Title: AUTONOMOUS SYRINGE AND GRID SYSTEMS

Abstract: A syringe and grid interface (10) provides for improved wear and performance characteristics by providing compliant contacts on the grid. Also disclosed is a grid (1) design that can provide continuous electrical contact between the grid and a syringe as the syringe is moved axially relative to the grid.
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Autonomous Syringe and Grid Systems

Priority
This application claims priority of U.S. Provisional Application Nos. 60/948,620 filed July 9, 2007 and 61/024,285 filed January 29, 2008, both of which are hereby incorporated herein by reference.

Field of the Invention
The invention herein described relates generally to laboratory sample management operations and systems including robotic handling systems, components and methods, particularly for analytical applications, more particularly for liquid sample analytical systems, and still more particularly for bioanalytical and pharmaceutical applications.

Related Applications
International Publication No. WO 2005/124366 A1, which is hereby incorporated herein by reference, describes a system and method that enables efficient transport of movable devices such as sampling probes and other transportable devices. The system and method permit operational timesharing of a transport mechanism or multiple transport mechanisms for the movable devices. In addition, control of a transport mechanism can be effected on an event-driven basis. To facilitate system control, each movable device may be uniquely identified for independent operation by the controller.

The sampling probes typically provide for aspirating and/or dispensing an agent. The sampling probes may be self-contained thereby eliminating the need for a tether and thus reducing the complexity of coordinating the flow of the sampling probes through the system. An untethered self-contained sampling probe typically would include a plunger and a motive device for moving the plunger in response to a command signal. The command signal may be effected wirelessly between the sampling probe and a stationary system component, and/or by other suitable means.
The self-contained sampling probe may include a dedicated metering device for independent aspiration and/or dispensing of an agent, and control circuitry for receiving commands and controlling the metering device. The metering device generally comprises a syringe including a lumen, a plunger for drawing and/or dispensing a fluid into and/or from the lumen, and a motive device, such as an electric motor, for moving the plunger. In addition, the sampling probe may include a power supply for powering the motor and associated control circuitry, or other means by which power is supplied to the syringe at a station.

International Patent Application No. PCT/US06/02845 discloses various components that may be used in a system as above-described. In particular, said application discloses a grid assembly that provides mechanical support, electrical power, and communication for autonomous syringes during normal, automated operation. The grids may consist of alternating horizontal strata of insulating and electrically conducting material with at least one vertically contiguous, round hole constructed through the layers exposing annular, layered, alternating edges of the two materials at specific heights within the hole. The device may be constructed by starting with an insulating sheet at the bottom followed by three alternating sheets each of conductive and insulating material respectively. The sheets may be made to specific thicknesses to place respective conducting layers at specific distances from the upper surface of the top insulating layer to match axially separated conductive pins protruding through the peripheral surface of an autonomous syringe. This configuration an be used to provide continuous electrical contact between the grid and syringe independent of the syringe’s orientation about its long axis.

The disclosed configuration works very well for applications requiring only a modest to moderate number of insertions and retractions of the syringe between normal maintenance intervals. However, after only roughly 1,000 to 2,000 insertions and retractions, incidental scraping of the syringe’s exterior surface along the grid’s annulus as it is being placed into and withdrawn from the grid can cause enough of the grid’s insulating material, the syringe body’s external coating, and/or general debris, to skive off and get dragged over the
conductive layers forming an intermittent insulation layer between the syringe's push pins and the grid's conductors resulting in highly unreliable behavior.

Summary of the Invention

The present invention provides a new syringe and grid interface that enables one or more advantages to be achieved.

According to one aspect of the invention, there is provided a new syringe and grid interface for applications requiring large numbers of reliable syringe insertions and retractions. Surprisingly and unexpectedly, the use of compliant electrical contact(s) on the grid rather than or in addition to compliant electrical contact(s) on the syringe, avoids one or more of the previously encountered problems and enables large numbers of reliable syringe insertions and retractions.

In particular, the invention provides a novel and inventive grid comprising at least one annulus into which a syringe can be axially inserted; and at least one compliant, electrical contact protruding from the inner surface of the annulus for effecting electrical contact with a fixed or compliant contact on the syringe whereby electrical contact between the syringe and the grid can be established. In most applications, the grid will have a plurality of compliant, electrical contacts for establishing electrical contact with correspondingly arranged electrical contacts on the syringe.

