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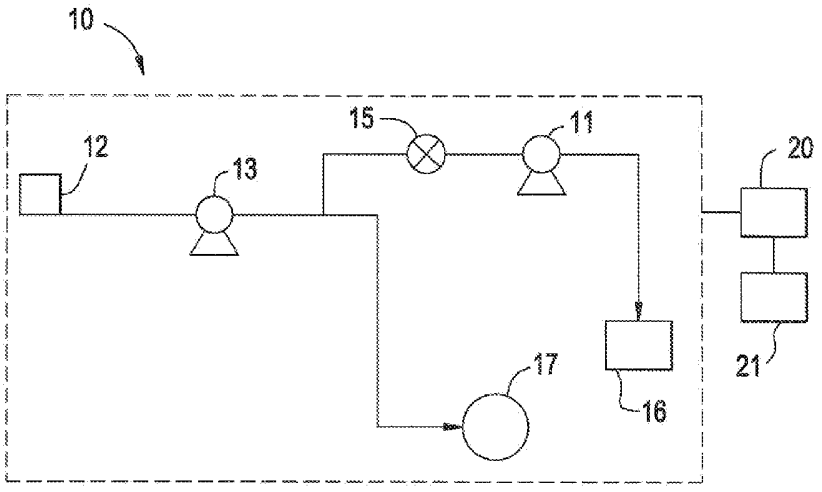
(54) **Title**: PUMP PRIMING SYSTEMS

FIG. 1



(57) **Abstract**: Pump priming systems and chromatography systems containing the same are, disclosed. Methods of making and methods of using pump priming systems are also disclosed. In conventional chromatography instrumentation, pump priming is performed in a manual mode where the operator manually opens a mechanical valve and uses a syringe to move liquid through the pump until the lines and the pump are filled with liquid.

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PUMP PRIMING SYSTEMS

FIELD OF THE INVENTION

[0001] The present invention is directed to pump priming systems and chromatography systems containing an pump priming system, methods of making pump priming systems, and methods of using pump priming systems.

BACKGROUND OF THE INVENTION

[0002] In conventional chromatography instrumentation, pump priming is performed in a manual mode where the operator manually opens a mechanical valve and uses a syringe to move liquid through the pump until the lines and the pump are filled with liquid. Manually priming the pump in conventional chromatography instrumentation has one or more shortcomings including, but not limited to, (1) man hours needed to (i) open a mechanical valve, (ii) prepare a syringe, and (iii) utilize the syringe to move liquid through the pump until the lines and the pump are filled with liquid; (2) potential human error relating to (i) manually opening the mechanical valve, (ii) manually preparing the syringe, and (iii) manually utilizing the syringe to move liquid through the pump until the lines and the pump are filled with liquid; (3) uncertainty with regard to the effectiveness of the manual pump priming operation; and (4) potential inconsistency between manual pump priming operations from one pump to another pump.

[0003] There is a need in the art to improve a pump priming operation so as to remove one of more of the above-mentioned shortcomings.

SUMMARY OF THE INVENTION

[0004] The present invention addresses some of the difficulties and problems discussed above by the discovery of a pump priming system suitable for use in chromatography system. The disclosed pump priming systems enable a more efficient, productive and/or consistent pump priming operation due to one or more of the following advantages over conventional chromatographic operations: (1) elimination of man hours needed to (i) manually open a mechanical valve, (ii) manually prepare a syringe, and (iii) manually utilize the syringe to move liquid through the pump until the lines and the pump are filled with liquid; (2) potentially remove human error relating to (i) manually opening the mechanical valve, (ii) manually preparing the syringe, and (iii) manually utilizing the syringe to move liquid through the pump until the lines and the pump are filled with liquid; (3) potentially remove uncertainty with regard to the effectiveness of a given pump priming

operation; and (4) potentially remove inconsistency between pump priming operations from one pump to another pump.

[0005] In one exemplary embodiment, the pump priming system of the present invention comprises a priming device in fluid communication with (i) at least one solvent reservoir, (ii) at least one solvent pump, (iii) an optional solvent selection device positioned between each solvent reservoir and each solvent pump, and (iv) a valve positioned between the priming device and the at least one solvent pump; and an optional microprocessor with user interface, the microprocessor being programmed to (i) receive input from a user, and in response to receiving input from the user, (ii) initiate a pump priming process, wherein fluid from at least one of the at least one solvent reservoir is moved through the at least one solvent pump via the priming device.

[0006] The present invention is further directed to chromatography systems comprising an automated pump priming system. In one exemplary embodiment, the chromatography system of the present invention comprises at least one solvent reservoir; at least one solvent pump, each of which is in fluid communication with the at least one solvent reservoir; an optional solvent selection device positioned between each solvent reservoir and each solvent pump; a priming device in fluid communication with (i) the at least one solvent reservoir, (ii) the at least one solvent pump, and (iii) the optional solvent selection device positioned between each solvent reservoir and each solvent pump; a valve positioned between the priming device and the at least one solvent pump; and an optional microprocessor with user interface, the microprocessor being programmed to (i) receive input from a user, and in response to receiving input from the user, (ii) initiate a pump priming process, wherein fluid from at least one of the at least one solvent reservoir is moved through the at least one solvent pump via the priming device.

[0007] The present invention is even further directed to methods of priming a pump. In one exemplary embodiment, the method of priming a pump comprises moving a pump priming fluid from at least one solvent reservoir through at least one solvent pump via a priming device. The disclosed methods of priming a pump may further comprise one or more additional steps, such as, optionally opening a solvent selection device positioned between one of the at least one solvent reservoir and a first solvent pump; opening a valve positioned between the priming device and the at least one solvent pump; and activating the priming device. In some embodiments, the disclosed method of priming a pump comprises priming a pump in a chromatography system.

[0008] The present invention is also directed to kits for incorporating a pump priming system into an existing chromatography system. In one exemplary embodiment, the kit for incorporating a pump priming system into an existing chromatography system comprises a priming device; a valve positioned between the priming device and at least one solvent pump of the existing chromatography system; and an optional software update for a microprocessor of the existing chromatography system, the software update, when loaded onto the microprocessor, enabling the microprocessor to perform one or more of the herein disclosed methods of priming a pump.

[0009] The present invention is additionally directed to methods of making a chromatography system. In one exemplary embodiment, the method of making a chromatography system comprises incorporating (i) at least one solvent reservoir; (ii) at least one solvent pump, each of which is in fluid communication with the at least one solvent reservoir; (iii) an optional solvent selection device positioned between each solvent reservoir and each solvent pump; (iv) a priming device in fluid communication with the at least one solvent reservoir, the at least one solvent pump, and the optional solvent selection device; (v) a valve positioned between the priming device and the at least one solvent pump; and (vi) an optional microprocessor with user interface into the chromatography system, wherein the microprocessor is programmed to (1) receive input from a user, and in response to receiving input from the user, (2) initiate a pump priming process, wherein fluid from at least one of the at least one solvent reservoir is moved through the at least one solvent pump via the priming device.

[0010] These and other features and advantages of the present invention will become apparent after a review of the following detailed description of the disclosed embodiments and the appended claims.

BRIEF DESCRIPTION OF THE FIGURES

[0011] FIG. 1 depicts a view of an exemplary automated pump priming system of the present invention;

[0012] FIG. 2 depicts a view of an exemplary chromatography system comprising the exemplary automated pump priming system shown in FIG. 1;

[0013] FIG. 3 depicts a view of an exemplary user interface display suitable for use in the exemplary chromatography system shown in FIG. 2; and

[0014] FIGS. 4A-4C depict a flowchart showing exemplary steps for utilizing the exemplary automated pump priming system shown in FIG. 1 (FIGS. 4A-4B) and in a chromatography system such as the exemplary chromatography system shown in FIG. 2 (FIGS. 4A and 4C).

DETAILED DESCRIPTION OF THE INVENTION

[0015] To promote an understanding of the principles of the present invention, descriptions of specific embodiments of the invention follow and specific language used to describe the specific embodiments. It will nevertheless be understood that no limitation of the scope of the invention is intended by the use of specific language. Alterations, further modifications, and such further applications of the principles of the present invention discussed are contemplated as would normally occur to one ordinarily skilled in the art to which the invention pertains.

[0016] It must be noted that as used herein and in the appended claims, the singular forms "a", "and", and "the" include plural referents unless the context clearly dictates otherwise. Thus, for example, reference to "an oxide" includes a plurality of such oxides and reference to "oxide" includes reference to one or more oxides and equivalents thereof known to those skilled in the art, and so forth.

[0017] "About" modifying, for example, the quantity of an ingredient in a composition, concentrations, volumes, process temperatures, process times, recoveries or yields, flow rates, and like values, and ranges thereof, employed in describing the embodiments of the disclosure, refers to variation in the numerical quantity that may occur, for example, through typical measuring and handling procedures; through inadvertent error in these procedures; through differences in the ingredients used to carry out the methods; and like proximate considerations. The term "about" also encompasses amounts that differ due to aging of a formulation with a particular initial concentration or mixture, and amounts that differ due to mixing or processing a formulation with a particular initial concentration or mixture. Whether modified by the term "about" the claims appended hereto include equivalents to these quantities.

[0018] As used herein, the term "chromatography" means the process of passing a mixture dissolved in a mobile phase through a stationary phase (i.e., chromatography media) housed in a column or cartridge or other container, which separates a target molecule from other molecules in the mixture and allows it to be isolated. Depending upon the type of

chromatography used, the target molecule may be adsorbed onto the stationary phase while the undesired components are passed through the device, or vice versa. The term "liquid chromatography" is a form of chromatography where a liquid is used as the mobile phase and a solid or a liquid on a solid support as the stationary phase. The term "flash chromatography" means liquid chromatography that is conducted under a positive pressure (e.g., up to 300 psi). The term "high performance liquid chromatography" (HPLC) means liquid chromatography that is conducted under a high positive pressure (e.g., up to 5000 psi). The term "preparatory chromatography" means HPLC for the isolation and purification of a target compound or molecule. The mobile phase may include one or more solvents that include the target molecule.

[0019] As used herein, the term "fluid" means any substance that flows or deforms under an applied shear stress. Fluids comprise liquids, gases, plasma, and combinations thereof (e.g., supercritical fluid).

[0020] As used herein, the term "pump" means a device used to move fluids by mechanical action, such as direct lift, displacement, and gravity pumps. The mechanical action is often reciprocating or rotary, which may be created by manual operation, electricity, an engine, or other energy, such as wind or other energy.

[0021] As used herein, the term "valve" means a device that regulates, directs, or controls the flow of a fluid by opening, closing, restricting or moving the fluid, and may be categorized as passive and active valves. Passive valves operate without the need for external energy sources, but instead exploit energies already present in the system (often, pressure differentials). Active valves, on the other hand, require external energy, and an actuation principle where the external energy is transducted to typically a mechanical action that either restricts or opens for the passage of fluids. As used herein, the term "splitter valve" means a device that splits the flow of a fluid stream or moves fluid from one stream to another stream, and includes passive valves (e.g., tee, splitters, and the like), and active valves (e.g., shuttle valves, splitter pumps, and the like).

[0022] The present invention is directed to pump priming systems and chromatography systems containing a pump priming system. The present invention is further directed to methods of making pump priming systems and chromatography systems, as well as methods of using pump priming systems and chromatography systems. A description of exemplary pump priming systems, exemplary chromatography systems, methods of making

pump priming systems and chromatography systems, and methods of using pump priming systems and chromatography systems is provided below.

[0023] FIG. **1** provides a view of an exemplary pump priming system **10** of the present invention. As shown in FIG. **1**, exemplary pump priming system **10** comprises a at least one priming device **11** in fluid communication with (i) at least one solvent reservoir **12**, (ii) at least one solvent pump **13**, (iii) an optional manifold valve (not shown) positioned between each solvent reservoir **12** and each solvent pump **13**, and (iv) at least one valve **15** positioned between at least one priming device **11** and at least one solvent pump **13**. In some desired embodiments, priming device **11** comprises a vacuum pump, positive displacement pump, impulse pump, valve-less pump, velocity pump or the like. Even though FIG. **1** depicts only one priming device **11**, one solvent reservoir **12**, one valve **15**, and one solvent pump **13**, there may be multiple priming devices, solvent reservoirs, or valves and solvent pumps, which may be in fluid communication with each other in series or parallel configuration, or in fluid communication with a solvent section device so as to minimize the number of components required in the pump priming system **10**.

[0024] Exemplary pump priming system **10** may further comprises a microprocessor **20** with user interface **21**, wherein microprocessor **20** is programmed to (i) receive input from a user (not shown), and in response to receiving input from the user, (ii) initiate a pump priming process, wherein pump priming fluid (not shown) from at least one of the at least one solvent reservoir **12** is moved (e.g., pulled or pushed) through at least one solvent pump **13** via priming device **11**. As shown in FIG. **1**, once pump priming fluid (not shown) flows through priming device **11**, the pump priming fluid is collected in a reservoir **16** (e.g., a waste reservoir). Even though a microprocessor is utilized in this exemplary embodiment, the pump priming system may be operated manually using switches to turn the pumps on and off, and to open and close the valves.

[0025] As shown in FIG. **1**, exemplary pump priming system **10** comprises one solvent reservoir **12**; however, it should be noted that pump priming systems of the present invention may comprise at least one solvent reservoir **12**, typically, two or more solvent reservoirs **12**. Further, exemplary pump priming system **10** comprises a single solvent pump **13**; however, it should be noted that pump priming systems of the present invention may comprise at least one solvent pump **13**, typically, two or more solvent pumps **13**. In addition, priming device **11** may be located upstream of, or prior to, solvent pump **13** instead of downstream as depicted in FIG. **1**. In one embodiment, the system includes at least one

solvent pump for each solvent reservoir. Alternatively, the system may include at least one solvent pump in combination with a solvent selection device that allows one or more solvents to be pumped through each solvent pump.

[0026] In the embodiment where a microprocessor **20** is utilized, it may be combined with the user interface **21**, which may comprise any computing device, and may be connected to interact with exemplary pump priming system **10** using known connection techniques (e.g., wired connections, wireless connections, etc.). Upon receiving input from a user (not shown), microprocessor **20** is programmed to (1) open a priming device valve (e.g., solenoid valve **15**), (2) open a first manifold valve positioned between a solvent reservoir and a first solvent pump (e.g., one of manifold valves between one of solvent reservoirs **12** and solvent pump **13**), and (3) activate priming device **11**.

