holding a plurality of syringes (12), each syringe having a barrel (14), a plunger (18) and a needle (16), the syringe array (10) including a distal assembly (50) which holds the plungers (18) of the plurality of syringes (12) and by which all of the plurality of plungers (18) are urged to move in unison, a pivot assembly (52) wherein a portion of each the barrels (14) of the plurality of syringes (12) is pivotally attached to a pivot (92, 94) and a proximal assembly (48) wherein each needle (16) of the plurality of syringes (12) is positioned with a controlled center–to–center spacing (100, 102) from each other. An adjusting portion (62, 64, 70) of the syringe array (10) is adjustable to controllably changer the needle center–to–center spacing from a first spacing (100) to at least a second spacing (102) as the barrel portions (14) are allowed to rotate about the pivots (92, 94).

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SYRINGE ARRAY WITH ADJUSTABLE NEEDLE SPACING

This application claims priority from U.S. Provisional Application Serial No. 60/119,470, filed 2/10/99, which has the same inventors as the present application.

TECHNICAL FIELD

The present invention relates generally to multi-channel devices used in collecting, transporting and dispensing laboratory materials, and more particularly to syringe arrays used in loading sequencing gels.

BACKGROUND ART

Syringes have long been used as devices for measuring and dispensing liquids in laboratory and health care situations. Recent developments in laboratory processing have allowed the use of standardized 96 well microplates with 9mm center-to center spacing, or 384 well microplates with 4.5mm spacing. The Society of Biomolecular Screening (SBS) has established standard XY dimensions for multi-well microplates. This has allowed many processes to be automated. One such process uses sequencing gels for processing on an automated sequencer. Sequencing gels for automated sequencers are typically 0.2mm or 0.4mm thick. They are made of a porous matrix of cross-linked polymers sandwiched between two glass plates. The length and width of the gels can range in size up to approximately 30cm x 40cm. Syringes are used to dispense samples so that they flow between the glass plates and onto the top of the gel which is about one centimeter below the top edges of the glass plates. The needles are therefore necessarily of a very narrow gauge. It has been found that grouping syringes into arrays is an efficient way to withdraw material from an entire row or column of a micro-well plate and transfer this material either to

another micro-well plate or to a sequencing gel.

Sequencing gels can be configured for different numbers of "wells", each of which will hold a different sample. A well is essentially a chamber at the top surface of the gel where the surface of the gel is the well bottom and the sides of the well are formed by two "teeth" of a plastic "comb". A comb is inserted down between the plates until all the teeth contact the top of the gel and form the wells. The tops of the wells are open for samples to enter. Although width of a gel for a given automated sequencer generally stays the same, recently new sequencers have increased the number teeth in a comb, and thus increasing the number of wells present in a given gel. The result is that there are more, narrower wells with decreased center-to-center spacing of the wells. Syringe arrays that are to be used with these newer sequencers have had to deal with the change in center-to-center spacing either by having dedicated syringe arrays with fixed spacing which will accommodate only one such center-to-center spacing, or by attempting to adjust the spacing of the needle to match several different sequencers with different spacings. Prior art syringe arrays with adjustable spacing have provided sliding spreaders at the needle end of the syringes, which bend the needles so that the separation between them matches the center-to-center spacing of the wells. This has obvious disadvantages of causing stress and damage to the needles.

Thus there is a need for a syringe array with adjustable needle spacing which can match a variety of center-to-center spacings of sequencing gel wells without bending the needles of the array.

DISCLOSURE OF INVENTION

Accordingly, it is an object of the present invention to provide a device

for collecting, transporting and dispensing multiple samples of material simultaneously.

Another object of the present invention is to provide a multi-syringe device with adjustable needle spacing.

And, another object of the invention is to provide needle spacings for a multiple syringe array which are compatible with standard multi-well center-to-center spacing, but which can expand to a different, larger needle spacing to fit the center-to-center well spacing of new automated gel sequencers.

A further object of the present invention is to provide an adjustable spacing device which does not bend and put stress upon the needles of the array.

Briefly, one preferred embodiment of the present invention is a syringe array for holding a plurality of syringes, each syringe having a barrel, a plunger and a needle. The syringe array includes a distal assembly which holds the plungers of the syringes and by which all of the plungers are urged to move in unison. The syringe array also includes a pivot assembly wherein a portion of each the barrels is pivotally attached to a pivot, and a proximal assembly wherein each needle of the plurality of syringes is positioned with a controlled center-to-center spacing from each other. An adjusting portion of the syringe array is adjustable to controllably change the needle center-to-center spacing from a first spacing to at least a second spacing as the barrel portions are allowed to rotate about the pivots.

An advantage of the present invention is that needle spacing can be easily adjusted.

Another advantage of the present invention is the adjustable spacing can be used when going from a larger spacing to a smaller spacing or from a smaller spacing to a larger.

And, another advantage of the present invention is that it is adjustable to

9mm needle spacing, which is standard center-to-center spacing for 96 multi-well microplates, and also to 10.8 mm needle spacing for use with newly introduced automated gel sequencers.

A further advantage of the present invention is that there is no bending of the needles, and the accompanying stress on the needles and other components is eliminated.

These and other objects and advantages of the present invention will become clear to those skilled in the art in view of the description of the best presently known mode of carrying out the invention and the industrial applicability of the preferred embodiment as described herein and as illustrated in the several figures of the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The purposes and advantages of the present invention will be apparent from the following detailed description in conjunction with the appended drawings in which:

FIG. 1 illustrates a top plan view of the syringe array of the present invention, which is in the closed and dispensing positions;

FIG. 2 shows a top plan view of the syringe array of the present invention, which is in the closed and dispensing positions with the top cover of the pivot assembly removed;

FIG. 3 illustrates a side cutaway view of the syringe array of the present invention as taken through line 3-3 in Figure 2;

FIG. 4 shows a front side plan view of the syringe array of the present invention; and

FIG. 5 illustrates a top plan view of the syringe array of the present invention, which is in the open and dispensing positions.