Accordingly, there is provided a syringe and grid system comprising a grid having at least one annulus, the annulus having at least one compliant, electrical contact on an inner diameter surface of the annulus; a syringe insertable into and removable from the annulus of the grid, the syringe having at least one fixed or compliant electrical contact at the periphery of the syringe; wherein the contact at the inner diameter surface of the annulus engages the contact at the periphery of the syringe when the syringe is inserted into the annulus of the grid.

According to another aspect of the invention, there is provided a syringe and grid system comprising a grid having at least one annulus, the annulus having at least one fixed or compliant, electrical contact on an inner diameter surface of the annulus; a syringe insertable into and removable from the annulus.
of the grid, the syringe having at least one fixed electrical contact at the
periphery of the syringe; wherein the contact on the inner diameter surface of
the annulus is actively retracted into the grid during insertion of the syringe into
the annulus of the grid or removal of the syringe from the annulus of the grid;
and wherein the contact on the inner diameter surface of the annulus is actively
extended into the annulus of the grid when the syringe is at a predetermined
position within the annulus and the contact of the annulus registers against the
contact on the syringe.

According to a further additional or alternative aspect of the invention,
there is provided a grid assembly that can provide continuous electrical contact
between the grid and syringe as the syringe is moved axially relative to the grid.
While providing rotationally isotropic grids is desirable in some instances such
as when human beings insert or retract syringes from the grid elements,
providing vertically continuous grids is desirable in other situations. The latter
allows, for instance, syringe placement at continuously selectable heights over
various modules such as sample plates. A vertical grid can also enable the
transfer of syringes from an energized gripper/syringe collection into grid
elements, and vice versa, without having to power down the syringe to eliminate
spurious communication signals as the syringe's contacts pass across the grid's
annular contacts.

The herein disclosed grid designs are complimentary to the grid design
disclosed in International Patent Application No. PCT/US06/02845, all of which
are useful for typical applications of the autonomous syringe described in said
application or in this application.

Further features of the invention will become apparent from the following
detailed description when considered in conjunction with the drawings.

Brief Description of the Drawings

In the annexed drawings,
FIG. 1 is a perspective view of an exemplary grid assembly according to
the invention;

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FIG. 2 is a perspective view of the grid assembly of FIG. 1, wherein a grid block (housing) and mount are partly broken away in cross-section;

FIG. 3 is a perspective view of the grid assembly of FIG. 1, with the grid block removed to show the electrical contacts of the grid assembly;

FIG. 4 is a perspective view of the electrical contacts;

FIG. 5 is a perspective view showing a syringe partway inserted into the grid assembly;

FIG. 6 is a perspective view showing a syringe partway inserted into the grid assembly;

FIG. 7 is a cross-sectional view of the grid assembly, with the syringe having been fully inserted into the grid assembly by a robotic gripper on a motion mechanism;

FIG. 8 is a cross-sectional view of the grid assembly with the syringe fully inserted therein;

FIG. 9 is a cross-sectional view of the grid assembly with the syringe partially withdrawn;

FIG. 10 is a cross-sectional view of the grid assembly with the syringe being manipulated by the robotic gripper;

FIG. 11 is an isometric view of another grid according to the invention, with compliant contacts and its interaction with an autonomous syringe with non-compliant contacts;

FIG. 12 is a cross-sectional view of the grid and a side elevational view of the syringe of FIG. 11;

FIG. 13 is a side elevational view of the syringe of FIG. 11 and a contact of the grid;

FIG. 14 is a cross-sectional view of the grid and a side elevational view of the syringe of FIG. 11; and

FIG. 15 is a top view of a grid with a syringe inserted showing solid, guide areas and milled electrical contact areas.
Detailed Description

Because the various aspects of the invention were conceived and
developed for use in an adaptive, synchronized motion and fluids system for
automating the sample handling process associated with analytical processes
and especially bioanalytical processes such as introducing samples into LC
systems, HPLC systems, etc., it will be herein described chiefly in this context.
However, the principles of the invention in their broader aspects can be adapted
to other types of systems.

Referring now in detail to the drawings and initially to FIG. 1, an
exemplary embodiment of a grid assembly according to one aspect of the
invention, herein also referred to as a vertical grid, is designated generally by
reference character 1. The assembly 1 generally comprises grid block (housing)
9 supporting a plurality of electrical contacts 2 (three in the illustrated example),
and a mount 3, such as a bracket, for mounting the grid assembly in relation to
other components of an overall sample handling system.