[0027] In some embodiments, microprocessor **20**, upon receiving input from a user (not shown), is further programmed to perform one or more of the following tasks: (4) run priming device **11** for a desired length of time (e.g., for up to 60 or 120 seconds), (5) deactivate priming device **11**, (6) close priming device valve **15**, (7) close the first manifold valve (e.g., one of manifold valves between one of solvent reservoirs **12** and solvent pump **13**), (8) initiate a pump priming test for solvent pump **13**, and if solvent pump **13** does not pass the pump priming test, (9) repeat steps (1) to (8) or warns the user.

[0028] In embodiments wherein a second solvent pump is present (see, for example, exemplary chromatography system **100** in FIG. 2), microprocessor **20**, upon receiving input from a user (not shown), is further programmed to (10) open priming device valve **15**, (11) open a second manifold valve (e.g., any one of manifold valves) positioned between a solvent reservoir (e.g., any one of solvent reservoir **12**) and the second solvent pump (see, for example, second pump **131** in FIG. 2), (12) activate priming device **11**, (13) run priming device **11** for a desired length of time, (14) deactivate priming device **11**, (15) close priming device valve **15**, (17) initiate a pump priming test for the second solvent pump, and if the second solvent pump does not pass the pump priming test, (18) repeat steps (10) to (17) or warns the user.

[0029] Desirably, microprocessor **20** is programmed to provide one or more prompts to a user (not shown) via a user interface, such as user interface **21** comprising user interface display **210** (see FIG. 3). User interface display **210** may display one or more prompts including, but not limited to, prompts comprising (1) an auto prime initiation prompt, (2) a solvent selection prompt, (3) a pump priming test initiation prompt, (4) a solvent pump or

reservoir selection prompt, (5) a pump priming completion prompt, or (6) any combination of prompts (1) to (5).

[0030] Exemplary pump priming system **10** shown in FIG. **1** may be incorporated into a variety of systems, wherein fluid from at least one solvent reservoir **12** is pumped into a given system **17** as shown in FIG. **1**. In one desired embodiment of the present invention, exemplary pump priming system **10** shown in FIG. **1** is incorporated into a chromatography system such as exemplary chromatography system **100** shown in FIG. **2**.

[0031] As shown in FIG. **2**, exemplary chromatography system **100** comprises the following components: priming device **11**; solvent reservoirs **12**; first and second solvent pumps **13** and **131**; manifold valves; priming device valve **15**; and microprocessor **20** with user interface **21**. Exemplary chromatography system **100** further comprises chromatography cartridge **30**; sample injection port **31**; sample injection valve **32**; dampener **33**; UV detector **34**, active splitter valve (e.g., shuttle valve or splitter pump) **35**; ELSD **36**; fluid source **37**; fraction collector **38**; and waste collector/reservoir **16**.

[0032] As shown in FIG. **2**, chromatography systems of the present invention, such as exemplary chromatography system **100**, comprise at least one solvent reservoir **12** (e.g., exemplary chromatography system **100** comprises four solvent reservoirs **12**); at least one solvent pump **13** (e.g., exemplary chromatography system **100** comprises two solvent pumps **13** and **131**), each of which is in fluid communication with at least one solvent reservoir **12**; a manifold valve (e.g., exemplary chromatography system **100** comprises eight manifold valves) positioned between each solvent reservoir **12** and each solvent pump **13** and **131**; a priming device **15** in fluid communication with (i) at least one solvent reservoir **12**, (ii) at least one solvent pump **13** and **131**, and (iii) manifold valve positioned between each solvent reservoir **12** and each solvent pump **13** or **131**; a priming device valve **15** positioned between priming device **11** and at least one solvent pump **13** or **131**; a microprocessor **20** with user interface (e.g., display **210**), microprocessor **20** being programmed to (i) receive input from a user (not shown), and in response to receiving input from the user, (ii) initiate a pump priming process, wherein fluid from at least one of the at least one solvent reservoir **12** is moved through at least one solvent pump **13** or **131** via priming device **11**; and at least one chromatography column/cartridge **30** in fluid communication with the at least one solvent reservoir **12**.

[0033] Chromatography systems of the present invention, such as exemplary chromatography system **100**, may comprise at least one solvent reservoir **12**. As shown in

FIG. **2**, exemplary chromatography system **100** comprises four solvent reservoirs **12**. Further, chromatography systems of the present invention may comprise at least one solvent pump **13** or **131**. As shown in FIG. **2**, exemplary chromatography system **100** comprises two solvent pumps **13** and **131**.

[0034] In an embodiment where a microprocessor **20** is utilized, the exemplary chromatography system **100**, upon receiving input from a user (not shown), is desirably programmed to perform (i.e., cause to occur) one or more of the following steps: (1) open priming device valve **15**; (2) open a first manifold valve positioned between a solvent reservoir **12** and a first solvent pump **13**; (3) activate priming device **11**; (4) run priming device **11** for a desired length of time (e.g., up to 60 or 120 seconds); (5) deactivate priming device **11**; (6) close priming device valve **15**; (7) close first manifold valve; (8) initiate a pump priming test for first solvent pump **13**, and if first solvent pump **13** does not pass the pump priming test, (9) repeat steps (1) to (8) or warns the user. For example, microprocessor **20** may be programmed to repeat steps (1) to (8) one or more times, typically, at least two times (e.g. up to 10 times), and thereafter inform the user that an error or system problem has occurred.

[0035] When a given chromatography system, such as exemplary chromatography system **100**, comprises a second solvent pump (e.g., second solvent pump **131**), microprocessor **20**, upon receiving input from a user (not shown), is further programmed to perform (i.e., cause to occur) one or more of the following steps: (10) open priming device valve **15**; (11) open a second manifold valve positioned between a solvent reservoir **12** (i.e., the same solvent reservoir **12** as used to prime solvent pump **13** or a different solvent reservoir **12**) and second solvent pump **131**; (12) activate priming device **11**; (13) run priming device **11** for a desired length of time; (14) deactivate priming device **11**; (15) close priming device valve **15**; (17) initiate a pump priming test for second solvent pump **131**; and if second solvent pump **131** does not pass the pump priming test, (18) repeat steps (10) to (17) or warns the user. For example, microprocessor **20** may be programmed to repeat steps (10) to (17) one or more times, typically, at least two times (e.g. up to ten times).

[0036] Microprocessor **20** of exemplary chromatography system **100** is further desirably programmed to provide one or more prompts to a user (not shown) via user interface **21** (e.g., a computer display **210**). The one or more prompts may comprise, but are not limited to, (1) an auto prime initiation prompt, (2) a solvent selection prompt, (3) a pump

priming test initiation prompt, (4) a solvent pump or reservoir selection prompt, (5) a pump priming completion prompt, or (6) any combination of prompts (1) to (5).

[0037] Priming device **11** of exemplary chromatography system **100** may be any type of pump that moves a pump priming fluid (not shown) from at least one of the at least one solvent reservoir **12** through the at least one solvent pump **13** and/or **131** (e.g. sequentially as discussed above). In some desired embodiments, priming device **11** of exemplary chromatography system **100** comprises a vacuum pump, positive displacement pump, impulse pump, valve-less pump, velocity pump or the like..

[0038] The present invention is further directed to methods of priming a pump, such as solvent pump **13** shown in FIGS. **1** or **2**. In one exemplary embodiment, the method of priming a pump comprises moving a pump priming fluid (e.g., a solvent) from at least one solvent reservoir **12** through at least one solvent pump **13** via a priming device **11**. The disclosed methods of priming a pump may further comprise one or more additional steps. Suitable additional steps include, but are not limited to, (1) opening a first manifold valve positioned between one of the at least one solvent reservoir **12** and a first solvent pump **13** of the at least one solvent pump (i.e., at least one solvent pump **13** and **131**); (2) opening a priming device valve **15** positioned between the priming device **11** and the at least one solvent pump (i.e., first solvent pump **13**); and (3) activating priming device **11**.

[0039] The disclosed methods of priming a pump may further comprise one or more additional steps including, but not limited to, (4) deactivating priming device **11** after a pump priming period; (5) initiating a pump priming test on first solvent pump **13**; and if first solvent pump **13** does not pass the pump priming test, repeating steps (1) to (5) at least one time (e.g. up to ten times). In some embodiments, the initiating a pump priming test step is performed a maximum of two times, three times, four times, or more.

[0040] The disclosed methods of priming a pump of the present invention may further comprise one or more additional steps including those in response to receiving one or more inputs into user interface **21** of microprocessor **20**. In some embodiments, in response to receiving one or more inputs from a user (not shown) into user interface **21** of microprocessor **20**, the disclosed methods include one or more of the following steps: (1) initiating the method; (2) opening the priming device valve **15**; (3) opening a first manifold valve; (4) activating priming device **11**; (5) running priming device **11** for a desired length of time (e.g., any desired time period, for example, 60 seconds); (6) deactivating priming device **11**; (7) closing priming device valve **15**; and (9) initiating a pump priming test for the first solvent

pump **13**; and if the first solvent pump **13** does not pass the pump priming test, (10) repeating steps (2) to (9) or warns the user.

[0041] When a given system comprises a second solvent pump, such as in exemplary chromatography system **100**, in response to receiving one or more inputs from a user (not shown) into user interface **21** of microprocessor **20**, the disclosed methods may include one or more of the following additional steps: (11) opening priming device valve **15**; (12) opening a second manifold valve positioned between a solvent reservoir **12** (e.g., any one of solvent reservoirs **12** shown in FIG. **2**) and the second solvent pump **131**; (13) activating priming device **11**; (14) running priming device **11** for a desired length of time; (15) deactivating priming device **11**; (16) closing priming device valve **15**; (18) initiating a pump priming test for the second solvent pump **131**; and if the second solvent pump **131** does not pass the pump priming test, (19) repeat steps (11) to (18) or warns the user.

[0042] The methods of the present invention may further comprise providing one or more prompts to a user (not shown) via user interface **21** of microprocessor **20**. The one or more prompts may comprise, but are not limited to, (1) an auto prime initiation prompt, (2) a solvent selection prompt, (3) a pump priming test initiation prompt, (4) a solvent pump or reservoir selection prompt, (5) a pump priming completion prompt, or (6) any combination of prompts (1) to (5).

[0043] In one desired embodiment of the present invention, the method of priming a pump comprises priming a pump in a chromatography system, such as exemplary chromatography system **100** shown in FIG. **2**. In these embodiments, the method may comprise moving a pump priming fluid (not shown; e.g., a solvent) from one of the at least one solvent reservoir **12** through one of the at least one solvent pump **13** or **131** via priming device **11**. In these embodiments, the method may further comprise running a solvent (not shown) from the at least one solvent reservoir **12** through at least one chromatography column/cartridge **30** in fluid communication with the at least one solvent reservoir **12**.

[0044] The present invention is further directed to kits that can be used to incorporate a pump priming system, such as exemplary pump priming system **10** shown in FIG. **1**, into an existing chromatography system. In one exemplary embodiment, the kit for incorporating a pump priming system into an existing chromatography system comprises a priming device **11**; a priming device valve **15** positionable between priming device **11** and at least one solvent pump (e.g., solvent pump **13** and/or **131**) of the existing chromatography system; and a software update for a microprocessor of the existing chromatography system, the software

update, when loaded onto the microprocessor, enabling the microprocessor to perform one or more of the herein disclosed methods and method steps of priming a pump. Such kits may be used to retrofit existing chromatography systems, such as the REVELERIS® Flash Chromatography System available from Alltech Associates, Inc.

[0045] The present invention is even further directed to methods of making a chromatography system, such as exemplary chromatography system **100** shown in FIG. **2**. In some embodiments, the method of making a chromatography system comprises incorporating the herein-described pump priming system (e.g., exemplary pump priming system **10** of FIG. **1**) into an existing chromatography system (e.g., using a kit as discussed above).

[0046] In other embodiments, the method of making a chromatography system comprises incorporating (i) at least one solvent reservoir **12**; (ii) at least one solvent pump **13** and **131**, each of which is in fluid communication with the at least one solvent reservoir **12**; (iii) a manifold valve positioned between each solvent reservoir **12** and each solvent pump **13** and **131**; (iv) a priming device **11** in fluid communication with the at least one solvent reservoir **12**, the at least one solvent pump **13** and **131**, and the manifold valve; (v) a priming device valve **15** positioned between the priming device **11** and the at least one solvent pump **13** and **131**; and (vi) a microprocessor **20** with user interface **21** into the chromatography system (e.g., exemplary chromatography system **100**), wherein the microprocessor **20** is programmed to (1) receive input from a user (not shown), and in response to receiving input from the user, (2) initiate a pump priming process, wherein fluid (not shown) from at least one of the at least one solvent reservoir **12** is moved through the at least one solvent pump **13** or **131** via the priming device **11**.

[0047] The method of making a chromatography system may further comprise incorporating a microprocessor (e.g., exemplary microprocessor **20**) into the chromatography system, wherein the microprocessor is programmed to perform one or more of the following tasks/operations: (1) open a priming device valve **15**; (2) open a first manifold valve positioned between a solvent reservoir **12** and a first solvent pump **13**; (3) activate the priming device **11** upon receiving input from a user; (4) run the priming device **11** for a desired length of time; (5) deactivate the priming device **11**; (6) close the priming device valve **15**; and (8) initiate a pump priming test for the first solvent pump **13** upon receiving input from a user; and if the first solvent pump **13** does not pass the pump priming test, (9) repeat steps (1) to (8) or warns the user. Typically, when repeated, steps (1) to (8) are repeated a maximum number of times (e.g. up to ten times), such as a maximum of two

times. If the first solvent pump **13** does not pass the pump priming test after a set number of times, the pump priming cycle/run is stopped to investigate possible problems within the pump priming system.

[0048] When a given chromatography system comprises two or more solvent pumps, the method of making a chromatography system may further comprise incorporating a microprocessor (e.g., exemplary microprocessor **20**) into the chromatography system, wherein the microprocessor is programmed to perform one or more of the following additional tasks/operations: (10) open the priming device valve **15**; (11) open a second manifold valve positioned between a solvent reservoir **12** and the second solvent pump **131**; (12) activate the priming device **11**; (13) run the priming device **11** for a desired length of time; (14) deactivate the priming device **11**; (15) close the priming device valve **15**; (17) initiate a pump priming test for the second solvent pump **131**; and if the second solvent pump **131** does not pass the pump priming test, (18) repeat steps (10) to (17) or warns the user.

[0049] The method of making a chromatography system may further comprise incorporating a microprocessor (e.g., exemplary microprocessor **20**) into the chromatography system, wherein the microprocessor is programmed to provide one or more prompts to a user (not shown) via the user interface (e.g., interface **21** with display **210**). The one or more prompts may comprise, but are not limited to, (1) an auto prime initiation prompt, (2) a solvent selection prompt, (3) a pump priming test initiation prompt, (4) a solvent pump or reservoir selection prompt, (5) a pump priming completion prompt, or (6) any combination of prompts (1) to (5).