BEST MODE FOR CARRYING OUT THE INVENTION

A preferred embodiment of the present invention is a syringe array with variable needle spacing. As illustrated in the various drawings herein, and particularly in the view of FIG. 1, a form of this preferred embodiment of the inventive device is depicted by the general reference character **10**. In all figures, the tip of the needles will be considered to be the proximal end of the device and the handles of the plungers will be at the distal end, and the directions "proximal" and "distal" shall in all cases be relative to these reference points.

FIG. 1 illustrates a top plan view of the syringe array with variable needle spacing **10**. In the preferred embodiment, the array holds 8 syringes **12**, although greater or lesser numbers of syringes are also contemplated by this invention as well. Eight syringes **12** have been used in this embodiment because of the ease of use with standard multi-well microplates, which conventionally have 96 wells in an 8 X 12 configuration. The syringes **12** are also preferably of the type having replaceable needles as shown in Applicant's co-pending application No. 60/089,422, but the syringe array **10** is meant to work with any standard syringe. Also as described in Applicant's co-pending application, the currently preferred replaceable needle assemblies have "two-stage needles" in which an inner member of highly flexible or "superelastic" material such as binary nickel-titanium alloy is joined to a sheath of more rigid material. This allows for sufficient rigidity that precise placement of the needle tip is facilitated, but allows some flexibility at or near the needle tip in order to minimize damage to the tip and ease directing the needle tips into very narrow channels. Such superelastic material for the inner member is available as "Alloy BB" from Memry Corporation.

Syringe arrays of different sizes are contemplated to accommodate syringes of different sizes and capacities, as well as different needle spacings and ranges of adjustment for the needle spacings.

Each syringe **12** is an assembly having a barrel **14**, a needle assembly **16**, a plunger assembly **18**, and volumetric markings **20**. The needle assembly **16** is in turn made up of an inner member **22** and a sheath **24**. Referring now also to Fig. 2, the plunger assembly **18** also includes a plunger **26** with a tip **27**, an enlarged plunger portion **28**, a handle **30** with a shaft **32** and enlarged handle end **34** and a plunger cap **36.** The plunger cap **36** has an upper pivot hole **42** and lower pivot hole **44**.

Especially when removable needle syringes are used, the barrel can optionally include an enlarged internal diameter portion with a plunger stop which can prevent the plunger tip from traveling too far in the proximal direction and dislodging the needle assembly. Alternately, the plunger enlarged portion can be made of larger diameter than the inner bore of the barrel to limit the travel of the plunger tip. The barrel may also have a conical lead-in portion so that the plunger tip can be easily inserted into the barrel with out damage.

The syringe array **10** support structure **46** includes a proximal assembly **48**, a distal assembly **50** and a pivot assembly **52**, as well as slide rods **54** and stationary rods **56**.

The proximal assembly **48** includes a proximal housing **58**, a footplate **60**, a slot plate **62**, a guide pin retainer **63** (see Fig. 4), and a number of guide pins **64**, one for each syringe **12** in the array **10**, each guide pin having a needle slot **66**. The proximal housing **58** has a transverse slot **68** and a control tab **70**. The footplate **60** also has a series of footplate transverse slots **72**(see also Fig. 4). The guide pins **64** are made to travel in guide slots **74**, which are shown in dashed lines in Fig. 1.

The distal assembly **50** includes a distal housing **76** having a number of handle slots **78** and a transverse handle slot **80**. There are also optional finger

grooves **82** and cut away **84**.

The pivot assembly **52** includes a pivot housing **86** with a top cover **88** and a housing cavity **90** (see Fig. 2) into which the syringe barrels **14** and plunger caps **36** fit. The top cover **88** is provided with a number of upper pivot pins **92,** which are equal in number to the number of syringes **10**. The pivot housing **86** also has lower pivot pins **94** which are equal in number to the syringes **10**. The pivot housing **86** additionally has through channels **96** (seen in dashed lines in Fig. 2) through which the slide rods **54** extend. Although the pivot assembly **52** is pictured as being at the distal end of the syringe barrel **14**, it is perfectly possible that the pivot assembly **52** be located at the proximal end of the syringe barrels **14,** or anywhere intermediate to these points.

The stationary rods **56** are rigidly attached at one end to the pivot housing **86** and at the other to the proximal housing **58**, thus keeping the pivot assembly **52** and proximal assembly **48** in fixed spatial relation to each other. The slide rods **54** are rigidly fixed at one end to the distal assembly **50** and extend through the channels **96** in the pivot housing **86** and are each clamped with a retaining collar **98**. The pivot assembly **52** is thus allowed to travel in the axial direction of the slide rods **54** until stopped by contact with the retaining collars **98**, but are prevented from motion in any direction except along the axis of the slide rods **54**.

When the syringe array **10** is to be assembled, the top cover **88** of the pivot assembly **52** is removed. A syringe **12** is installed by inserting the needle inner member **22** into the transverse slot **72** of the footplate **60** of the proximal assembly **48.** The needle sheath **24** is placed into the needle slot **66** of a guide pin **64**. Each guide pin **64** has previously been placed in a guide slot **74,** which will control its path of travel. The barrel **14** and plunger cap **36** of the syringe **10** are placed in the housing cavity **90** so that one of the lower pivot pins **94** is inserted into the lower pivot hole **44** of the plunger cap **36**. The syringe handle **30** is then inserted into the distal assembly **50** by placing the handle shaft **32**

into a handle slot **78** and the enlarged handle end **34** into the transverse handle slot **80**. Each syringe **12** is placed into the array **10** until all positions have been filled. The top cover **88** of the pivot assembly **52** is then replaced, so that the upper pivot pins **92** are all inserted into the upper pivot holes **42** of the plunger cap **36**. The upper and lower pivot pins **92, 94** form a series of hinge points at which each of the syringes **10** can move.