As seen in FIGS. 1-4, each electrical contact 2 has internal and external
features. Internal contact portions 2a of the electrical contacts can interface with
push pins 5 on an autonomous syringe 4 while external contact portions 2b of
the electrical contacts can provide convenient connection to an on-board or
remote power and communication electronics. The internal contact portions are
disposed around an aperture 9a in the housing that receives the syringe 4.
Possible power and communication devices for vertical grids are described in
International Patent Application No. PCT/US06/02845, which is hereby
incorporated herein by reference.

FIG. 2 is a cut away view of the vertical grid device shown in Fig 1. As
shown, the internal contact portions of the contacts are circumferentially spaced
apart and electrically isolated from one another, and each has a vertical (axial)
extent that may be equal in length to the height of the grid block 9. Thus, the
internal contact portions 2a of the electrical contacts 2 have a vertical, linear
nature as compared to the horizontal, annular nature of the corresponding
internal electrical contacts of the horizontal grid described in International Patent
Application No. PCT/US06/02845. Electrical continuity between the internal and

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external electrical contact portions can be effected by any suitable means such as by the illustrated unitary structure, or by conductive traces, conductor affixed to the inner and outer contact portions, etc.

In FIG. 3 the grid block has been partly removed to show just the electrical contacts and their relation to the mounting bracket 3. FIG. 3 also shows how the internal electrical contact portion has a substantial vertical surface to provide considerable vertical freedom for placement of the syringe within the grid element while still maintaining electrical contact therebetween. The internal electrical contact shape (e.g. arcuate) also has a significant horizontal surface to allow reasonable rotational freedom of the syringe while maintaining reliable electrical contact. This provides a large amount of tolerance in assembling and aligning the grids with the syringe push pins 5.

If desired, one or more of the contacts 2 could be radially compliant, i.e. radially movable and resiliently biased radially inwardly. This could be done, for example, by interposing a spring (not shown) between the grid block and the illustrated nut or other abutment on the radially extending stem of the contact, as well as by other suitable means. Another grid design with compliant contacts is shown in FIGS. 11-15 and described below.

FIG. 4 shows the vertical grid electrical contacts 2 by themselves.

FIGS. 5 and 6 illustrate how the grid device articulates with an autonomous syringe such as the syringe disclosed in International Patent Application No. PCT/US06/02845. FIG. 5 shows the syringe capable of either rotationally anisotropic or isotropic application. This style of syringe contains an asymmetric clocking screw passing through its diameter which can be used to nestle into a corresponding notch on the grid top plate (not shown in this figure) to enforce rotational compliance to a predefined orientation. FIGS. 7 and 10 show a grid top plate containing a clocking notch. In situations where total rotational freedom is allowed or desirable, the grid top plate can be made flat (with no clocking notch) allowing the syringe to be freely rotated about its long axis despite possessing an asymmetric clocking screw. Another possibility for conferring full rotational freedom is to utilize a syringe without a clocking screw as shown in FIG. 6. This syringe style maintains total rotational freedom with
either a flat or notched grid top plate. To allow full rotational freedom electrically in cases where it is allowed mechanically, the grid can be configured with auto-sensing circuitry to determine which internal electrical contact is mated with which syringe push pin. This is a similar mechanism to that described for the gripper assembly in International Patent Application No. PCT/US06/02845.

FIGS. 7 through 10 are cross-sectional views further illustrating various aspects and features already mentioned regarding the vertical grid assembly. FIGS. 7 and 8 depict how fully seated syringes and their electrical push pins can engage with the grid inner vertical contacts. They also show the grid assembly and syringe in relation to a gripper assembly 8. FIGS. 9 and 10 provide cross-sectional views showing relations among the grid assembly, a partially inserted or retracted syringe, and the gripper assembly 8.

As will be appreciated, the vertical grid assembly enables one or more of the following characteristics:

1) does not require "shutting down" a syringe before inserting it into or removing it from the grid to prevent data corruption - leading to faster overall transport and drop-off times for automated systems.

2) allows autonomous syringes to be placed at any desired vertical location within hardware limitations.

3) can be single entities or be made to form arrays of multiple grid elements with spacing as close as 9 mm between nearest neighbors.