[0050] The present invention is even further directed to methods of using a pump priming system in a chromatography system. In one exemplary embodiment, the method of using a pump priming system in a chromatography system comprises, in response to receiving input from a user (not shown), initiating a pump priming procedure comprising moving a pump priming fluid (not shown) from at least one solvent reservoir **12** through at least one solvent pump **13** or **131** via a priming device **11**.

[0051] The method of using a pump priming system in a chromatography system may further comprise one or more of the following steps: opening a first manifold valve positioned between one of the at least one solvent reservoir **12** and a first solvent pump **13** of the at least one solvent pump (e.g., pumps **13** and **131**); opening a priming device valve **15** positioned between the priming device **11** and the at least one solvent pump **13**; activating the priming device **11**; deactivating the priming device **11** after a pump priming period; initiating

a pump priming test on the first solvent pump **13**; and if the first solvent pump **13** does not pass the pump priming test, repeating the steps from opening of the manifold valve step to the deactivating step at least one time (e.g., initiating a repeat of the pump priming test step a maximum of two times, up to a maximum of ten times).

[0052] The method of using a pump priming system in a chromatography system may further comprise one or more of the following steps: in response to receiving one or more inputs into a user interface **21** of a microprocessor **20**, (1) initiating the pump priming method; (2) opening the priming device valve **15**; (3) opening the first manifold valve; (4) activating the priming device **11**; (5) running the priming device **11** for a desired length of time; (6) deactivating the priming device **11**; (7) closing the priming device valve **15**; (9) initiating a pump priming test for the first solvent pump **13**; and if the first solvent pump **13** does not pass the pump priming test, (10) repeating steps (2) to (9), or warn the user.

[0053] In chromatography systems with two or more solvent pumps, the methods of using a pump priming system in a chromatography system may further comprise, in response to receiving one or more inputs into a user interface **21** of a microprocessor **20**, one or more additional steps such as: (11) opening the priming device valve **15**; (12) opening a second manifold valve positioned between a solvent reservoir **12** and the second solvent pump **131**; (13) activating the priming device **11**; (14) running the priming device **11** for a desired length of time; (15) deactivating the priming device **11**; (16) closing the priming device valve **15**; (18) initiating a pump priming test for the second solvent pump **131**; and if the second solvent pump **131** does not pass the pump priming test, (19) repeat steps (11) to (18), or warns the user.

[0054] The methods of using a pump priming system in a chromatography system may further comprise responding to one or more prompts provided by user interface **21** of a microprocessor **20**. The one or more prompts may comprise (1) an auto prime initiation prompt, (2) a solvent selection prompt, (3) a pump priming test initiation prompt, (4) a solvent pump or reservoir selection prompt, (5) a pump priming completion prompt, or (6) any combination of prompts (1) to (5). In addition, the methods of using a pump priming system in a chromatography system may further comprise running a solvent from the at least one solvent reservoir **12** through at least one chromatography column **30** in fluid communication with the at least one solvent reservoir **12**.

[0055] In order to provide interaction between a user (not shown) and a given pump priming system, the pump priming system may comprise a user interface, such as user

interface **21** of microprocessor **20** with display **210** as shown in FIG. **3**. As shown in FIG. **3**, display **210** comprises main menu display **22** with various parameters/options **23** (e.g., flow rate, duration units, run length, etc.) that a user may choose prior to operating the system (e.g., exemplary chromatography system **100** shown in FIG. **2**). Main menu display **22** also comprises solvent options **24**, wherein a user can input one or more solvent types corresponding to a given solvent reservoir (e.g., solvent reservoirs **12** shown in FIG. **2**).

[0056] Although not shown in FIGS. **1-3**, it should be understood that, in addition to display **210**, user interface **21** of microprocessor **20** may also comprise other user interface components including, but not limited to, a keyboard, a mouse, a laptop, a desktop computer, a wireless router, etc. Further, display **210** may comprise a touch-screen that enables a user to interact with microprocessor **20** without the need of a keyboard and/or mouse when choosing one or more options shown, for example, on main menu display **22** in FIG. **3**.

[0057] As disclosed herein, the methods of using the disclosed pump priming systems of the present invention may comprise a combination of various steps. FIGS. **4A-4C** depict a flowchart showing a variety of exemplary steps for utilizing a pump priming system. It should be noted that although the flowchart shown in FIGS. **4A-4C** depict numerous steps of exemplary method **40** in sequence with one another, methods of using the disclosed pump priming systems of the present invention may comprise any one or any combination of two or more of the steps shown in exemplary method **40**, alone or in combination with other steps not shown in FIGS. **4A-4C**.

[0058] As shown in FIG. **4A**, exemplary method **40** begins at start box **42** and proceeds to step **44**, wherein a user is prompted to choose a solvent. For example, user interface **21** of microprocessor **20** could display a user interface screenshot **22** as shown in FIG. **3**. Once a user chooses one of solvents A-D (shown as solvent options **24** in FIG. **3**), one or more prompts **25** may appear on user interface display **210**. Once a user selects a solvent with option **26**, the user can choose the "AUTO PRIME" option **27** to initiate pump priming, namely, step **46** of exemplary method **40**.

[0059] From step **46** of exemplary method **40**, exemplary method **40** proceeds to step **48**, wherein a manifold valve (e.g., one of manifold valves for solvent **A** shown in FIG. **2**) for the selected solvent is opened. Exemplary method **40** then proceeds to step **50**, wherein the priming device valve (e.g., solenoid valve **15** shown in FIG. **2**) is opened. Exemplary method **40** then proceeds to step **52**, wherein the priming device (e.g., priming device **11** shown in FIG. **2**) is activated.

[0060] From step **52**, exemplary method **40** proceeds to step **54**, wherein the priming device is run for a desired period of time. Typically, the priming run time is less than 120 seconds, or more typically less than 60 seconds, depending upon the fluidic configuration of the system. However, any priming run time may be inputted into the microprocessor (e.g., microprocessor **20**) by a user. Exemplary method **40** then proceeds to step **56**, wherein the priming device is deactivated. From step **56** of exemplary method **40**, exemplary method **40** proceeds to step **58**, wherein a pump priming test is initiated for the primed pump. In one embodiment, the pump priming test may include any test that determines whether the pump is primed, such as pressure indicator, flow indicator or other sensor that detects whether liquid is present in the pump.

[0061] From step **58** of exemplary method **40**, exemplary method **40** proceeds to decision block **43**, wherein a determination is made whether the primed pump passed the pump priming test. If a determination is made at decision block **43** that the primed pump did not pass the pump priming test (e.g., the pump exhibits these traits: absence of pressure, absence of flow, or absence of liquid), exemplary method **40** proceeds to decision block **45**, wherein a determination is made whether the primed pump has been primed a maximum number of times during the present priming cycle/run. If a determination is made at decision block **45** that the primed pump has been primed a maximum number of times during the present priming cycle/run, exemplary method **40** proceeds to step **60**, wherein exemplary method 40 stops so that the pump priming system can be evaluated. If a determination is made at decision block **45** that the primed pump has not been primed a maximum number of times during the present priming cycle/run, exemplary method **40** proceeds to step **62**, wherein exemplary method **40** returns to step **48** to perform another AUTO PRIME run.

[0062] Returning to decision block **43** of exemplary method **40**, if a determination is made at decision block **43** that the primed pump does pass the pump priming test, exemplary method **40** proceeds to decision block **47**, wherein a determination is made whether the primed pump system has another solvent pump (i.e., that has not yet been primed during this run). If a determination is made at decision block **47** that the primed pump system does not have another solvent pump (e.g., see exemplary pump priming system **10** in FIG. **1**), exemplary method **40** proceeds to step **64**, wherein the "DONE" option (e.g., see, done option **29** shown in FIG. **3**) is shown to the user. At this time, the user (not shown) can select the done option to end the exemplary method **40** as shown in step **88**. If a determination is made at decision block **47** that the primed pump system does have another solvent pump

(e.g., see exemplary pump priming system **10** in FIG. **2**), exemplary method **40** proceeds to step **66**, wherein exemplary method **40** proceeds to decision block **49** shown in FIGS. **4B** and **4C**.

[0063] It should be noted that in alternative embodiments, microprocessor **20** may provide a prompt to a user (not shown) asking the user if the primed pump system has another solvent pump. In other embodiments, microprocessor **20** makes this determination without the input from a user (e.g., from solvent pump input provided previously by the user using main menu display **22** of display **210** shown in FIG. **3**).

[0064] As shown in either of FIGS. **4B** and **4C**, exemplary method **40** proceeds to decision block **49**, wherein a determination is made whether to change the solvent for the next pump priming run. If a determination is made at decision block **49** to change the solvent for the next pump priming, exemplary method **40** proceeds to step **68**, wherein exemplary method **40** returns to step **44**, and proceeds as discussed above. If a determination is made at decision block **49** not to change the solvent for the next pump priming, exemplary method **40** proceeds to step **70**, wherein exemplary method **40** returns to step **48**, and proceeds as discussed above (i.e., a second manifold valve **12** for the chosen solvent will open and proceed as discussed above).

[0065] FIG. **4C** depicts possible method steps when the pump priming system is part of a chromatography system. As shown in FIG. **4C**, exemplary method **40** proceeds to decision block **49**. If a determination is made at decision block **49** not to change the solvent for the next pump priming run, exemplary method **40** proceeds to step **72**, wherein one or more run parameters are changed and/or selected in preparation for a chromatography sample run. From step **72**, exemplary method **40** proceeds to step **74**, wherein a sample is run through a chromatography cartridge (e.g., exemplary chromatography cartridge **30** shown in FIG. **2**). During the run, a pump priming test in step **76** may be conducted to determine whether one or more of the solvent pumps is still fully primed. If a determination is made in decision block **82** that the one or more solvent pumps does pass the priming test, the chromatography run is completed in step **84**, wherein the exemplary method **40** ends. If a determination is made in decision block **82** that the one or more solvent pumps does not pass the priming test, the chromatography run is paused in step **78** and the pump(s) is primed pursuant to steps **48-58**.

[0066] From step **78**, exemplary method **40** proceeds to decision block **86**, wherein a determination is made in decision block **86** that the one or more primed solvent pumps does

pass the priming test, the chromatography run is completed in step **92**, wherein the exemplary method **40** ends. If a determination is made in decision block **86** that the one or more primed solvent pumps does not pass the priming test, the method proceeds to step **94** where the pump is re-primed in step **78** (until the maximum number of times is reached) or proceeds to step **76** and another solvent pump is selected and primed, or the method **40** ends if no pump(s) can be primed, and an error message is sent to the user.

[0067] In some embodiments, microprocessor **20** may provide a prompt to a user (not shown), such as prompt **25** shown in FIG. 3, asking the user if the user wants to initiate another AUTO PRIME run. If the user wants to initiate another AUTO PRIME run, the user simply selects the AUTO PRIME option **27** as discussed above. If the user does not want to initiate another AUTO PRIME run, the user simply selects the CANCEL option **28** shown in FIG. 3.

[0068] It should be understood that although the above-described pump priming systems, chromatography systems, kits, and methods are described as "comprising" one or more components or steps, the above-described pump priming systems, chromatography systems, kits, and methods may "comprise," "consists of," or "consist essentially of" any of the above-described components or steps of the pump priming systems, chromatography systems, kits, and methods. Consequently, where the present invention, or a portion thereof, has been described with an open-ended term such as "comprising," it should be readily understood that (unless otherwise stated) the description of the present invention, or the portion thereof, should also be interpreted to describe the present invention, or a portion thereof, using the terms "consisting essentially of" or "consisting of" or variations thereof as discussed below.

[0069] As used herein, the terms "comprises," "comprising," "includes," "including," "has," "having," "contains", "containing," "characterized by" or any other variation thereof, are intended to encompass a non-exclusive inclusion, subject to any limitation explicitly indicated otherwise, of the recited components. For example, a pump priming system, a chromatography system, a kit, and/or method that "comprises" a list of elements (e.g., components or steps) is not necessarily limited to only those elements (or components or steps), but may include other elements (or components or steps) not expressly listed or inherent to the pump priming system, chromatography system, a kit, and/or method.

[0070] As used herein, the transitional phrases "consists of" and "consisting of" exclude any element, step, or component not specified. For example, "consists of" or

"consisting of" used in a claim would limit the claim to the components, materials or steps specifically recited in the claim except for impurities ordinarily associated therewith (i.e., impurities within a given component). When the phrase "consists of" or "consisting of" appears in a clause of the body of a claim, rather than immediately following the preamble, the phrase "consists of" or "consisting of" limits only the elements (or components or steps) set forth in that clause; other elements (or components) are not excluded from the claim as a whole.

[0071] As used herein, the transitional phrases "consists essentially of" and "consisting essentially of" are used to define a pump priming system, a chromatography system, a kit, and/or a method that includes materials, steps, features, components, or elements, in addition to those literally disclosed, provided that these additional materials, steps, features, components, or elements do not materially affect the basic and novel characteristic(s) of the claimed invention. The term "consisting essentially of" occupies a middle ground between "comprising" and "consisting of".

[0072] Further, it should be understood that the herein-described pump priming systems, chromatography systems, kits, and/or methods may comprise, consist essentially of, or consist of any of the herein-described components and features, as shown in the figures with or without any feature(s) not shown in the figures. In other words, in some embodiments, the pump priming systems, chromatography systems, kits, and/or methods of the present invention do not have any additional features other than those shown in the figures, and such additional features, not shown in the figures, are specifically excluded from the pump priming systems, chromatography systems, kits, and/or methods. In other embodiments, the pump priming systems, chromatography systems, kits, and/or methods of the present invention do have one or more additional features that are not shown in the figures.

[0073] The present invention is further illustrated by the following examples, which are not to be construed in any way as imposing limitations upon the scope thereof. On the contrary, it is to be clearly understood that resort may be had to various other embodiments, modifications, and equivalents thereof which, after reading the description herein, may suggest themselves to those skilled in the art without departing from the spirit of the present invention and/or the scope of the appended claims.

EXAMPLES

[0074] A pump priming system within a chromatography system as shown in FIG. 2 was prepared and used to analyze one or more samples pursuant to Examples 1 and 2 below. The system included four solvent reservoirs and two solvent pumps, a priming pump, a microprocessor, a flat panel display, a chromatography column, a fraction collector, and other system components as shown in FIG. 2.