The spacing between the needles is represented by dimension **100**, which in Fig. 1 is minimized, as the syringe array is in "closed position". In this position, the proximal housing **58** is positioned at the far extreme of its travel in the proximal direction, and the guide pins **64** are in the proximal end of the guide slots **74**. As the guide slots **74** are angled, the guide pins **64** are not only closest to the proximal end, but are the closest to each other, and consequently the needles **16** are closest to each other, with minimum spacing **100**.

FIG. 2 illustrates the syringe array **10** from which the top cover **88** has been removed. The syringes **12** can now be more easily seen in the housing cavity **90**. The plunger caps **36** can be seen with the upper pivot holes **42** into which the upper pivot pins (not shown in this view) are inserted. The array in this figure is in "closed position" and also in "dispensing position" in which the plungers are all drawn back by pulling the distal assembly, which has captured the handles of all the syringes, away from the pivot assembly **52**. The slide rods **54** travel through the through channels **96** until the retaining collar **98** contacts the pivot housing **86** and prevents further motion in the distal direction. Preferably this point is reached before any of the plungers **26** leave the barrels **14**. When material is to be dispensed, the distal assembly **50** is pushed towards the pivot assembly **52**, simultaneously pushing all the plungers **26** into the barrels **14** of the syringes **12**. This motion continues until the plunger portion **26** reaches the limit of travel in the proximal direction. This position is referred to as the "aspirating position" as the syringe **12** is now ready to draw material

into the barrel **14** by aspiration. This position preferably corresponds with the tip **27** of the plunger **26** reaching the zero point of the volumetric markings **20**.

FIG. 3 shows a cut-away view of the syringe array **10** as taken through line 3-3 in Fig. 2. Line 3-3 is assumed to pass directly through the guide pins **64**, and upper and lower pivot pins **92**, **94**.

In the proximal assembly **48**, the footplate **60**, slot plate **62**, guide pin retainer **63**, guide pin **64**, guide slot **74** and control tab **70** can be seen. It can be seen how the needle **16** passes through the footplate transverse slots **72** and rests in the needle slot **66**. In the preferred embodiment, the transverse slots **72** are tapered to allow easy replacement of syringe needles **16**, as the tapering allows the needle **16** to be rotated up out of the needle slot **66**.

In the pivot assembly **52**, the syringe **12** with plunger cap **36**, can be seen in the housing cavity **90**, being held in place by the upper pivot pin **92** engaged in upper pivot hole **42**, and lower pivot pin **94** engaged in lower pivot hole **44**. The top cover **88** is shown holding the upper pivot pin **92** in place, while the pivot housing **86** holds the lower pivot pin **94**. Also visible are the plunger **26** and the plunger enlarged portion **28**.

In the distal assembly **50**, the handle shaft **32** is placed in the handle slot **78**, while the enlarged handle end **34** is captured by the transverse handle slot **80**. A portion of the finger groove **82** is also visible.

Holding the assemblies together, a slide rod **54** can be seen passing through the through channel **96** with a retaining collar **98** at its end. Also illustrated is a stationary rod **56**.

FIG. 4 shows an end view of the syringe array **10** with the proximal housing **58**, footplate **60**, control tab **70**, guide pin retainer **63**, and the ends of the stationary rods **56**, as well as the ends of the needle inner members **22** and the needle sheaths **24**. The guide pins **64**, slot plate **62** and needle slots **66** are

all shown in dashed lines. It can be seen how the needles **16** of the syringes **12** are held in the needle slots **66** of the guide pins **64**, and then pass through the footplate transverse slots **72**, where they are free to move laterally in response to changes in the needle spacing. Needle slots **66** allow easy replacement of syringe & syringe needles **16**. Guide pin retainer **63** keeps guide pins **64** in place and allows guide pins **64** to move in guide slots **74**. The guide pins **64** guide slots **74** and control tab **70** thus make up an adjusting portion **75** of the syringe array **10**. This adjusting portion **75** is in this case shown to be in the proximal assembly **48**. It is of course possible that the adjusting portion **75** could be located in the pivot assembly **52**, as an alternative.

The transverse slots **72** shown in this figure are a series of separate slots of varying width which are useful in limiting the lateral travel of the needles **16**. It should be understood that there could be many variations in the slots from the embodiment shown, and could, for example, be replaced with a single transverse slot extending from side to side and enclosing all 8 of the needles.

FIG. 5 illustrates a top plan view of the syringe array **10** in which the top cover **88** is still attached. The distal assembly **52** is again drawn back away from the pivot assembly **50**, so that the device is in dispensing position. Now, however, the control tab **70** has been drawn in the distal direction so that the proximal housing **58** has pulled all the guide pins **66** to the distal ends of the guide slots **74** in the slot plate **62**, and away from the footplate **60**. The guide pins **66** thus slip toward the distal end of the needles **16** and move apart from each other in the proximal housing transverse slot **68**. The needles **16** consequently spread apart in the transverse slots **72** and assume the open position, wherein the needle spacing **102** has been maximized.

As the tips of the needles **16** travel from a first, closed position having a closed position spacing **100** (Fig. 1) to a final open position spacing **102** (Fig. 2), the needle tips can be conceived of as traveling a path **104**, shown

exaggerated in Fig. 5. It is possible that the path be a smooth continuum from first spacing to a final spacing, with positioning anywhere in between. It is possible that the control tab be fitted with a pointer which could indicate spacings on a small chart to make adjustment easier. It is also possible that the path contain discrete stops which correspond to spacings used in various models of sequencers. The stops could be implemented by having the control tab 70 biased against a surface containing teeth or notches which would serve to establish the desired spacing dimensions. Thus although the preferred range of spacing for this device is presently 9.0mm to 10.8mm, these could be stops along a wider continuum of adjustment.