Turning now to FIGS. 11 and 12, an exemplary syringe and grid system according to another aspect of the invention is shown at 10. The system 10 includes a grid 12 including at least one annulus 15, an at least one compliant, electrical contact 14 located at an inner diameter surface of the annulus. A syringe 11 is shown insertable into and removable from the annulus of the grid body 15, the syringe 11 having at least one fixed electrical contact 13 on the periphery of the syringe body 16. The contact 14 on the inner diameter surface of the annulus 15 engages the contact 13 on the periphery of the syringe body 16 when the syringe 11 is inserted into the annulus of the grid 12. As shown, the grid 12 contains compliant, conductive push pins 14 while the syringe 11 contains fixed contacts 13. The use of compliant, electrical contacts 14 in the

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grid 12 allows much larger, more robust components/contacts than can be fitted to the syringe body 16 providing better reliability, lifetime, and a larger electrical contact surface area. The compliant contacts 14 (push pins in this example) are spatially separated axially and azimuthally (circumferentially) on the inner surface of the annulus 15 with each contact having a bullet shaped electrical contact surface at its nose end. Conversely, the fixed contacts 13 on the syringe 1 are correspondingly spatially arranged to mate with the contacts 14 of the grid 12. Although not shown, alternative arrangements include compliant electrical contacts 14 on both the syringe 11 and grid 12.

The electrical contacts can provide convenient connection to an on-board or remote power and communication electronics. Possible power and communication devices for vertical grids are described in International Patent Application No. PCT/US06/02845, which is hereby incorporated herein by reference.

In another embodiment, the contacts may have axially and/or radially elongated contact surfaces as described above in connection with the embodiment shown in FIGS. 1-10.

To further enhance the electrical make and break lifetime and reliability, complimentary shapes for the corresponding syringe and grid contacts 13 and 14 may be used. An example is shown in FIGS. 3 and 4 where the grid 12 contains compliant probes 14 having a bullet shaped electrical contact surface 20. The syringe 11, on the other hand, contains fixed contacts 13 with a dimple or other recess 21 on its mating surface similar in form, but complimentary (i.e. loosely in relief), to the grid contact's bullet shape contact surface thus enhancing the contact area. FIG. 3 highlights the dimpled nature of the syringe's electrical contact 13 as well as the bullet shaped, compliant electrical contact 14 (probe) used in the grid 12. The grid contact 14 is shown slightly displaced away from the syringe contact 13 to illustrate its full surface shape. FIG. 4 shows the grid contact 14 fully seated in the recess of the syringe contact. The nose 20 of the grid contact 14 recesses into the dimple 21 of the syringe's contact member 12, to provide enhanced electrical contact 14 as well as holding force for the syringe 11 while it's placed in the grid 12. Improvements
in both lifetime and insertion force are obtained when the surfaces on both the grid and syringe contacts 13, 14 are smooth and have no sharp breaks or ridges. As will be appreciated, the grid contact could instead have the dimple and the syringe contact could have a bullet-shape contact surface, if desired.

Although only one annulus of the grid and one syringe is shown, the syringe and grid system may have multiple annuluses and syringes. The multiple annuluses may be discrete or formed by a common body. For example, a grid block may contain a unitary arrangement of annuluses, the annuluses being the portions of the grid block that respectively form an array of apertures for receiving respective syringes.

Preferably, the optimum electrical contact placement for passive syringe/grid systems which use the above-described electrical contact mechanism to prevent the syringe from being displaced from the grid during operation is to place each contact pair such that the holding force for it is 1/n the total desired holding force needed to prevent the syringe from dislodging from the grid during its operation. Here n is the total number of grid probes 14 contacting syringe contacts 13 for each grid. For passive syringe/grid systems employing a means other than the electrical contact mechanism (including no means at all) to prevent the syringe from dislodging from the grid during operation, each contact pair is positioned such that the contact force is 1/n the gravitational force of the syringe. Again, n is the total number of grid probes contacting syringe contacts for each grid. More generally, the holding force effected between the mating contacts can be used to hold the syringes in the grid against any forces that otherwise would tend to unseat the syringes from the grid and/or move the contacts out of registry with one another.

To assist with achieving the optimal tension and alignment between the compliant probe 14 and its corresponding syringe contact 13, probe adjustment capabilities can be designed into the grid housing such that the probe's position can be modified in all spatial dimensions including toward and away from the syringe on the grid's inner diameter aspect. Alternatively or in addition, syringe contact adjustment capabilities can be designed into the syringe housing such that the contact's position can be modified in all spatial dimensions including.