Example 1

[0075] In the initial setup, the pumps in the chromatography system need to be primed and the following procedure is used: Insert lines 1-4 into appropriate solvent bottles. Using the microprocessor software and display, the solvent loading page is accessed at the top menu bar by clicking Tools, Solvent Loading. A solvent line is selected (1-4 are shown) by clicking Load from the Solvent Loading box. The arrow on the right side of the solvent name box is selected, which shows a drop down menu. From this list, the name of the solvent that corresponds to the desired line is chosen. The Auto prime tab is selected and the system automatically primes the pumps. The status of the Auto prime is be displayed in the bottom left corner of the box throughout the process. When Auto prime is finished, the "Close" is selected to close the box for the current solvent line. This returns the user back to the original box showing Solvent Loading for all 4 individual lines. The user can now choose a different line to repeat the process, if necessary, or close if no priming of other lines is needed. After all the required lines are primed, all the boxes are closed and the system is now ready for the chromatography run.

Example 2

[0076] Before a chromatography run is conducted, the system automatically checks to see if the pumps are primed. If any of the pumps fail the programmed confirm prime process, the system will stop and ask the user to prime the pump. To prime the pump, the user selects the Tools tab, and then the Solvent loading tab to select the desired solvent line used in the chromatography run. The arrow on the right side of the solvent name box is selected, which displays a drop down solvent menu. The solvent to be used in the chromatography run is selected, and then the Auto prime tab is selected whereby the system automatically primes the pumps. The status of the Auto prime progress will be displayed in the bottom left corner

of the box throughout the process. When the Auto prime is finished the "Close" tab is selected to close the box, which closes all the other boxes and the system is ready for the chromatography run.

[0077] While the invention has been described with a limited number of embodiments, these specific embodiments are not intended to limit the scope of the invention as otherwise described and claimed herein. It may be evident to those of ordinary skill in the art upon review of the exemplary embodiments herein that further modifications, equivalents, and variations are possible. All parts and percentages in the examples, as well as in the remainder of the specification, are by weight unless otherwise specified. Further, any range of numbers recited in the specification or claims, such as that representing a particular set of properties, units of measure, conditions, physical states or percentages, is intended to literally incorporate expressly herein by reference or otherwise, any number falling within such range, including any subset of numbers within any range so recited. For example, whenever a numerical range with a lower limit, R_L, and an upper limit R_U, is disclosed, any number R falling within the range is specifically disclosed. In particular, the following numbers R within the range are specifically disclosed: $R = R_L + k(R_U - R_L)$, where k is a variable ranging from 1% to 100% with a 1% increment, e.g., k is 1%, 2%, 3%, 4%, 5%. ... 50%, 51%, 52%. ... 95%, 96%, 97%, 98%, 99%, or 100%. Moreover, any numerical range represented by any two values of R, as calculated above is also specifically disclosed. Any modifications of the invention, in addition to those shown and described herein, will become apparent to those skilled in the art from the foregoing description and accompanying drawings. Such modifications are intended to fall within the scope of the appended claims. All publications cited herein are incorporated by reference in their entirety.

WHAT IS CLAIMED IS:

1. A pump priming system comprising:

a priming device in fluid communication with (i) at least one solvent reservoir, (ii) at least one solvent pump, and (iii) at least one valve positioned between said priming device and said at least one solvent pump; and

an activation device that initiates a pump priming process, wherein fluid from said at least one solvent reservoir is moved through said at least one solvent pump via said priming device.

2. The pump priming system of claim 1, wherein said system comprises a solvent selection device positioned between each solvent reservoir and each solvent pump.

3. The pump priming system of claim 1 or 2, wherein said system comprises a priming device valve positioned between said priming device and said solvent pump.

4. The pump priming system of any one of claims 1 to 3, wherein said activation device comprises an electrical switch, a pneumatic switch, or a mechanical switch

5. The pump priming system of any one of claims 1 to 4, wherein said at least one solvent reservoir comprises two or more solvent reservoirs.

6. The pump priming system of any one of claims 1 to 5, wherein said at least one solvent pump comprises two or more solvent pumps.

7. The pump priming system of any one of claims 1 to 6, wherein said system comprises a microprocessor with user interface, said microprocessor being programmed to (i) receive input from a user, and in response to receiving input from the user, and (ii) initiate a pump priming process.

8. The pump priming system of any one of claims 1 to 7, wherein said microprocessor, upon receiving input from the user, is programmed to (1) open said priming device valve, (2)

open a first manifold valve positioned between a solvent reservoir and a first solvent pump, and (3) activate said priming device.

9. The pump priming system of any one of claims 1 to 8, wherein said microprocessor, upon receiving input from the user, is programmed to (1) open said priming device valve, (2) open a first manifold valve positioned between a solvent reservoir and a first solvent pump, (3) activate said priming device, (4) run said priming device for a desired length of time, (5) deactivate said priming device, and (6) close said priming device valve.

10. The pump priming system of any one of claims 1 to 9, wherein said microprocessor, upon receiving input from the user, is programmed to (1) open said priming device valve, (2) open a first manifold valve positioned between a solvent reservoir and a first solvent pump, (3) activate said priming device, (4) run said priming device for a desired length of time, (5) deactivate said priming device, (6) close said priming device valve, (7) initiate a pump priming test for said first solvent pump, and if said first solvent pump does not pass the pump priming test, (8) repeat steps (1) to (7) or warns the user.

11. The pump priming system of claim 10, wherein when said at least one solvent pump comprise a second solvent pump, said microprocessor, upon receiving input from the user, is further programmed to (9) open said priming device valve, (10) open a second manifold valve positioned between a solvent reservoir and said second solvent pump, (11) activate said priming device, (12) run said priming device for a desired length of time, (13) deactivate said priming device, (14) close said priming device valve, (15) initiate a pump priming test for said second solvent pump, and if said second solvent pump does not pass the pump priming test, (16) repeat steps (9) to (15) or warns the user.

12. The pump priming system of any one of claims 1 to 11, wherein said microprocessor is programmed to provide one or more prompts to the user via said user interface, the one or more prompts comprising (1) an auto prime initiation prompt, (2) a solvent selection prompt, (3) a pump priming test initiation prompt, (4) a solvent pump or reservoir selection prompt, (5) a pump priming completion prompt, or (6) any combination of prompts (1) to (5).

13. The pump priming system of any one of claims 1 to 12, wherein said priming device comprises a vacuum pump, positive displacement pump, impulse pump, valve-less pump, velocity pump or the like..

14. The pump priming system of any one of claims 1 to 13, wherein said system comprises a microprocessor, said microprocessor being programmed to (i) detect whether said at least one solvent pump is not primed, and (ii) initiate a pump priming process if said at least one pump is not primed.

15. The pump priming system of claim 14, wherein said microprocessor performs steps (i) and (ii) without input from a user.

16. A chromatography system comprising the pump priming system of any one of claims 1 to 15.

17. The chromatography system of claim 16, further comprising:

at least one chromatography column in fluid communication with said at least one solvent reservoir.

18. A chromatography system comprising:

at least one solvent reservoir;

at least one solvent pump, each of which is in fluid communication with said at least one solvent reservoir;

a priming device in fluid communication with (i) said at least one solvent reservoir, (ii) said at least one solvent pump, and (iii) said valve positioned between each solvent reservoir and each solvent pump;

a valve positioned between said priming device and said at least one solvent pump;

an activation device that initiates a pump priming process, wherein fluid from at least one of said at least one solvent reservoir is moved through said at least one solvent pump via said priming device; and

at least one chromatography column in fluid communication with said at least one solvent reservoir.

19. The chromatography system of claim 18, wherein said at least one valve system comprises a solvent selection device positioned between each solvent reservoir and each solvent pump.

20. The chromatography system of claim 18 or 19, wherein said system comprises a priming device valve positioned between said priming device and said solvent pump.

21. The chromatography system of any one of claims 18 to 20, wherein said activation device comprises an electrical switch, a pneumatic switch, or a mechanical switch.

22. The chromatography system of any one of claims 18 to 21, wherein said at least one solvent reservoir comprises two or more solvent reservoirs.

23. The chromatography system of any one of claims 18 to 22, wherein said at least one solvent reservoir comprises four solvent reservoirs.

24. The chromatography system of any one of claims 18 to 23, wherein said at least one solvent pump comprises two or more solvent pumps.

25. The chromatography system of any one of claims 18 to 24, wherein said at least one solvent pump comprises two solvent pumps.

26. The chromatography system of any one of claims 18 to 25, wherein said microprocessor, upon receiving input from the user, is programmed to (1) open said priming device valve, (2) open a first manifold valve positioned between a solvent reservoir and a first solvent pump, and (3) activate said priming device.

27. The chromatography system of any one of claims 18 to 26, wherein said microprocessor, upon receiving input from the user, is programmed to (1) open said priming device valve, (2) open a first manifold valve positioned between a solvent reservoir and a first solvent pump, (3) activate said priming device, (4) run said priming device for a desired length of time, (5) deactivate said priming device, and (6) close said priming device valve.

28. The chromatography system of any one of claims 18 to 27, wherein said microprocessor, upon receiving input from the user, is programmed to (1) open said priming device valve, (2) open a first manifold valve positioned between a solvent reservoir and a first solvent pump, (3) activate said priming device, (4) run said priming device for a desired length of time, (5) deactivate said priming device, (6) close said priming device valve, (7) initiate a pump priming test for said first solvent pump, and if said first solvent pump does not pass the pump priming test, (8) repeat steps (1) to (7) or warns the user.

29. The chromatography system of claim 28, wherein when said at least one solvent pump comprise a second solvent pump, said microprocessor, upon receiving input from the user, is further programmed to (9) open said priming device valve, (10) open a second manifold valve positioned between a solvent reservoir and said second solvent pump, (11) activate said priming device, (12) run said priming device for a desired length of time, (13) deactivate said priming device, (14) close said priming device valve, (15) initiate a pump priming test for said second solvent pump, and if said second solvent pump does not pass the pump priming test, (16) repeat steps (9) to (15) or warns the user.

30. The chromatography system of any one of claims 18 to 29, wherein said microprocessor is programmed to provide one or more prompts to the user via said user interface, the one or more prompts comprising (1) an auto prime initiation prompt, (2) a solvent selection prompt, (3) a pump priming test initiation prompt, (4) a solvent pump or reservoir selection prompt, (5) a pump priming completion prompt, or (6) any combination of prompts (1) to (5).

31. The chromatography system of any one of claims 18 to 30, wherein said priming device comprises a vacuum pump, positive displacement pump, impulse pump, valve-less pump, velocity pump or the like..

32. The chromatography system of any one of claims 18 to 31, wherein said system comprises a microprocessor, said microprocessor being programmed to (i) detect whether said at least one solvent pump is not primed, and (ii) initiate a pump priming process if said at least one pump is not primed.

33. The chromatography system of claim 32, wherein said microprocessor performs steps (i) and (ii) prior to or during a chromatography run.

34. The pump priming system of claim 32, wherein said microprocessor performs steps (i) and (ii) without input from a user.

35. A method of priming a pump in the chromatography system of any one of claims 18 to 34, said method comprising:

moving a pump priming fluid from one of the at least one solvent reservoir through one of the at least one solvent pump via the priming device.

36. A method of priming a pump, said method comprising:

moving a pump priming fluid from at least one solvent reservoir through at least one solvent pump via a priming device.

37. The method of claim 36, further comprising:

opening a first manifold valve positioned between one of the at least one solvent reservoir and a first solvent pump of the at least one solvent pump;

opening a priming device valve positioned between the priming device and the at least one solvent pump; and

activating the priming device.

38. The method of claim 36 or 37, further comprising:

deactivating the priming device after a pump priming period;

initiating a pump priming test on the first solvent pump; and

if the first solvent pump does not pass the pump priming test, repeating said steps from said opening of the manifold valve step to said deactivating step at least one time.

39. The method of claim 38, wherein said initiating a pump priming test step is performed a maximum of two times.

40. The method of any one of claims 36 to 39, wherein in response to receiving one or more inputs into a user interface of a microprocessor, initiating said method.

41. The method of claim 40, wherein in response to receiving one or more inputs into a user interface of a microprocessor, (1) opening the priming device valve, (2) opening the first manifold valve, and (3) activating the priming device.

42. The method of claim 40 or 41, wherein in response to receiving one or more inputs into a user interface of a microprocessor, (1) opening the priming device valve, (2) opening the first manifold valve, (3) activating the priming device, (4) running the priming device for a desired length of time, (5) deactivating the priming device, and (6) closing the priming device valve.

43. The method of any one of claims 40 to 42, wherein in response to receiving one or more inputs into a user interface of a microprocessor, (1) opening the priming device valve, (2) opening the first manifold valve, (3) activating the priming device, (4) running the priming device for a desired length of time, (5) deactivating the priming device, (6) closing the priming device valve, (7) initiating a pump priming test for the first solvent pump, and if the first solvent pump does not pass the pump priming test, (8) repeating steps (1) to (7) or warns the user.

44. The method of claim 43, wherein when the at least one solvent pump comprise a second solvent pump, in response to receiving one or more inputs into a user interface of a microprocessor, (9) opening the priming device valve, (10) opening a second manifold valve positioned between a solvent reservoir and the second solvent pump, (11) activating the priming device, (12) running the priming device for a desired length of time, (13) deactivating the priming device, (14) closing the priming device valve, (15) initiating a pump priming test for the second solvent pump, and if the second solvent pump does not pass the pump priming test, (16) repeat steps (9) to (15) or warns the user.

45. The method of any one of claims 36 to 44, further comprising:

providing one or more prompts to a user via a user interface of a microprocessor, the one or more prompts comprising (1) an auto prime initiation prompt, (2)

a solvent selection prompt, (3) a pump priming test initiation prompt, (4) a solvent pump or reservoir selection prompt, (5) a pump priming completion prompt, or (6) any combination of prompts (1) to (5).

46. The method of any one of claims 36 to 45, further comprising:

running a solvent from the at least one solvent reservoir through at least one chromatography column in fluid communication with the at least one solvent reservoir.

47. A kit comprising for incorporating a pump priming system into an existing chromatography system, said kit comprising:

a priming device;

a priming device valve positionable between said priming device and at least one solvent pump of the existing chromatography system; and

a software update for a microprocessor of the existing chromatography system, the software update, when loaded onto the microprocessor, enabling the microprocessor to perform the method of any one of claims 36 to 46.

48. A method of making a chromatography system, said method comprising:

incorporating the pump priming system of any one of claims 1 to 9 into the chromatography system.