A typical operating situation for the syringe array **10** is for use in transferring micro-liter volumes of liquid from 96 well microplates with 9mm center-to center spacing, or 384 well microplates with 4.5mm spacing, to a sequencing gel for processing on an automated sequencer. Sequencing gels for automated sequencers are typically 0.2mm or 0.4mm thick. They are made of a porous matrix of cross-linked polymers sandwiched between two glass plates. The length and width of the gels can range in size up to approximately 30cm x 40cm. The syringe array **10** has to be able to dispense samples so that they flow between the glass plates and onto the top of the gel which is about one centimeter below the top edges of the glass plates. The needles **22** are therefore necessarily of a very narrow gauge.

Sequencing gels can be configured for different numbers of "wells", each of which will hold a different sample. A well is essentially a chamber at the top surface of the gel where the surface of the gel is the well bottom and the sides of the well are formed by two "teeth" of a plastic "comb". A comb is inserted down between the plates until all the teeth contact the top of the gel and form the wells. The tops of the wells are open for samples to enter. For the ABI 377Automated Sequencer, which is typical of devices in the industry, the

maximum number of wells has been 72. Recently ABI has introduced an upgrade to hardware and software that allows 96 samples (in 96 wells) to be run on a single gel. The different combs that form 64, 72, 96, etc. wells are all the same length but differ in their number of teeth contained in that length, and therefore the number of wells they will form. The width of the gel for a given automated sequencer stays the same so when there is an increase in the number of wells, the wells become more narrow. An important point is that by changing the width of the wells the center-to-center spacing of the wells is changed.

Most of the combs available conform to a "standard" center-to-center well spacing such that when the spacing is multiplied by 2, 3, 4, or 5 it equals 9mm. A multi-channel loader with a fixed 9mm spacing is able to aspirate 8 samples from a 96 well plate and dispense into every 2nd, 3rd, or 4th, etc. well of a sequencing gel made with a "standard" comb. In other words, 9mm is the distance between the centers of wells 1 and 3, or 1 and 4, or 1 and 5. It is necessary to skip the intervening wells and come back with subsequent transfers to fill them and then have some algorithm set up to keep track of which sample is which.

The center-to-center spacing of the wells made with the new 96 well comb for the ABI377 automated sequencer is 1.8mm. Since 1.8mm x 5 = 9.0mm, one could load many (but not all) wells of a gel made with this comb using the 9.0 mm fixed spacing gel loaders now available on the market. The problem with the 9.0mm fixed spacing loader is that after 10 transfers of eight samples each wells 1-80 are filled but wells 81-96 cannot be filled. The next transfer would try to fill wells 81, 86, 91, 96, 101, 106, 111, and 116 but would be beyond the right edge of the gel. The only way to fill all 96 wells with an eight channel loader is with 12 dispenses of every sixth well (1.8mm x 6 = 10.8 mm), 12 dispenses of every third well (1.8mm x 3 = 5.4), or by loading adjacent wells. The preferred embodiment is designed to expand from a 9.0mm spacing of the needles to 10.8 mm spacing thereby allowing all 96 wells to be filled with

12 dispenses loading every sixth well. In the transfer of material from wells having smaller spacing to wells having larger spacing, the syringe array **10** will be adjusted so that the control tab **70** is pushed to the limit of the proximal direction and the array **10** is in closed position. The needle spacing **100** is thus preferably 9mm, as in Fig. 1, to match the 9mm center-to center spacing of the multi-well microplate from which material is to be collected. The distal assembly **50** will be initially pressed to the limit of travel in the proximal direction so that the array **10** is in aspirating position. After the needle tips **22** are inserted in the wells of the material to be transferred, the distal assembly **50** is then drawn in the distal direction so that all eight plungers are simultaneously withdrawn to collect the material in the syringes **12**.

When dispensing material to a sequencing gel where a center-to-center spacing of 10.8 mm is desirable, the control tab is pulled to the limit of travel in the distal direction, thus expanding the needle spacing **102** to the open position, as seen in Fig. 5. The material is then dispensed by moving the distal assembly **50** in the proximal direction, thus pressing all the plungers **18** simultaneously to place material in the wells of the gel.

The transfers just described assume going from lesser to greater spacings but the reverse would be possible as well. It is also possible to use other ranges of spacings than from 9 mm to 10.8 mm. It is possible that 9 mm and 10.8 mm are stops in a larger range of spacings, and there may be an additional mechanism included in the syringe array that has notches or indicator settings to mark the more commonly used spacings. For example, the control tab could be spring biased to fit in a series of notches as it is drawn further into a wider and wider open position, one of which notches corresponds to 9mm spacing and other which could be for 10.8 mm spacing. Any number of such mechanisms will be obvious to one skilled in the art, and are included in the true spirit and complete scope of the present invention. It is also possible the spacing could be 9 mm to 4.5 mm for 96-well to 384-well transfers or 2.25 mm for 1536-well

transfers. Other spacings could be used for transfers from 384-well or 1536-well plates to gel loaders of various well-to-well spacing.

In addition to the above mentioned examples, various other modifications and alterations of the inventive device **10** may be made without departing from the invention.

INDUSTRIAL APPLICABILITY

The present syringe array with adjustable needle spacing **10** is well suited for many laboratory applications. In particular, for applications where multiple wells of a gel sequencer are being loaded, the present invention will be very useful.

ABI 377Automated Sequencer, which is typical of devices in the industry, has used 72 well format. Recently ABI has introduced an upgrade to hardware and software that allows 96 samples (in 96 wells) to be run on a single gel. This of course, allows a greater number of samples to be run simultaneously in the same period of time. In order for laboratory personnel to take advantage of this opportunity for increased efficiency, it is important that materials handling apparatus be compatible with these new advances. To be able to interface with the changed center-to-center spacing of these newer sequencers, the present invention 10 allows the needle spacing to be adjusted. Without this capability, laboratory personnel must purchase new syringe arrays to match the sequencer in use. Worse yet, in a lab which may have a variety of sequencers, some new, some old, each with differing well spacings, it would be necessary to assign a dedicated set of syringe arrays with compatible needle spacings to each machine.