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toward and away from the probe on the grid's inner diameter aspect. Once the grid's probes' optimal position relative to the syringe's contacts has been established, hard features can be designed into the grid itself and/or syringe to ensure proper probe and contact positioning from grid to grid and syringe to syringe as shown in FIGS. 11-14.

Alternatively or in addition, the biasing force of the compliant contacts 14 can be selected to provide the desired contact force and/or holding force against axial movement of the syringe relative to the grid. The compliant contact may be, for example, a resiliently biased plunger contact member (pogo pin) that extend through and protrude from the interior side wall of the annulus. The pogo pins may be threaded into or otherwise secured to the annulus, and position adjustment may be provided as desired. Also, pogo pins with the desired spring force and plunger stroke may be selected. As seen in FIG. 13, the compliant grid contact 14 may have a tubular housing 24 and a telescoping plunger 25.

As shown in FIG. 15, there is no material of any kind between the grid's electrical contacts 14 and the top of the grid 12. This configuration prevents skiving between the syringe 11 and the grid 12 in the regions above the grid's electrical contacts 14, which greatly reduces or completely eliminates non-conductive material from falling or being dragged between the respective electrical connections 13 and 14. On the other hand, the interstitial zones (i.e. the azimuthal sectors between a grid's electrical contacts 14) are designed to contact the syringe 11, guide it vertically into the station, and provide lateral support to the syringe 11 once inserted.

The top aspect of the grid 12 may contain a smoothed lead-in shape forming a tapered mouth 28 to accommodate proper syringe insertion despite possible slight to moderate misalignment of the x, y, z gantry or human placement relative to the grid's centerline. The bottom aspect of the grid 12 may also have a rounded profile to handle any non-smooth surfaces along the syringe's length as the syringe 11 is retracted from the grid 12 during normal operation. Finally, to assist with smooth insertion and retraction as well as minimize any material shedding or skiving, the grid material may be chosen to possess the following properties: 1) high lubricity, 2) non-shedding, 3) high
chemical inertness to common solvents used in the application, and/or 4) easily machined. While any suitable material having these qualities would be particularly acceptable, Delrin® AF100 (E. I. du Pont de Nemours and Company) has performed acceptably in terms of specific wear rate and dynamic coefficient of friction against steel (the external housing of the syringes may be made of steel).

As illustrated in FIGS. 11-14, the contacts 14 on the grid side, whether compliant or fixed, are oriented either horizontally or slightly downward in order to prevent the restorative forces of the grid's contact from pushing the syringe upward and releasing the contact needed for reliable electrical connections. Conversely, also shown on FIGS. 11-14, the contacts 13 on the syringe side, whether compliant or fixed, may be oriented either horizontally or slightly upward in order to prevent the restorative forces of the syringe's contact from pushing the syringe upward and releasing the contact needed for reliable electrical connections.

The grid 12 may also be an active grid configuration whereby the electrical probes 14 are actively retracted into the grid body 12 during the syringe's insertion or removal and are actively extended into the grid's annulus when the syringe 11 is in place to make contact with its counterpart on the syringe 11. The active grid itself might or might not contain the lead-in features described in the above passive grid description. Whether the lead-in is needed or not mostly depends on the accuracy and reliability of the gantry motion mechanism on the system. Like with the passive grid, both the syringe and grid can contain fixed or compliant electrical contacts in any combination. Much better performance is achieved when at least one of the elements contains compliant contacts, however.

For instance, the grid contacts (or additionally or alternatively the syringe contacts) may be actively moved radially inwardly and/or outwardly other than by engagement with the mating contact. For instance, the contacts may be moved by a motive device controlled by grid electronics and/or syringe electronics. For instance, the contact plungers could be threaded into the grid body and rotatably driven by a drive mechanism (such as an electric motor and associated gearing).
to move the contact plunger radially inwardly and outwardly. During syringe insertion, the grid and/or syringe contacts are retracted until the contacts on the grid and syringe are brought into axial registry, after which the grid and/or syringe contacts can be moved radially into engagement with one another.