49. A method of making a chromatography system, said method comprising:

incorporating (i) at least one solvent reservoir; (ii) at least one solvent pump, each of which is in fluid communication with the at least one solvent reservoir; (iii) a priming device in fluid communication with the at least one solvent reservoir, the at least one solvent pump; (iv) a priming device valve positioned between the priming device and the at least one solvent pump; and (v) a microprocessor with user interface into the chromatography system, wherein the microprocessor is programmed to (1) receive input from a user, and in response to receiving input from the user, (2) initiate a pump priming process, wherein fluid from at least one of the at least one solvent reservoir is moved through the at least one solvent pump via the priming device.

50. The method of claim 49, wherein the microprocessor is programmed to (1) open the priming device valve, (2) activate a solvent selector device positioned between, and in fluid communication with, a solvent reservoir and a first solvent pump, which opens a first manifold valve, and (3) activate the priming device.

51. The method of claim 49 or 50, wherein the microprocessor is programmed to (1) open the priming device valve, (2) open a first manifold valve positioned between a solvent reservoir and a first solvent pump, (3) activate the priming device, (4) run the priming device for a desired length of time, (5) deactivate the priming device, and (6) close the first manifold valve.

52. The method of any one of claims 49 to 51, wherein the microprocessor is programmed to (1) open the priming device valve, (2) open a first manifold valve positioned between a solvent reservoir and a first solvent pump, (3) activate the priming device, (4) run the priming device for a desired length of time, (5) deactivate the priming device, (6) close the priming device valve, and (7) initiate a pump priming test for the first solvent pump, and if the first solvent pump does not pass the pump priming test, (8) repeat steps (1) to (7) or warns the user.

53. The method of claim 52, wherein when the at least one solvent pump comprises a second solvent pump, the microprocessor is further programmed to (9) open the priming device valve, (10) open a second manifold valve positioned between a solvent reservoir and the second solvent pump, (11) activate the priming device, (12) run the priming device for a desired length of time, (13) deactivate the priming device, (14) close the priming device valve, (15) initiate a pump priming test for the second solvent pump, and if the second solvent pump does not pass the pump priming test, (16) repeat steps (9) to (15) or warns the user.

54. The method of any one of claims 49 to 53, wherein the microprocessor is programmed to provide one or more prompts to the user via the user interface, the one or more prompts comprising (1) an auto prime initiation prompt, (2) a solvent selection prompt, (3) a pump priming test initiation prompt, (4) a solvent pump or reservoir selection prompt, (5) a pump priming completion prompt, or (6) any combination of prompts (1) to (5).

55. The method of any one of claims 49 to 54, wherein the priming device comprises a vacuum pump, positive displacement pump, impulse pump, valve-less pump, velocity pump or the like..

56. A method of using a pump priming system in a chromatography system, said method comprising:

initiating a pump priming procedure comprising:

moving a pump priming fluid from at least one solvent reservoir through at least one solvent pump via a priming device.

57. The method of claim 56, further comprising:

selecting a solvent using solvent selector device positioned between one of the at least one solvent reservoir and a first solvent pump of the at least one solvent pump;

opening a priming device valve positioned between the priming device and the at least one solvent pump; and

activating the priming device.

58. The method of claim 56 or 57, further comprising:

deactivating the priming device after a pump priming period;

initiating a pump priming test on the first solvent pump; and

if the first solvent pump does not pass the pump priming test, repeating said steps from said selecting of the solvent step to said deactivating step at least one time.

59. The method of claim 58, wherein said initiating a pump priming test step is performed a maximum of two times.

60. The method of any one of claims 56 to 59, wherein in response to receiving one or more inputs into a user interface of a microprocessor, initiating said method.

61. The method of claim 60, wherein in response to receiving one or more inputs into a user interface of a microprocessor, (1) opening the priming device valve, (2) selecting a solvent by opening a first manifold valve, and (3) activating the priming device.

62. The method of claim 61, wherein in response to receiving one or more inputs into a user interface of a microprocessor, (1) opening the priming device valve, (2) opening the first manifold valve, (3) activating the priming device, (4) running the priming device for a desired length of time, (5) deactivating the priming device, and (6) closing the priming device valve.

63. The method of any one of claims 61 or 62, wherein in response to receiving one or more inputs into a user interface of a microprocessor, (1) opening the priming device valve, (2) opening the first manifold valve, (3) activating the priming device, (4) running the priming device for a desired length of time, (5) deactivating the priming device, (6) closing the priming device valve, (7) initiating a pump priming test for the first solvent pump, and if the first solvent pump does not pass the pump priming test, (8) repeating steps (1) to (7) or warns the user.

64. The method of claim 63, wherein when the at least one solvent pump comprise a second solvent pump, in response to receiving one or more inputs into a user interface of a microprocessor, (9) opening the priming device valve, (10) opening a second manifold valve positioned between a solvent reservoir and the second solvent pump, (11) activating the priming device, (12) running the priming device for a desired length of time, (13) deactivating the priming device, (14) closing the priming device valve, (15) initiating a pump priming test for the second solvent pump, and if the second solvent pump does not pass the pump priming test, (16) repeat steps (9) to (15) or warns the user.

65. The method of any one of claims 56 to 64, further comprising:

providing one or more prompts to a user via a user interface of a microprocessor, the one or more prompts comprising (1) an auto prime initiation prompt, (2) a solvent selection prompt, (3) a pump priming test initiation prompt, (4) a solvent pump or reservoir selection prompt, (5) a pump priming completion prompt, or (6) any combination of prompts (1) to (5).

66. The method of any one of claims 56 to 65, further comprising:

running a solvent from the at least one solvent reservoir through at least one chromatography column in fluid communication with the at least one solvent reservoir.

67. A method of using a pump priming system in a chromatography system, said method comprising:

running a solvent from the at least one solvent reservoir through at least one chromatography column in fluid communication with the at least one solvent reservoir using at least one solvent pump;

initiating a pump priming test for the solvent pump.

68. The method of claim 67, wherein the pump priming test is performed during the running step.

69. The method of claims 67 or 68, further comprising;

initiating a pump priming procedure comprising:

moving a pump priming fluid from at least one solvent reservoir through at least one solvent pump via a priming device.

70. The method of claim 69, further comprising:

selecting a solvent using a solvent selector device positioned between one of the at least one solvent reservoir and a first solvent pump of the at least one solvent pump;

opening a priming device valve positioned between the priming device and the at least one solvent pump; and

activating the priming device.

71. The method of claim 69 or 70, further comprising:

deactivating the priming device after a pump priming period;

initiating a pump priming test on the first solvent pump; and

if the first solvent pump does not pass the pump priming test, repeating said steps from said selecting of the solvent step to said deactivating step at least one time.

72. The method of claim 71, wherein said initiating a pump priming test step is performed a maximum of two times.

73. The method of any one of claims 67 to 72, wherein in response to receiving one or more inputs into a user interface of a microprocessor, initiating said method.

74. The method of claim 70, wherein in response to receiving one or more inputs into a user interface of a microprocessor, (1) opening the priming device valve, (2) selecting a solvent by opening a first manifold valve, and (3) activating the priming device.

75. The method of claim 74, wherein in response to receiving one or more inputs into a user interface of a microprocessor, (1) opening the priming device valve, (2) opening the first manifold valve, (3) activating the priming device, (4) running the priming device for a desired length of time, (5) deactivating the priming device, and (6) closing the priming device valve.

76. The method of any one of claims 74 or 75, wherein in response to receiving one or more inputs into a user interface of a microprocessor, (1) opening the priming device valve, (2) opening the first manifold valve, (3) activating the priming device, (4) running the priming device for a desired length of time, (5) deactivating the priming device, (6) closing the priming device valve, (7) initiating a pump priming test for the first solvent pump, and if the first solvent pump does not pass the pump priming test, (8) repeating steps (1) to (7) or warns the user.

77. The method of claim 76, wherein when the at least one solvent pump comprise a second solvent pump, in response to receiving one or more inputs into a user interface of a microprocessor, (9) opening the priming device valve, (10) opening a second manifold valve positioned between a solvent reservoir and the second solvent pump, (11) activating the priming device, (12) running the priming device for a desired length of time, (13) deactivating the priming device, (14) closing the priming device valve, (15) initiating a pump priming test for the second solvent pump, and if the second solvent pump does not pass the pump priming test, (16) repeat steps (9) to (15) or warns the user.

78. The method of any one of claims 70 to 77, further comprising:

providing one or more prompts to a user via a user interface of a microprocessor, the one or more prompts comprising (1) an auto prime initiation prompt, (2) a solvent selection prompt, (3) a pump priming test initiation prompt, (4) a solvent pump or reservoir selection prompt, (5) a pump priming completion prompt, or (6) any combination of prompts (1) to (5).

FIG. 1

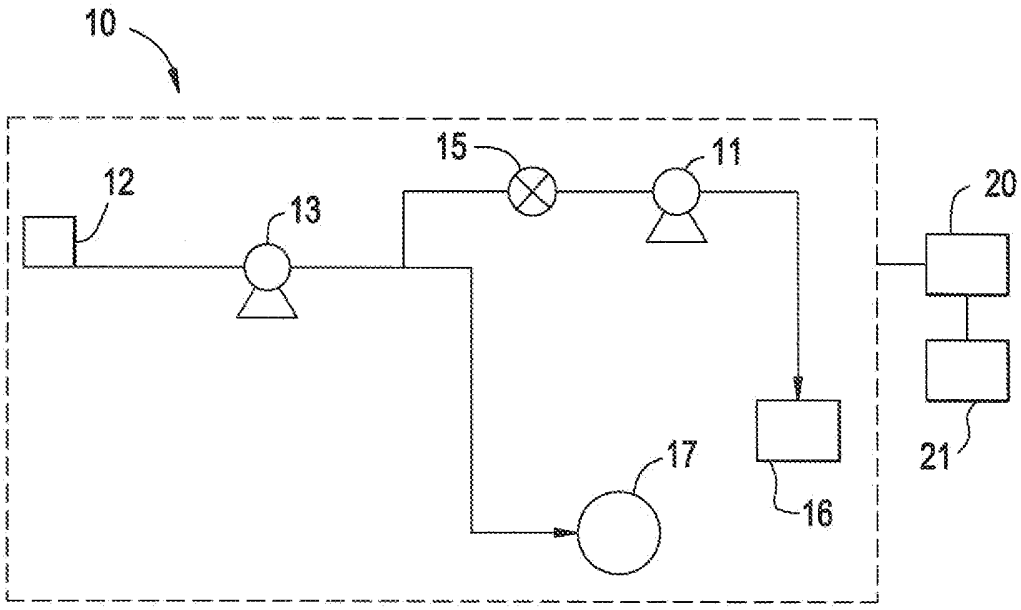


FIG. 2

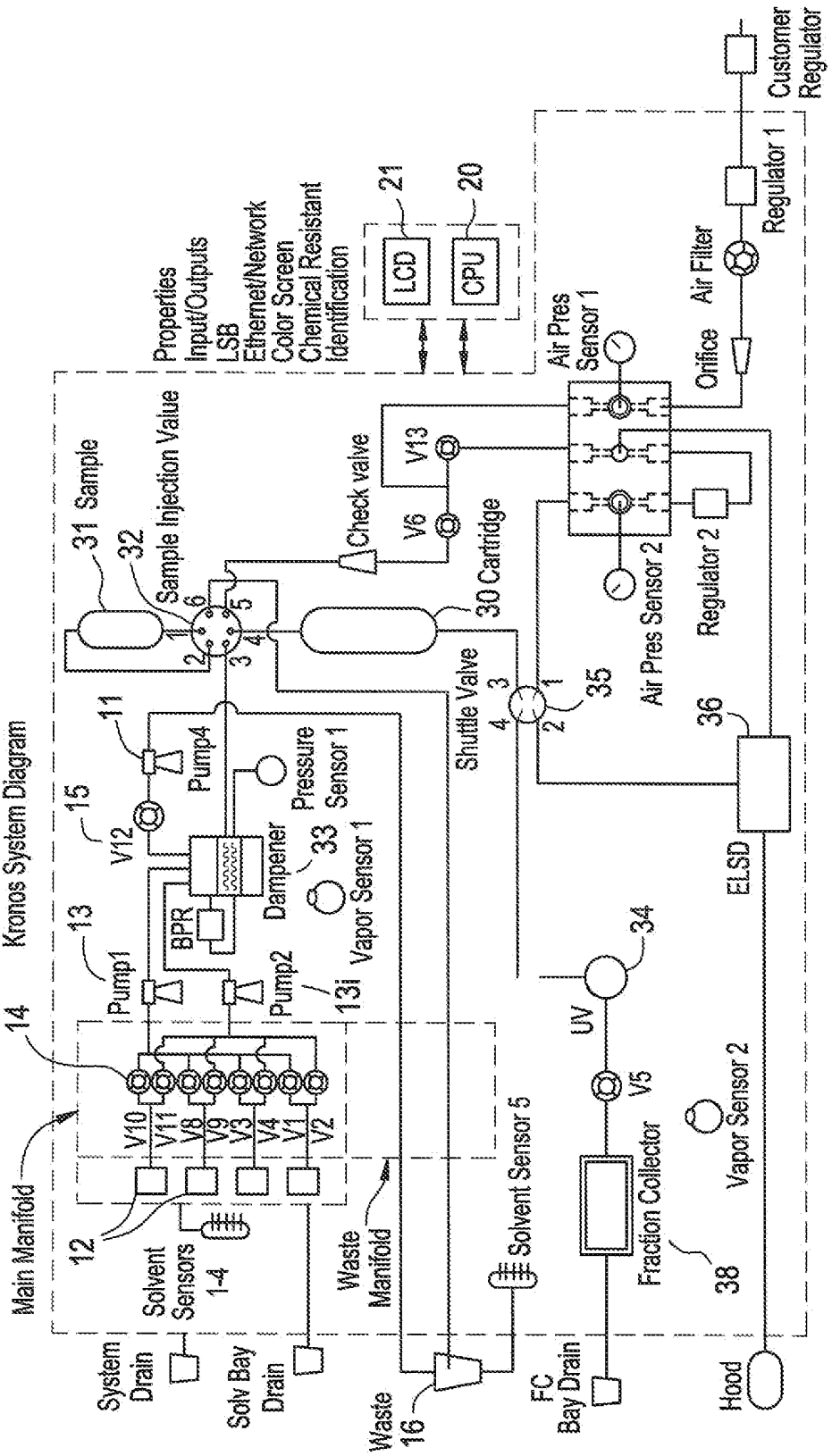

100
Kronos System Diagram
Properties
Input/Outputs
LSB
Ethernet/Network
Color Screen
Chemical Resistant
Identification
21
LCD
20
CPU
Air Pres Sensor 1
Orifice
Air Filter
Regulator 1
Customer Regulator
31 Sample
32
Sample Injection Value
Check valve
V13
V6
30 Cartridge
Air Pres Sensor 2
Regulator 2
Shuttle Valve
35
36
11
Pump4
Pressure Sensor 1
15
V12
Dampener
33
Vapor Sensor 1
13
Pump1
BPR
Pump2
13i
14
Main Manifold
V10
V11
V8
V9
V3
V4
V1
V2
12
Solvent Sensors 1-4
Waste Manifold
Solvent Sensor 5
UV
34
V5
Fraction Collector
38
Vapor Sensor 2
ELSD
System Drain
Solv Bay Drain
Waste 16
FC Bay Drain
Hood