By having adjustable needle spacing, dedicated syringe array sets are not necessary. It is not necessary to remember which set matches with which sequencer. Also it enables personnel to use a number of different sequencers at one time. An adjustable syringe array can be filled with material to be dispensed, a gel in one sequencer with one spacing requirement can be filled, and then a gel in a second machine with a second spacing requirement may be filled from the same syringe array after adjustment, perhaps without reloading the array.

Ordering new arrays is much easier if one array model can be purchased,

rather than a myriad of differing models. Processing in general is expedited. Innovation in sequencer efficiency design may be encouraged because further increase in the number of wells per gel may be accommodated by adjusting the needle spacing to fit. Innovation may not be hampered by the concern that customers will have to discard their old material handling equipment and by new ones in order to be compatible.

For the above, and other, reasons, it is expected that the syringe array with adjustable needle spacing **10** of the present invention will have widespread industrial applicability. Therefore, it is expected that the commercial utility of the present invention will be extensive and long lasting.

IN THE CLAIMS

What is claimed is:

1. A syringe array for holding a plurality of syringes, each syringe having a barrel, a plunger located at the syringe's distal end, and a needle located at the syringe's proximal end, comprising:

a distal assembly wherein each plunger of said plurality of syringes is held, and by which all of the plurality of plungers are urged to move in unison;

a pivot assembly wherein a portion of each said barrel of said plurality of syringes is pivotally attached to a pivot; and

a proximal assembly wherein each needle of said plurality of syringes is positioned with a controlled center-to-center spacing from each other, wherein;

an adjusting portion of said syringe array is adjustable to controllably change said needle center-to-center spacing from a first spacing to at least a second spacing as said barrel portions are allowed to rotate about said pivots.

2. A syringe array as in claim 1, wherein:

said adjusting portion of said syringe array is within said proximal assembly.

3. A syringe array as in claim 2, wherein:

said proximal assembly includes a plurality of guide pins which slidably capture and direct said needles, said guide pins being confined to travel in at least one slot in a slot plate, said at least one slot being configured so that said guide pins spread apart from each other as they

travel, thus changing said needle center-to-center spacing from a first spacing to at least a second spacing.

4. A syringe array as in claim 1, wherein:
said adjusting portion moves said needle center-to-center spacing along a path from a first spacing to a final spacing.

5. A syringe array as in claim 4, wherein:
said center-to-center spacing path from first spacing to final spacing is a smooth and continuous path whereby said center-to-center spacing is adjustable to any spacing along a continuum from first spacing to final spacing.

6. A syringe array as in claim 4, wherein:
said center-to-center spacing path from first spacing to final spacing include a plurality of discrete stops, corresponding to spacings useful for specific applications.

7. A syringe array as in claim 4, wherein:
said first spacing is 9.0mm and said final spacing is 10.8mm.

8. A syringe array as in claim 1, wherein:
the number of syringes in said plurality of syringes is chosen from the set consisting of 4, 6, 8, 10, and 12 syringes.

9. A syringe array as in claim 1, wherein:
said pivots of said pivot assembly are attached to the distal end of said syringe barrels.

10. A syringe array as in claim 1, wherein:

said pivots of said pivot assembly are attached to the proximal end of said syringe barrels.

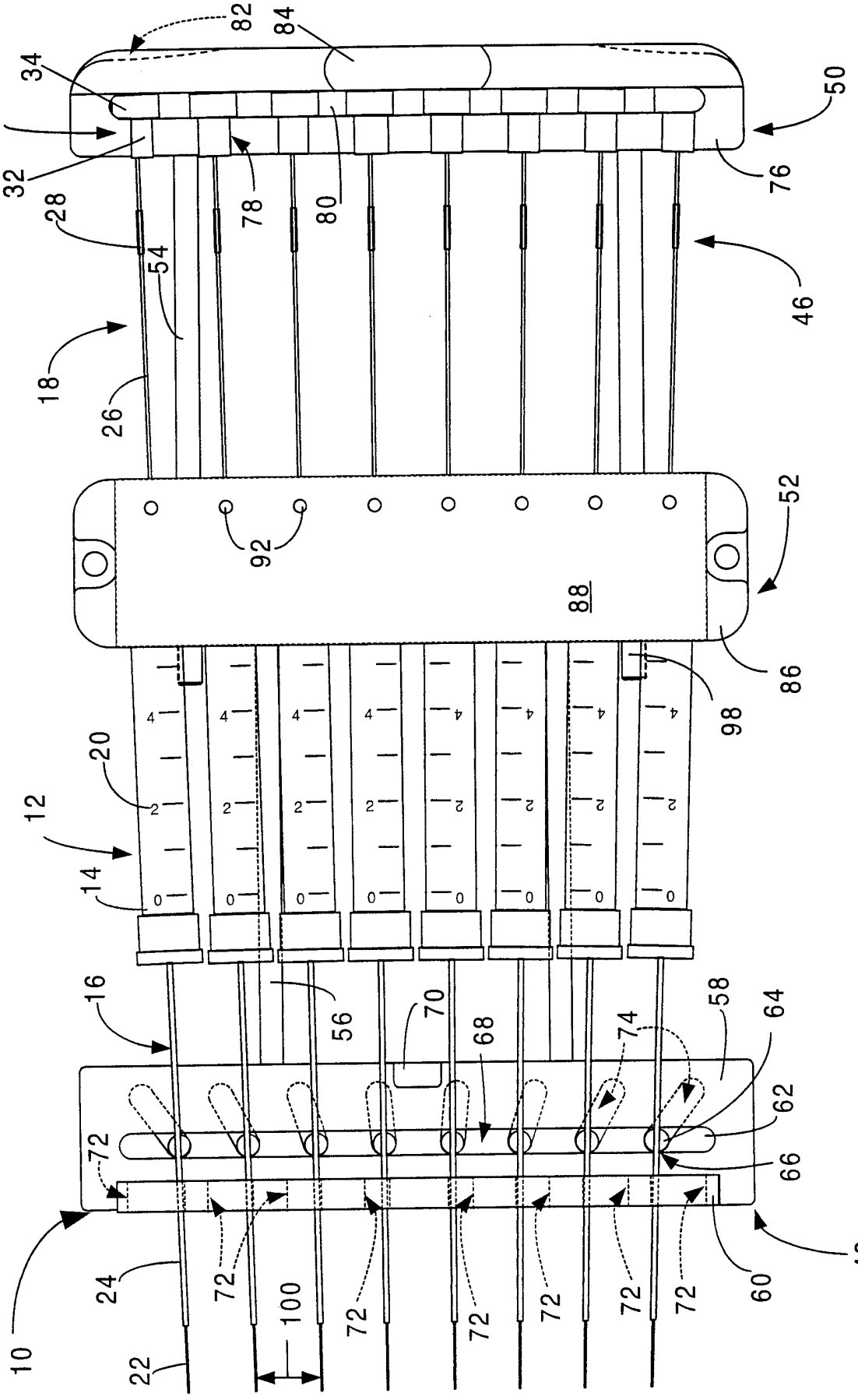
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FIGURE 1