Although the invention has been shown and described with respect to a certain embodiment or embodiments, it is obvious that equivalent alterations and modifications will occur to others skilled in the art upon the reading and understanding of this specification and the annexed drawings. In particular regard to the various functions performed by the above described elements (components, assemblies, devices, compositions, etc.), the terms (including a reference to a "means") used to describe such elements are intended to correspond, unless otherwise indicated, to any element which performs the specified function of the described element (i.e., that is functionally equivalent), even though not structurally equivalent to the disclosed structure which performs the function in the herein illustrated exemplary embodiment or embodiments of the invention. In addition, while a particular feature of the invention may have been described above with respect to only one or more of several illustrated embodiments, such feature may be combined with one or more other features of the other embodiments, as may be desired and advantageous for any given or particular application.
Claims

1. A grid for a laboratory sample management system comprising an annulus (15) into which a syringe (11) can be axially inserted; and at least one compliant, electrical grid contact (14) at the interior surface of the annulus for effecting electrical contact with a fixed or compliant syringe contact (13) on the syringe whereby electrical contact between the syringe and the grid can be established.

2. The grid of claim 1, comprising a plurality of compliant, electrical grid contacts circumferentially spaced apart around the interior surface of the annulus for establishing electrical contact with correspondingly arranged electrical syringe contacts on the syringe.

3. The grid of claim 1 or claim 2, wherein a plurality of compliant, electrical grid contacts are axially staggered along the annulus.

4. The grid of any preceding claim, wherein the grid contact includes a plunger contact (25) that is resiliently inwardly biased to an extended position protruding into the interior of the annulus.

5. The grid of any preceding claim, wherein the grid body has a tapered entry (28) for guiding the syringe into the annulus during insertion of the syringe into the grid.

6. The grid of any preceding claim, wherein the grid contact has a bullet-shaped nose (20).

7. The grid of claim 6, wherein the nose of the grid contact has a recess formed in the end thereof for mating receipt of a nose end of a syringe contact.

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8. A syringe and grid system comprising the grid of any preceding claim, and a syringe insertable into and removable from the annulus of the grid, the syringe having at least one fixed or compliant electrical syringe contact (13) on the periphery of the syringe which is engaged by the grid contact (14) on the inner diameter surface of the annulus when the syringe is inserted into the annulus of the grid.

9. The syringe and grid system of claim 8, wherein the grid contact is actively retracted into the grid body during insertion of the syringe into the annulus of the grid or removal of the syringe from the annulus of the grid; and the grid contact on the inner diameter surface of the annulus is actively extended into the annulus of the grid when the syringe is at a predetermined position within the annulus and the grid contact registers against the syringe contact.

10. An interface device (1) for a sampling probe (4) that includes electrical circuitry and a connector assembly for connecting the electrical circuitry to an external device, the connector assembly including at least one contact member (5) located at a side wall of the housing, said interface device (1) including an aperture (9a) for receiving the sampling probe, and at least one vertically elongated mating contact member (2a) for interfacing with the contact member of the connector assembly.

11. An interface device according to claim 10, wherein the at least one mating contact member includes a plurality of circumferentially arranged contacts surrounding the aperture for effecting contact with respective contact members of the connector assembly.

12. An interface device according to claim 10 or claim 11, wherein the contact or contacts are carried in a housing.
13. An interface device according to any one of claims 10-12, wherein each contact has an outer portion for connecting to another electrical component.

14. An interface device according to any one of claims 10-13, wherein a plurality of apertures are provided with respective contacts for receiving and interfacing with a plurality of sampling probes.

15. An interface device according to claim 14, wherein the apertures are arranged in an array with the apertures at a uniform center-to-center spacing in each row thereof.

16. A syringe and grid system comprising a grid (12) having at least one annulus (15), the annulus having at least one electrical grid contact (14) on an inner diameter surface of the annulus; and a syringe (11) insertable into and removable from the annulus of the grid, the syringe having at least one electrical syringe contact (13) on the periphery of the syringe for mating with the grid contact; and wherein at least one of the mating contacts is actively retracted for insertion of the syringe into the annulus of the grid or removal of the syringe from the annulus of the grid and actively extended to engage the other contact once the mating contacts have been brought into registry with respect to one another.

17. The system of claim 16, wherein the contact on the inner diameter surface of the annulus is actively retracted into the grid during insertion of the syringe into the annulus of the grid or removal of the syringe from the annulus of the grid; and wherein the contact on the inner diameter surface of the annulus is actively extended into the annulus of the grid when the syringe is at a predetermined position within the annulus and the contact of the annulus registers against the contact on the syringe.
18. A method of effecting electrical communication between a syringe (11) and a grid (12) in a laboratory sample management system, comprising actively retracting at least one of the mating contacts (13, 14) for insertion of the syringe into the grid and/or removal of the syringe from the grid, and actively extending the at least one of the mating contacts to engage the mating contact once the mating contacts have been brought into registry with respect to one another.