FIG. 3

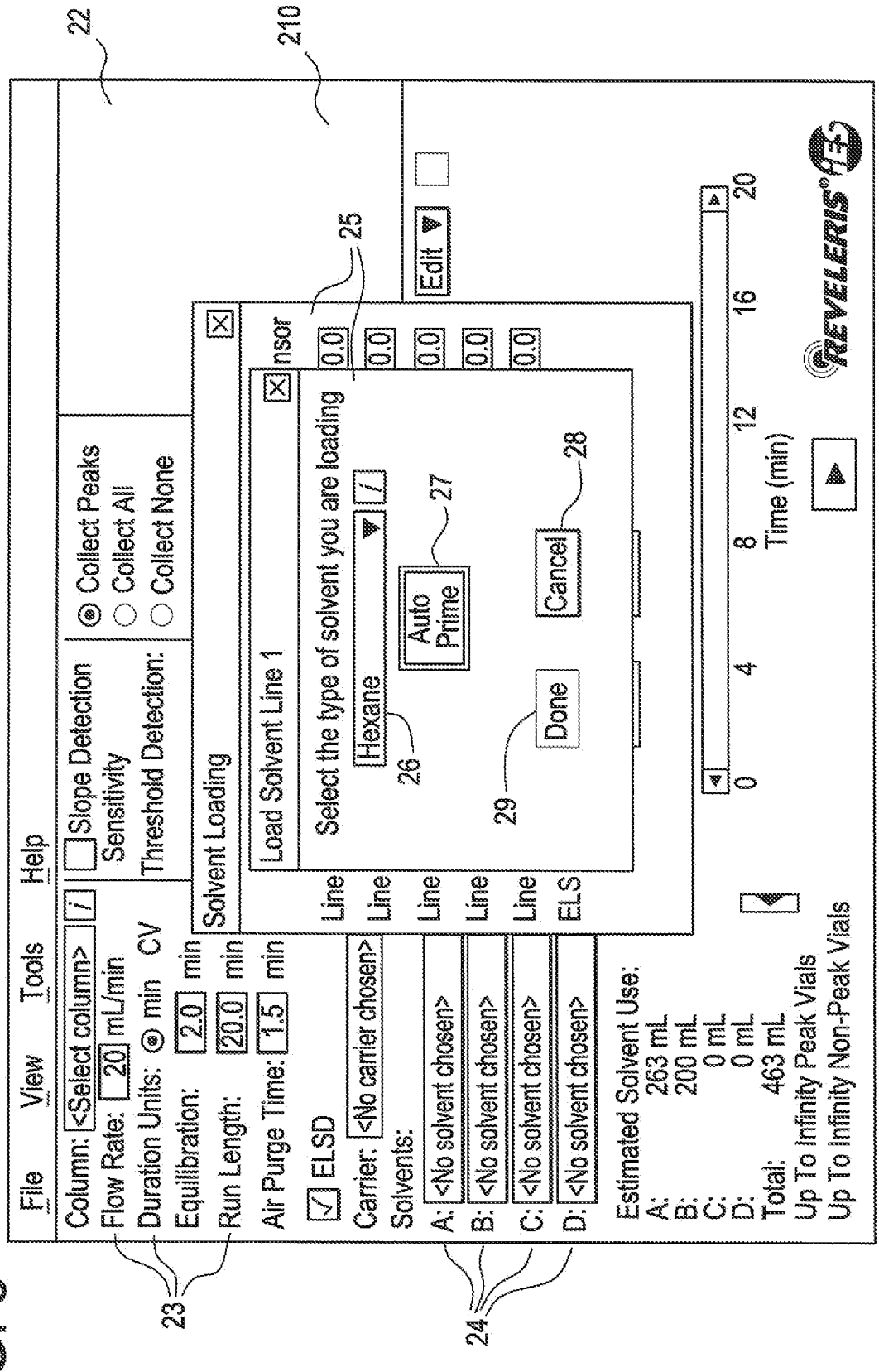

22
210
File
View
Tools
Help
Column: <Select column>
Flow Rate: 20 mL/min
Duration Units: min CV
Equilibration: 2.0 min
Run Length: 20.0 min
Air Purge Time: 1.5 min
ELSD
Carrier: <No carrier chosen>
Solvents:
A: <No solvent chosen>
B: <No solvent chosen>
C: <No solvent chosen>
D: <No solvent chosen>
Estimated Solvent Use:
A: 263 mL
B: 200 mL
C: 0 mL
D: 0 mL
Total: 463 mL
Up To Infinity Peak Vials
Up To Infinity Non-Peak Vials
Slope Detection Sensitivity
Threshold Detection:
Collect Peaks
Collect All
Collect None
Solvent Loading
Load Solvent Line 1
Select the type of solvent you are loading
Hexane
Auto Prime
Done
Cancel
Edit
25
26
27
28
29
23
24
Time (min)
REVELERIS

FIG. 4A

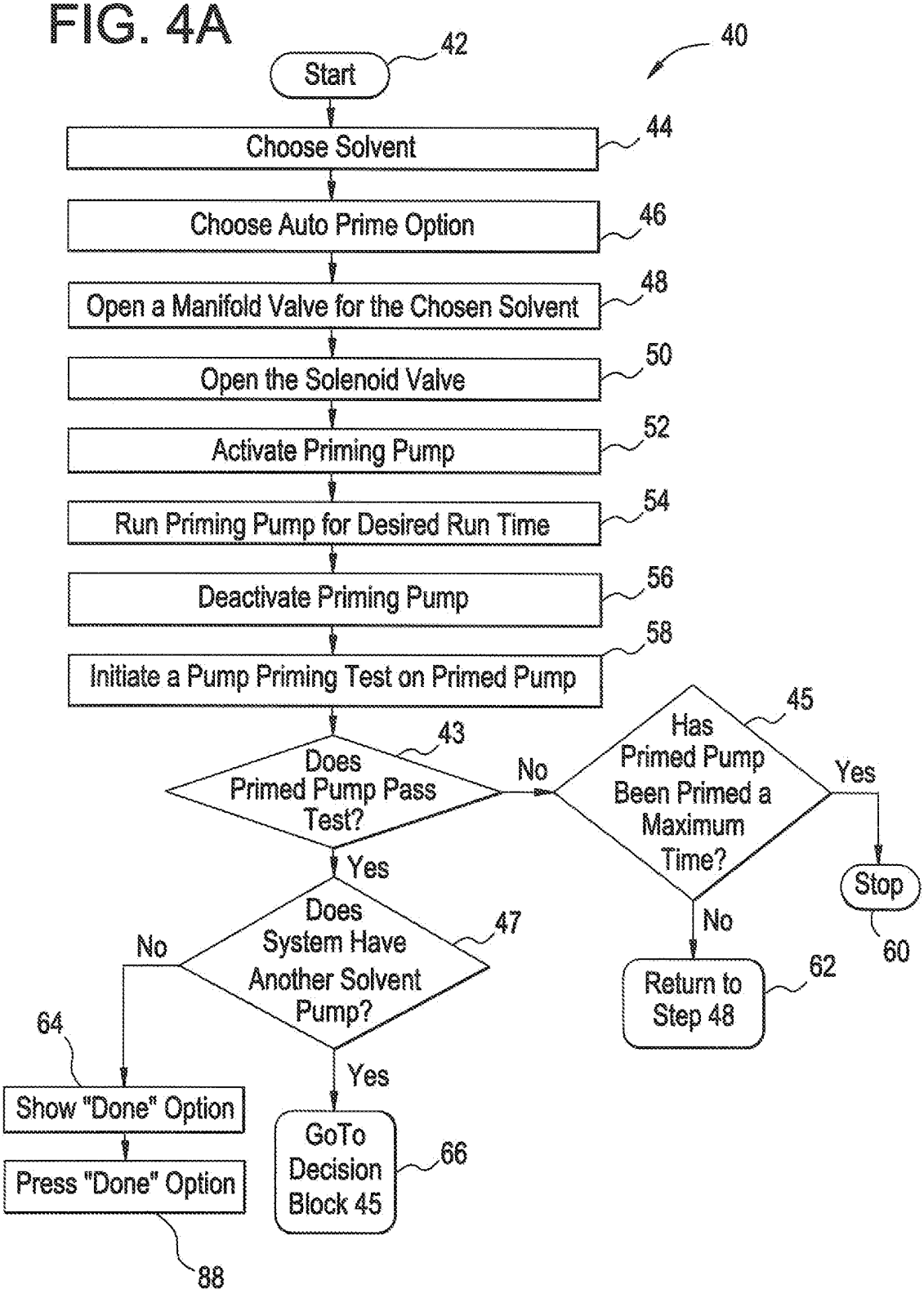

40
Start
42
Choose Solvent
44
Choose Auto Prime Option
46
Open a Manifold Valve for the Chosen Solvent
48
Open the Solenoid Valve
50
Activate Priming Pump
52
Run Priming Pump for Desired Run Time
54
Deactivate Priming Pump
56
Initiate a Pump Priming Test on Primed Pump
58
Does Primed Pump Pass Test?
43
No
Has Primed Pump Been Primed a Maximum Time?
45
Yes
Stop
60
Yes
No
Does System Have Another Solvent Pump?
47
No
Return to Step 48
62
64
Show "Done" Option
Press "Done" Option
88
Yes
GoTo Decision Block 45
66

FIG. 4B

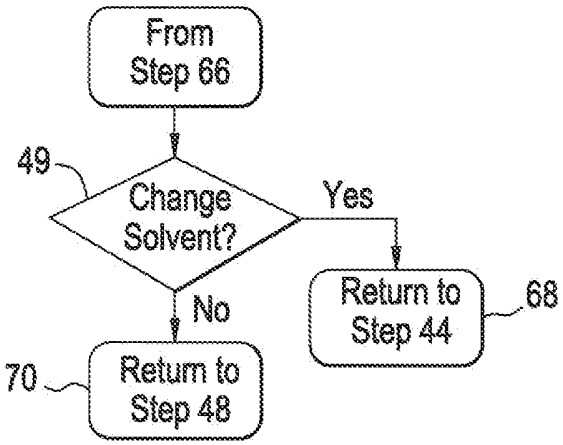
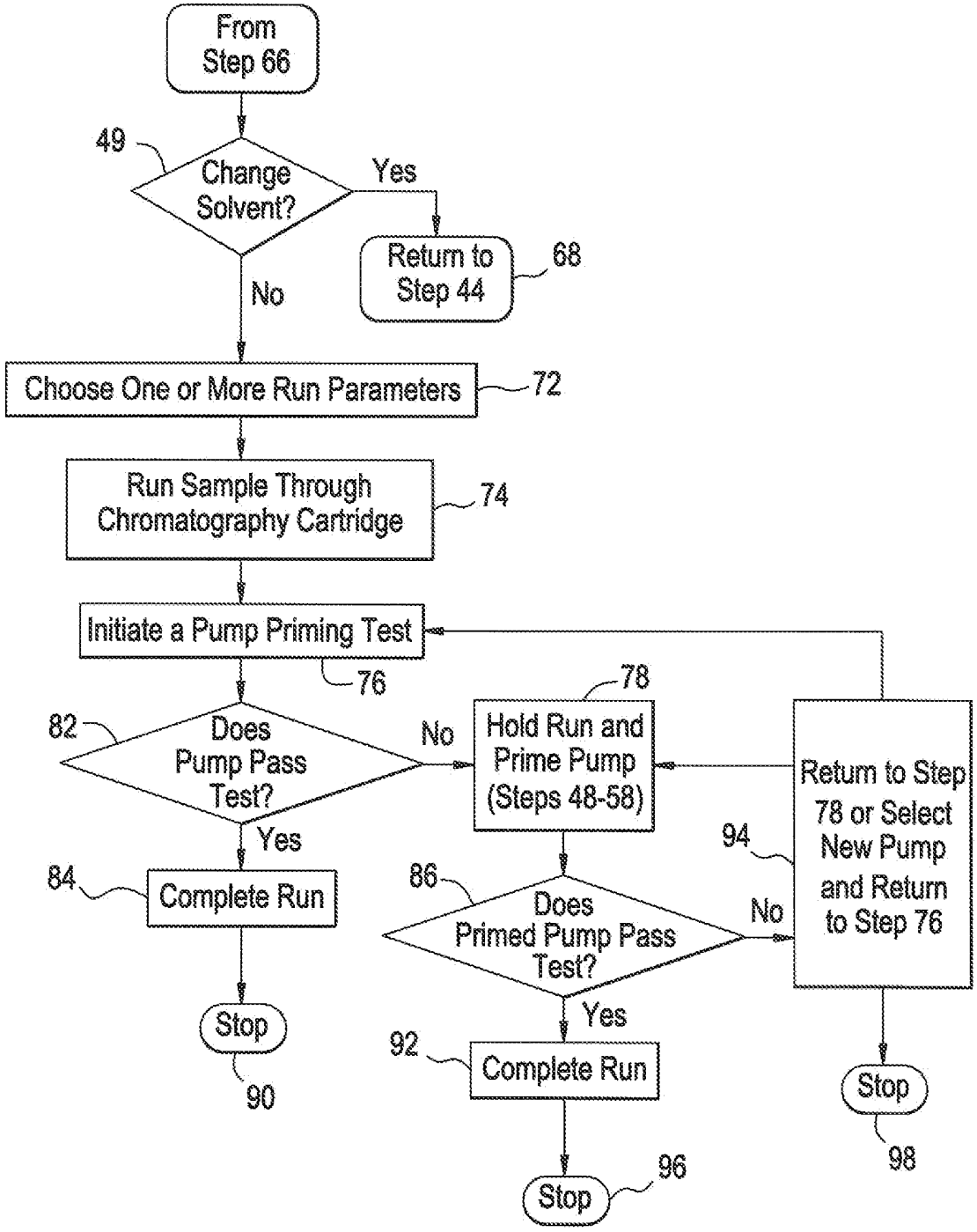