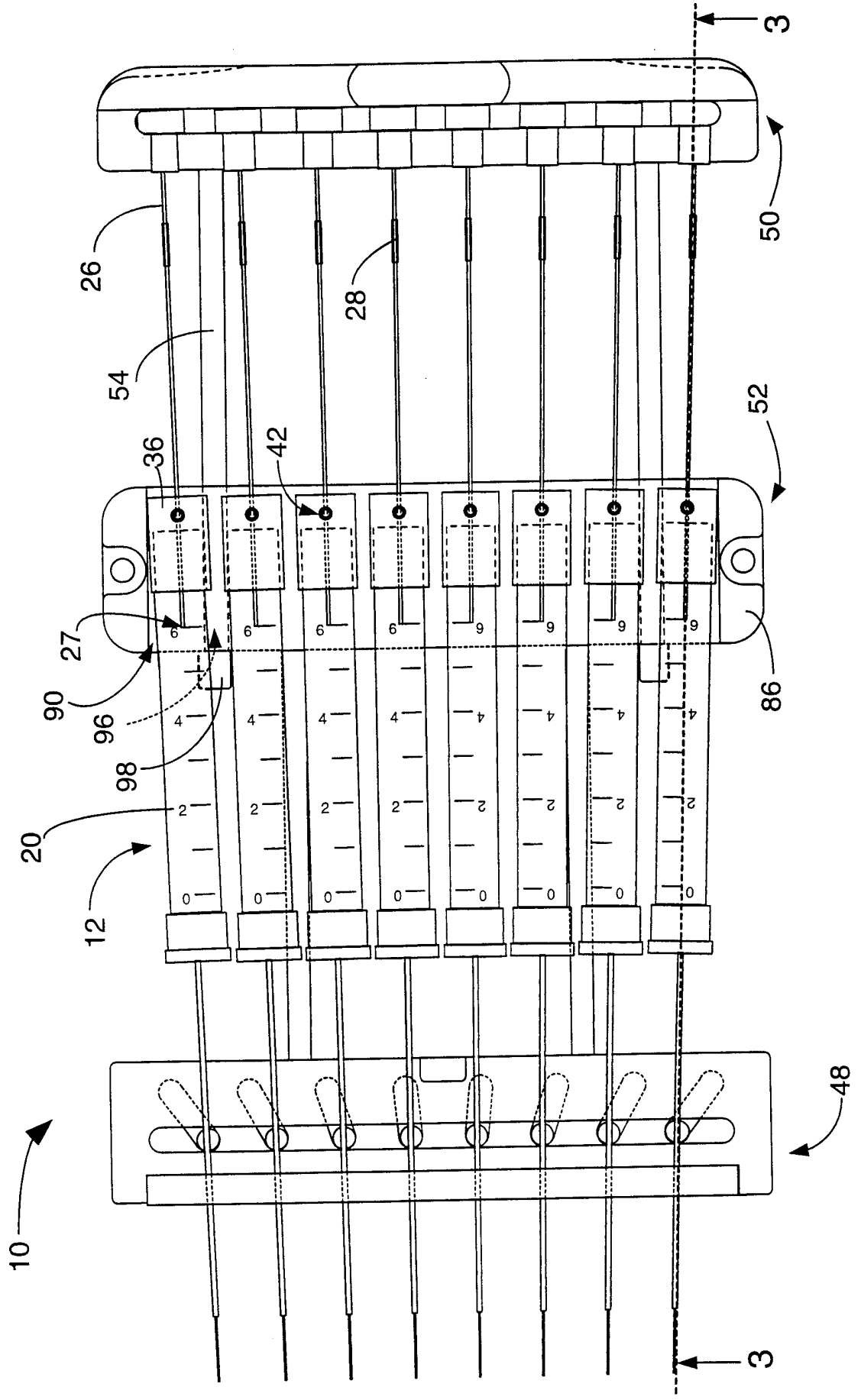

FIGURE 2

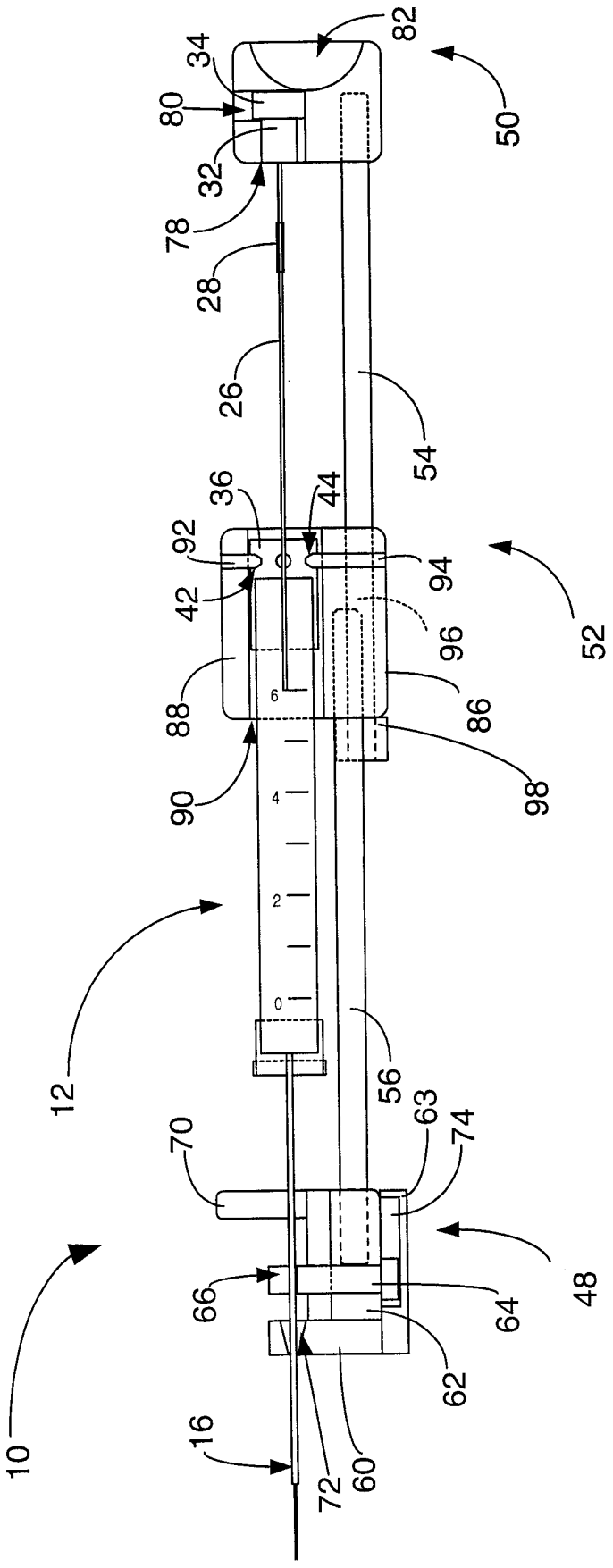
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FIGURE 3