From Step 66
49
Change Solvent?
Yes
No
Return to Step 44
68
70
Return to Step 48

FIG. 4C


From Step 66
49
Change Solvent?
Yes
Return to Step 44
68
No
Choose One or More Run Parameters
72
Run Sample Through Chromatography Cartridge
74
Initiate a Pump Priming Test
76
78
82
Does Pump Pass Test?
No
Hold Run and Prime Pump (Steps 48-58)
Return to Step 78 or Select New Pump and Return to Step 76
94
Yes
84
Complete Run
86
Does Primed Pump Pass Test?
No
Stop
90
Yes
92
Complete Run
Stop
98
Stop
96

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/066826

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - G01N 30/02 (2014.01)
USPC - 210/198.2
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)
IPC(8) - G01N 30/02 (2014.01)
USPC - 210/198.2, 656; 417/199.2, 200; 435/283.1

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
CPC - G01N 30/02 (2013.01)

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4,981,597 A (ALLINGTON et al) 01 January 1991 (01.01.1991) entire document	1-3, 18-20, 36-39, 49-51, 56-59, 67-70
Y	US 2005/0069421 A1 (BASORA) 31 March 2005 (31.03.2005) entire document	1-3, 18-20, 36-39, 49-51, 56-59, 69, 70
Y	US 2006/0074272 A1 (DIUBALDI) 06 April 2006 (06.04.2006) entire document	38, 39, 51, 58, 59, 67-70
Y	US 2004/0108273 A1 (RICHARDSON et al) 10 June 2004 (10.06.2004) entire document	1-3, 18-20, 37-39, 49-51, 57-59, 70

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"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)
"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
"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
"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
"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
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 February 2014	18 MAR 2014
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/066826

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos.: 4-17, 21-35, 40-48, 52-55, 60-66, 71-78
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

(19)中华人民共和国国家知识产权局

(12)发明专利申请

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2015.06.25
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WO2014/066769 EN 2014.05.01
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(51)Int.Cl.
G01N 30/02(2006.01)

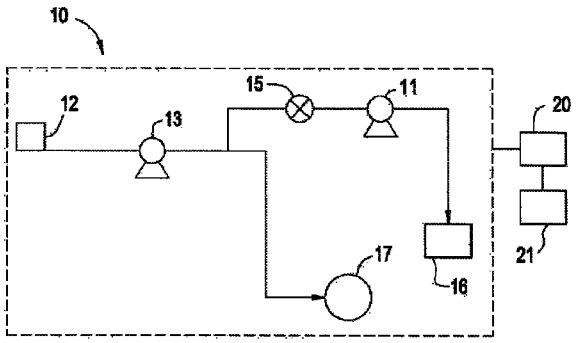
权利要求书8页 说明书12页 附图6页

(54)发明名称

泵灌注系统

(57)摘要

公开了泵灌注系统和包含所述泵灌注系统的色谱系统。还公开了制作泵灌注系统和使用泵灌注系统的方法。在常规的色谱仪器中，泵灌注以手动模式执行，其中，操作者手动打开机械阀，并且使用注射器来使液体移动通过泵，直至管道和泵充满液体。



CN 104870995 A

1. 一种泵灌注系统，包括：

灌注装置，其与(i)至少一个溶剂储存器、(ii)至少一个溶剂泵以及(iii)位于所述灌注装置和所述至少一个溶剂泵之间的至少一个阀流体连通；以及

启动泵灌注过程的激活装置，其中，来自所述至少一个溶剂储存器的流体通过所述灌注装置来移动通过所述至少一个溶剂泵。

2. 根据权利要求 1 所述的泵灌注系统，其特征在于，所述系统包括位于每个溶剂储存器和每个溶剂泵之间的溶剂选择装置。

3. 根据权利要求 1 或权利要求 2 所述的泵灌注系统，其特征在于，所述系统包括位于所述灌注装置和所述溶剂泵之间的灌注装置阀。

4. 根据权利要求 1 至 3 中任一项所述的泵灌注系统，其特征在于，所述激活装置包括电开关、气动开关或机械开关。

5. 根据权利要求 1 至 4 中任一项所述的泵灌注系统，其特征在于，所述至少一个溶剂储存器包括两个或更多个溶剂储存器。

6. 根据权利要求 1 至 5 中任一项所述的泵灌注系统，其特征在于，所述至少一个溶剂泵包括两个或更多个溶剂泵。

7. 根据权利要求 1 至 6 中任一项所述的泵灌注系统，其特征在于，所述系统包括具有用户接口的微处理器，所述微处理器被编程为：(i)接收来自用户的输入，并且响应于接收到来自所述用户的输入；以及(ii)启动泵灌注过程。

8. 根据权利要求 1 至 7 中任一项所述的泵灌注系统，其特征在于，在接收到来自所述用户的输入时，所述微处理器被编程为：(1)打开所述灌注装置阀；(2)打开位于溶剂储存器与第一溶剂泵之间的第一歧管阀；以及(3)激活所述灌注装置。

9. 根据权利要求 1 至 8 中任一项所述的泵灌注系统，其特征在于，在接收到来自所述用户的输入时，所述微处理器被编程为：(1)打开所述灌注装置阀；(2)打开位于溶剂储存器和第一溶剂泵之间的第一歧管阀；(3)激活所述灌注装置；(4)运行所述灌注装置持续期望的时间长度；(5)停用所述灌注装置；以及(6)关闭所述灌注装置阀。

10. 根据权利要求 1 至 9 中任一项所述的泵灌注系统，其特征在于，在接收到来自所述用户的输入时，所述微处理器被编程为：(1)打开所述灌注装置阀；(2)打开位于溶剂储存器和第一溶剂泵之间的第一歧管阀；(3)激活所述灌注装置；(4)运行所述灌注装置持续期望的时间长度；(5)停用所述灌注装置；(6)关闭所述灌注装置阀；(7)启动用于所述第一溶剂泵的泵灌注测试；并且如果所述第一溶剂泵没有通过所述泵灌注测试，则(8)重复步骤(1)至步骤(7)或者警告所述用户。

11. 根据权利要求 10 所述的泵灌注系统，其特征在于，当所述至少一个溶剂泵包括第二溶剂泵时，在接收到来自所述用户的输入时，所述微处理器还被编程为：(9)打开所述灌注装置阀；(10)打开位于溶剂储存器和所述第二溶剂泵之间的第二歧管阀；(11)激活所述灌注装置；(12)运行所述灌注装置持续期望的时间长度；(13)停用所述灌注装置；(14)关闭所述灌注装置阀；(15)启动用于所述第二溶剂泵的泵灌注测试；并且如果所述第二溶剂泵没有通过所述泵灌注测试，则(16)重复步骤(9)至步骤(15)或者警告所述用户。

12. 根据权利要求 1 至 11 中任一项所述的泵灌注系统，其特征在于，所述微处理器被编程为通过所述用户接口给所述用户提供一种或多种提示，所述一种或多种提示包括(1)

自动灌注启动提示、(2)溶剂选择提示、(3)泵灌注测试启动提示、(4)溶剂泵或储存器选择提示、(5)泵灌注完成提示或者(6)提示(1)至提示(5)的任何组合。

13. 根据权利要求 1 至 12 中任一项所述的泵灌注系统,其特征在于,所述灌注装置包括真空泵、容积式泵、脉冲泵、无阀泵、速度泵等。

14. 根据权利要求 1 至 13 中任一项所述的泵灌注系统,其特征在于,所述系统包括微处理器,所述微处理器被编程为:(i)检测所述至少一个溶剂泵是否没有被灌注;以及(ii)如果所述至少一个泵没有被灌注,则启动泵灌注过程。

15. 根据权利要求 14 所述的泵灌注系统,其特征在于,所述微处理器执行步骤(i)和步骤(ii),而无需来自用户的输入。

16. 一种色谱系统,包括根据权利要求 1 至 15 中任一项所述的泵灌注系统。

17. 根据权利要求 16 所述的色谱系统,还包括:

与所述至少一个溶剂储存器流体连通的至少一个色谱柱。

18. 一种色谱系统,包括:

至少一个溶剂储存器;

至少一个溶剂泵,其中每一个与所述至少一个溶剂储存器流体连通;

灌注装置,其与(i)所述至少一个溶剂储存器、(ii)所述至少一个溶剂泵以及(iii)位于每个溶剂储存器和每个溶剂泵之间的所述阀流体连通;

位于所述灌注装置和所述至少一个溶剂泵之间的阀;

启动泵灌注过程的激活装置,其中,来自所述至少一个溶剂储存器中的至少一个的流体通过所述灌注装置来移动通过所述至少一个溶剂泵;以及

与所述至少一个溶剂储存器流体连通的至少一个色谱柱。

19. 根据权利要求 18 所述的色谱系统,其特征在于,所述至少一个阀系统包括位于每个溶剂储存器和每个溶剂泵之间的溶剂选择装置。

20. 根据权利要求 18 或权利要求 19 所述的色谱系统,其特征在于,所述系统包括位于所述灌注装置和所述溶剂泵之间的灌注装置阀。

21. 根据权利要求 18 至 20 中任一项所述的色谱系统,其特征在于,所述激活装置包括电开关、气动开关或机械开关。

22. 根据权利要求 18 至 21 中任一项所述的色谱系统,其特征在于,所述至少一个溶剂储存器包括两个或更多个溶剂储存器。

23. 根据权利要求 18 至 22 中任一项所述的色谱系统,其特征在于,所述至少一个溶剂储存器包括四个溶剂储存器。

24. 根据权利要求 18 至 23 中任一项所述的色谱系统,其特征在于,所述至少一个溶剂泵包括两个或更多个溶剂泵。

25. 根据权利要求 18 至 24 中任一项所述的色谱系统,其特征在于,所述至少一个溶剂泵包括两个溶剂泵。

26. 根据权利要求 18 至 25 中任一项所述的色谱系统,其特征在于,在接收到来自所述用户的输入时,所述微处理器被编程为:(1)打开所述灌注装置阀;(2)打开位于溶剂储存器与第一溶剂泵之间的第一歧管阀;以及(3)激活所述灌注装置。

27. 根据权利要求 18 至 26 中任一项所述的色谱系统,其特征在于,在接收到来自所述

用户的输入时，所述微处理器被编程为：(1)打开所述灌注装置阀；(2)打开位于溶剂储存器和第一溶剂泵之间的第一歧管阀；(3)激活所述灌注装置；(4)运行所述灌注装置持续期望的时间长度；(5)停用所述灌注装置；以及(6)关闭所述灌注装置阀。

28. 根据权利要求18至27中任一项所述的色谱系统，其特征在于，在接收到来自所述用户的输入时，所述微处理器被编程为：(1)打开所述灌注装置阀；(2)打开位于溶剂储存器和第一溶剂泵之间的第一歧管阀；(3)激活所述灌注装置；(4)运行所述灌注装置持续期望的时间长度；(5)停用所述灌注装置；(6)关闭所述灌注装置阀；(7)启动用于所述第一溶剂泵的泵灌注测试；并且如果所述第一溶剂泵没有通过所述泵灌注测试，则(8)重复步骤(1)至步骤(7)或者警告所述用户。

29. 根据权利要求28所述的色谱系统，其特征在于，当所述至少一个溶剂泵包括第二溶剂泵时，在接收到来自所述用户的输入时，所述微处理器还被编程为：(9)打开所述灌注装置阀；(10)打开位于溶剂储存器和所述第二溶剂泵之间的第二歧管阀；(11)激活所述灌注装置；(12)运行所述灌注装置持续期望的时间长度；(13)停用所述灌注装置；(14)关闭所述灌注装置阀；(15)启动用于所述第二溶剂泵的泵灌注测试；并且如果所述第二溶剂泵没有通过所述泵灌注测试，则(16)重复步骤(9)至步骤(15)或者警告所述用户。

30. 根据权利要求18至29中任一项所述的色谱系统，其特征在于，所述微处理器被编程为通过所述用户接口给所述用户提供一种或多种提示，所述一种或多种提示包括(1)自动灌注启动提示、(2)溶剂选择提示、(3)泵灌注测试启动提示、(4)溶剂泵或储存器选择提示、(5)泵灌注完成提示或者(6)提示(1)至提示(5)的任何组合。

31. 根据权利要求18至30中任一项所述的色谱系统，其特征在于，所述灌注装置包括真空泵、容积式泵、脉冲泵、无阀泵、速度泵等。

32. 根据权利要求18至31中任一项所述的色谱系统，其特征在于，所述系统包括微处理器，所述微处理器被编程为：(i)检测所述至少一个溶剂泵是否没有被灌注；以及(ii)如果所述至少一个泵没有被灌注，则启动泵灌注过程。

33. 根据权利要求32所述的色谱系统，其特征在于，所述微处理器在色谱运行之前或期间执行步骤(i)和步骤(ii)。

34. 根据权利要求32所述的泵灌注系统，其特征在于，所述微处理器执行步骤(i)和步骤(ii)，而无需来自用户的输入。

35. 一种在根据权利要求18至34中任一项所述的色谱系统中灌注泵的方法，所述方法包括：

通过所述灌注装置使来自所述至少一个溶剂储存器中的一个的泵灌注流体移动通过所述至少一个溶剂泵中的一个。

36. 一种灌注泵的方法，所述方法包括：

通过灌注装置使来自至少一个溶剂储存器的泵灌注流体移动通过至少一个溶剂泵。

37. 根据权利要求36所述的方法，还包括：

打开位于所述至少一个溶剂储存器中的一个与所述至少一个溶剂泵中的第一溶剂泵之间的第一歧管阀；

打开位于所述灌注装置和所述至少一个溶剂泵之间的灌注装置阀；以及

激活所述灌注装置。

38. 根据权利要求 36 或权利要求 37 所述的方法，还包括：

在泵灌注期后，停用所述灌注装置；

在所述第一溶剂泵上启动泵灌注测试；以及

如果所述第一溶剂泵没有通过所述泵灌注测试，则重复从所述打开所述歧管阀的步骤至所述停用步骤的所述步骤至少一次。

39. 根据权利要求 38 所述的方法，其特征在于，所述启动泵灌注测试的步骤被执行最多两次。

40. 根据权利要求 36 至 39 中任一项所述的方法，其特征在于，响应于接收到至微处理器的用户接口中的一个或多个输入，启动所述方法。

41. 根据权利要求 40 所述的方法，其特征在于，响应于接收到至微处理器的用户接口中的一个或多个输入，(1)打开所述灌注装置阀，(2)打开所述第一歧管阀，以及(3)激活所述灌注装置。