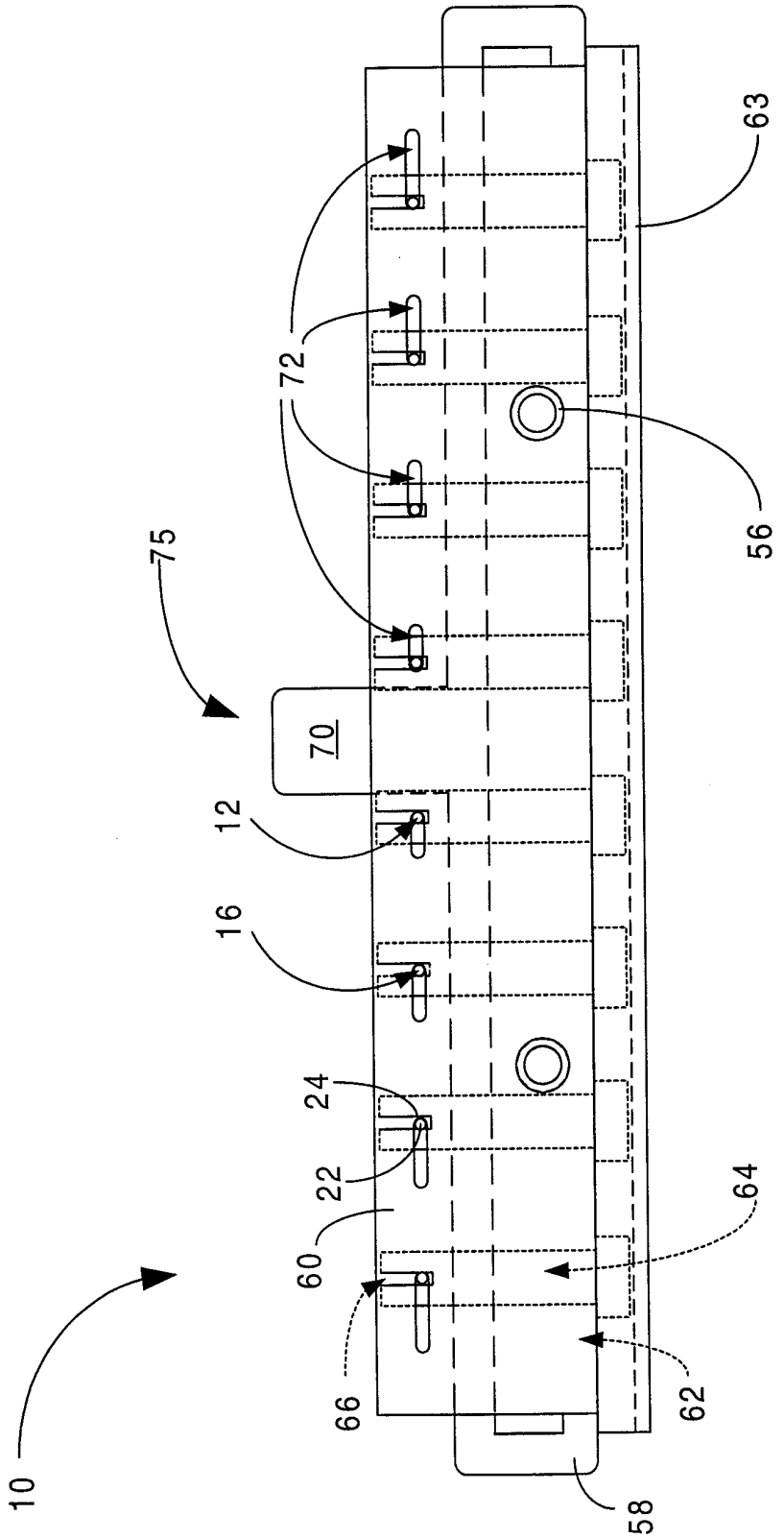

FIGURE 4

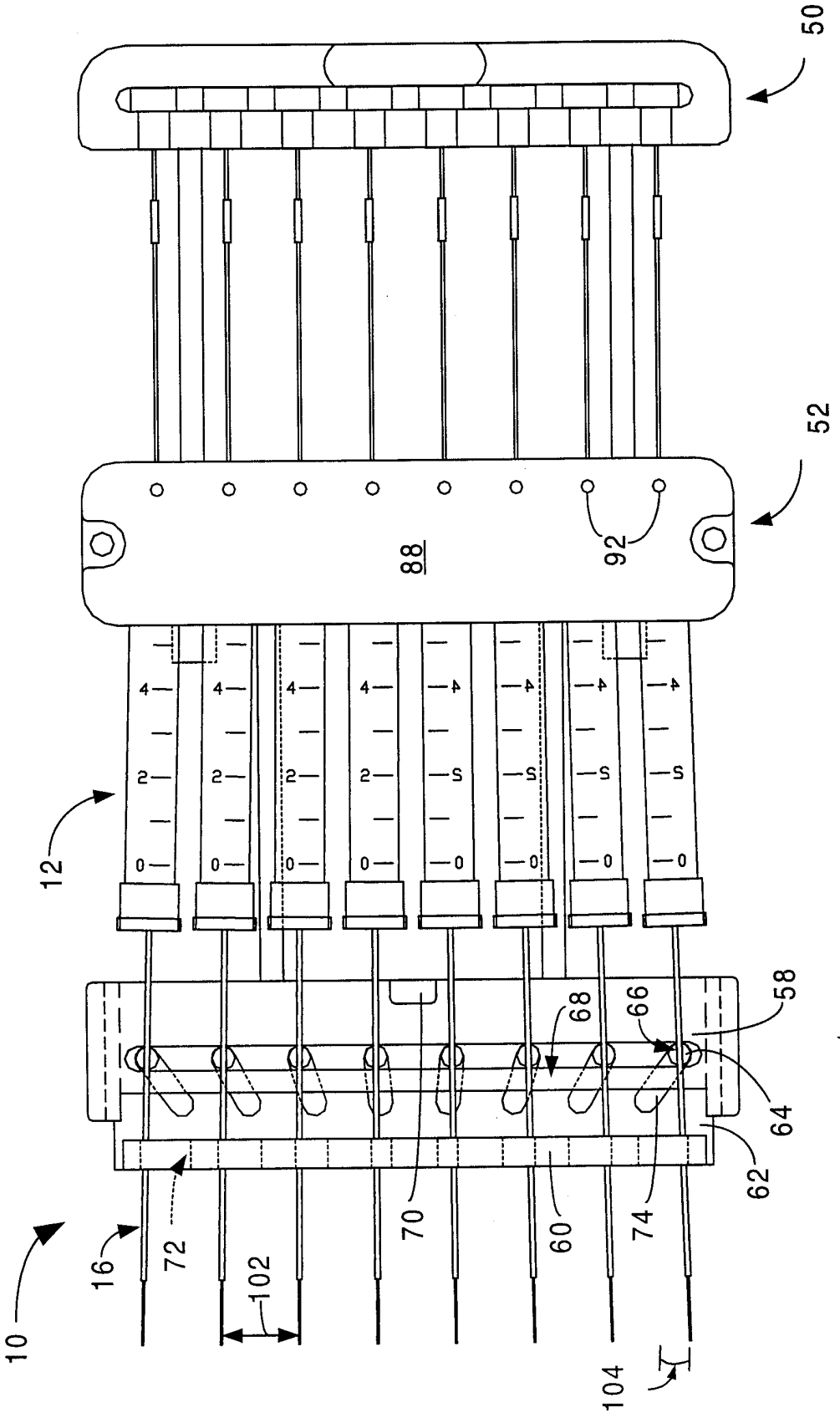

FIGURE 5

INTERNATIONAL SEARCH REPORT

In. ational application No.
PCT/US99/25347

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :A61M 5/00; G01N 1/26; B01L 3/00, 3/02, 9/00

US CL :Please See Extra Sheet.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 422/99, 100, 104; 604/207, 208; 73/863.31, 863.32, 864.11, 864.13, 864.16, 864.17

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EAST

search terms: syringe, needle, pipette, array, matrix, liquid or fluid dispensing, hamilton company

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3,738,493 A (CUMMINS et al) 12 June 1973, Figure 1, column 2.	1, 7, 8
A	US 4,106,911 A (MARCELLI) 15 August 1978, Figure 2, column 1.	1, 7, 8
A	US 4,141,833 A (CUMMINS) 27 February 1979, Figure 1, columnn 2.	1, 7, 8
A	US 4,276,048 A (LEABACK) 30 June 1981, Figure 4, column 5.	1, 7, 8
A	US 4,459,864 A (CIRINCIONE) 17 July 1984, Firgure 4-6.	1
A	US 4,846,797 A (HOWSON et al) 11 July 1989, entire document.	

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search	Date of mailing of the international search report
13 APRIL 2000	19 JUN 2000
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer DWAYNE K. HANDY Telephone No. (703) 308-0661

Form PCT/ISA/210 (second sheet) (July 1998)*