42. 根据权利要求 40 或权利要求 41 所述的方法，其特征在于，响应于接收到至微处理器的用户接口中的一个或多个输入，(1)打开所述灌注装置阀，(2)打开所述第一歧管阀，(3)激活所述灌注装置，(4)运行所述灌注装置持续期望的时间长度，(5)停用所述灌注装置，以及(6)关闭所述灌注装置阀。

43. 根据权利要求 40 至 42 中任一项所述的方法，其特征在于，响应于接收到至微处理器的用户接口中的一个或多个输入，(1)打开所述灌注装置阀，(2)打开所述第一歧管阀，(3)激活所述灌注装置，(4)运行所述灌注装置持续期望的时间长度，(5)停用所述灌注装置，(6)关闭所述灌注装置阀，(7)启动用于所述第一溶剂泵的泵灌注测试，并且如果所述第一溶剂泵没有通过所述泵灌注测试，则(8)重复步骤(1)至步骤(7)或者警告所述用户。

44. 根据权利要求 43 所述的方法，其特征在于，当所述至少一个溶剂泵包括第二溶剂泵时，响应于接收到至微处理器的用户接口中的一个或多个输入，(9)打开所述灌注装置阀，(10)打开位于溶剂储存器和所述第二溶剂泵之间的第二歧管阀，(11)激活所述灌注装置，(12)运行所述灌注装置持续期望的时间长度，(13)停用所述灌注装置，(14)关闭所述灌注装置阀，(15)启动用于所述第二溶剂泵的泵灌注测试，并且如果所述第二溶剂泵没有通过所述泵灌注测试，则(16)重复步骤(9)至步骤(15)或者警告所述用户。

45. 根据权利要求 36 至 44 中任一项所述的方法，还包括：

通过微处理器的用户接口给用户提供一种或多种提示，所述一种或多种提示包括(1)自动灌注启动提示、(2)溶剂选择提示、(3)泵灌注测试启动提示、(4)溶剂泵或储存器选择提示、(5)泵灌注完成提示或者(6)提示(1)至提示(5)的任何组合。

46. 根据权利要求 36 至 45 中任一项所述的方法，还包括：

使来自所述至少一个溶剂储存器的溶剂运行通过与所述至少一个溶剂储存器流体连通的至少一个色谱柱。

47. 一种用于将泵灌注系统结合到现有的色谱系统中的套件，所述套件包括：

灌注装置；

可位于所述灌注装置和所述现有的色谱系统的至少一个溶剂泵之间的灌注装置阀；以及

用于所述现有的色谱系统的微处理器的软件更新，当装载到所述微处理器上时，所述

软件更新使得所述微处理器能执行根据权利要求 36 至 46 中任一项所述的方法。

48. 一种制作色谱系统的方法，所述方法包括：

将根据权利要求 1 至 9 中任一项所述的泵灌注系统结合到所述色谱系统中。

49. 一种制作色谱系统的方法，所述方法包括：

采用(i)至少一个溶剂储存器；(ii)至少一个溶剂泵，其中每一个与所述至少一个溶剂储存器流体连通；(iii)与所述至少一个溶剂储存器、所述至少一个溶剂泵流体连通的灌注装置；(iv)位于所述灌注装置和所述至少一个溶剂泵之间的灌注装置阀；以及(v)具有到所述色谱系统中的用户接口的微处理器，其中，所述微处理器被编程为(1)接收来自用户的输入，并且响应于接收到来自所述用户的输入，(2)启动泵灌注过程，其中，来自所述至少一个溶剂储存器中的至少一个的流体通过所述灌注装置来移动通过所述至少一个溶剂泵。

50. 根据权利要求 49 所述的方法，其特征在于，所述微处理器被编程为：(1)打开所述灌注装置阀；(2)激活位于溶剂储存器与第一溶剂泵之间且与二者流体连通的溶剂选择器装置，所述溶剂选择器装置打开第一歧管阀；以及(3)激活所述灌注装置。

51. 根据权利要求 49 或权利要求 50 所述的方法，其特征在于，所述微处理器被编程为：(1)打开所述灌注装置阀；(2)打开位于溶剂储存器和第一溶剂泵之间的第一歧管阀；(3)激活所述灌注装置；(4)运行所述灌注装置持续期望的时间长度；(5)停用所述灌注装置；以及(6)关闭所述第一歧管阀。

52. 根据权利要求 49 至 51 中任一项所述的方法，其特征在于，所述微处理器被编程为：(1)打开所述灌注装置阀；(2)打开位于溶剂储存器和第一溶剂泵之间的第一歧管阀；(3)激活所述灌注装置；(4)运行所述灌注装置持续期望的时间长度；(5)停用所述灌注装置；(6)关闭所述灌注装置阀；以及(7)启动用于所述第一溶剂泵的泵灌注测试；并且如果所述第一溶剂泵没有通过所述泵灌注测试，则(8)重复步骤(1)至步骤(7)或者警告所述用户。

53. 根据权利要求 52 所述的方法，其特征在于，当所述至少一个溶剂泵包括第二溶剂泵时，所述微处理器还被编程为：(9)打开所述灌注装置阀；(10)打开位于溶剂储存器和所述第二溶剂泵之间的第二歧管阀；(11)激活所述灌注装置；(12)运行所述灌注装置持续期望的时间长度；(13)停用所述灌注装置；(14)关闭所述灌注装置阀；(15)启动用于所述第二溶剂泵的泵灌注测试；并且如果所述第二溶剂泵没有通过所述泵灌注测试，则(16)重复步骤(9)至步骤(15)或者警告所述用户。

54. 根据权利要求 49 至 53 中任一项所述的方法，其特征在于，所述微处理器被编程为通过所述用户接口给所述用户提供一种或多种提示，所述一种或多种提示包括(1)自动灌注启动提示、(2)溶剂选择提示、(3)泵灌注测试启动提示、(4)溶剂泵或储存器选择提示、(5)泵灌注完成提示或者(6)提示(1)至提示(5)的任何组合。

55. 根据权利要求 49 至 54 中任一项所述的方法，其特征在于，所述灌注装置包括真空泵、容积式泵、脉冲泵、无阀泵、速度泵等。

56. 一种使用色谱系统中的泵灌注系统的方法，所述方法包括：

启动泵灌注程序，其包括：

通过灌注装置使来自至少一个溶剂储存器的泵灌注流体移动通过至少一个溶剂泵。

57. 根据权利要求 56 所述的方法，还包括：

使用位于所述至少一个溶剂储存器中的一个与所述至少一个溶剂泵中的第一溶剂泵之间的溶剂选择器装置来选择溶剂；

打开位于所述灌注装置和所述至少一个溶剂泵之间的灌注装置阀；以及

激活所述灌注装置。

58. 根据权利要求 56 或权利要求 57 所述的方法，还包括：

在泵灌注期后，停用所述灌注装置；

在所述第一溶剂泵上启动泵灌注测试；以及

如果所述第一溶剂泵没有通过所述泵灌注测试，则重复从所述选择所述溶剂的步骤至所述停用步骤的所述步骤至少一次。

59. 根据权利要求 58 所述的方法，其特征在于，所述启动泵灌注测试的步骤被执行最多两次。

60. 根据权利要求 56 至 59 中任一项所述的方法，其特征在于，响应于接收到至微处理器的用户接口中的一个或多个输入，启动所述方法。

61. 根据权利要求 60 所述的方法，其特征在于，响应于接收到至微处理器的用户接口中的一个或多个输入，(1)打开所述灌注装置阀，(2)通过打开第一歧管阀来选择溶剂，以及(3)激活所述灌注装置。

62. 根据权利要求 61 所述的方法，其特征在于，响应于接收到至微处理器的用户接口中的一个或多个输入，(1)打开所述灌注装置阀，(2)打开所述第一歧管阀，(3)激活所述灌注装置，(4)运行所述灌注装置持续期望的时间长度，(5)停用所述灌注装置，以及(6)关闭所述灌注装置阀。

63. 根据权利要求 61 或权利要求 62 中任一项所述的方法，其特征在于，响应于接收到至微处理器的用户接口中的一个或多个输入，(1)打开所述灌注装置阀，(2)打开所述第一歧管阀，(3)激活所述灌注装置，(4)运行所述灌注装置持续期望的时间长度，(5)停用所述灌注装置，(6)关闭所述灌注装置阀，(7)启动用于所述第一溶剂泵的泵灌注测试，并且如果所述第一溶剂泵没有通过所述泵灌注测试，则(8)重复步骤(1)至步骤(7)或者警告所述用户。

64. 根据权利要求 63 所述的方法，其特征在于，当所述至少一个溶剂泵包括第二溶剂泵时，响应于接收到至微处理器的用户接口中的一个或多个输入，(9)打开所述灌注装置阀，(10)打开位于溶剂储存器和所述第二溶剂泵之间的第二歧管阀，(11)激活所述灌注装置，(12)运行所述灌注装置持续期望的时间长度，(13)停用所述灌注装置，(14)关闭所述灌注装置阀，(15)启动用于所述第二溶剂泵的泵灌注测试，并且如果所述第二溶剂泵没有通过所述泵灌注测试，则(16)重复步骤(9)至步骤(15)或者警告所述用户。

65. 根据权利要求 56 至 64 中任一项所述的方法，还包括：

通过微处理器的用户接口给用户提供一种或多种提示，所述一种或多种提示包括(1)自动灌注启动提示、(2)溶剂选择提示、(3)泵灌注测试启动提示、(4)溶剂泵或储存器选择提示、(5)泵灌注完成提示或者(6)提示(1)至提示(5)的任何组合。

66. 根据权利要求 56 至 65 中任一项所述的方法，还包括：

使来自所述至少一个溶剂储存器的溶剂运行通过与所述至少一个溶剂储存器流体连通的至少一个色谱柱。

67. 一种使用色谱系统中的泵灌注系统的方法，所述方法包括：

使用至少一个溶剂泵来使来自所述至少一个溶剂储存器的溶剂运行通过与所述至少一个溶剂储存器流体连通的至少一个色谱柱；

启动用于所述溶剂泵的泵灌注测试。

68. 根据权利要求 67 所述的方法，其特征在于，所述泵灌注测试在所述运行步骤期间被执行。

69. 根据权利要求 67 或权利要求 68 所述的方法，还包括：

启动泵灌注程序，其包括：

通过灌注装置使来自至少一个溶剂储存器的泵灌注流体移动通过至少一个溶剂泵。

70. 根据权利要求 69 所述的方法，还包括：

使用位于所述至少一个溶剂储存器中的一个与所述至少一个溶剂泵中的第一溶剂泵之间的溶剂选择器装置来选择溶剂；

打开位于所述灌注装置和所述至少一个溶剂泵之间的灌注装置阀；以及

激活所述灌注装置。

71. 根据权利要求 69 或权利要求 70 所述的方法，还包括：

在泵灌注期后，停用所述灌注装置；

在所述第一溶剂泵上启动泵灌注测试；以及

如果所述第一溶剂泵没有通过所述泵灌注测试，则重复从所述选择所述溶剂的步骤至所述停用步骤的所述步骤至少一次。

72. 根据权利要求 71 所述的方法，其特征在于，所述启动泵灌注测试的步骤被执行最多两次。

73. 根据权利要求 67 至 72 中任一项所述的方法，其特征在于，响应于接收到至微处理器的用户接口中的一个或多个输入，启动所述方法。

74. 根据权利要求 70 所述的方法，其特征在于，响应于接收到至微处理器的用户接口中的一个或多个输入，(1)打开所述灌注装置阀，(2)通过打开第一歧管阀来选择溶剂，以及(3)激活所述灌注装置。

75. 根据权利要求 74 所述的方法，其特征在于，响应于接收到至微处理器的用户接口中的一个或多个输入，(1)打开所述灌注装置阀，(2)打开所述第一歧管阀，(3)激活所述灌注装置，(4)运行所述灌注装置持续期望的时间长度，(5)停用所述灌注装置，以及(6)关闭所述灌注装置阀。

76. 根据权利要求 74 或权利要求 75 中任一项所述的方法，其特征在于，响应于接收到至微处理器的用户接口中的一个或多个输入，(1)打开所述灌注装置阀，(2)打开所述第一歧管阀，(3)激活所述灌注装置，(4)运行所述灌注装置持续期望的时间长度，(5)停用所述灌注装置，(6)关闭所述灌注装置阀，(7)启动用于所述第一溶剂泵的泵灌注测试，并且如果所述第一溶剂泵没有通过所述泵灌注测试，则(8)重复步骤(1)至步骤(7)或者警告所述用户。

77. 根据权利要求 76 所述的方法，其特征在于，当所述至少一个溶剂泵包括第二溶剂泵时，响应于接收到至微处理器的用户接口中的一个或多个输入，(9)打开所述灌注装置阀，(10)打开位于溶剂储存器和所述第二溶剂泵之间的第二歧管阀，(11)激活所述灌注装

置，(12)运行所述灌注装置持续期望的时间长度，(13)停用所述灌注装置，(14)关闭所述灌注装置阀，(15)启动用于所述第二溶剂泵的泵灌注测试，并且如果所述第二溶剂泵没有通过所述泵灌注测试，则(16)重复步骤(9)至步骤(15)或者警告所述用户。

78. 根据权利要求 70 至 77 中任一项所述的方法，还包括：

通过微处理器的用户接口给用户提供一种或多种提示，所述一种或多种提示包括(1)自动灌注启动提示、(2)溶剂选择提示、(3)泵灌注测试启动提示、(4)溶剂泵或储存器选择提示、(5)泵灌注完成提示或者(6)提示(1)至提示(5)的任何组合。

泵灌注系统

技术领域

[0001] 本发明涉及泵灌注(priming)系统和包含泵灌注系统的色谱系统、制作泵灌注系统的方法以及使用泵灌注系统的方法。

背景技术

[0002] 在常规的色谱仪器中,泵灌注以手动模式执行,其中,操作者手动打开机械阀,并使用注射器来使液体移动通过泵,直至管道和泵被液体充满。在常规的色谱仪器中手动灌注泵具有一个或多个缺点,包括但不限于:(1)(i)打开机械阀、(ii)准备注射器以及(iii)利用注射器使液体移动通过泵直至管道和泵被液体充满所需的工时;(2)与(i)手动打开机械阀、(ii)手动准备注射器以及(iii)手动利用注射器使液体移动通过泵直至管道和泵被液体充满相关的潜在的人为错误;(3)关于手动泵灌注操作的有效性的不确定性;以及(4)在从一个泵到另一个泵的手动泵灌注操作之间的潜在的不一致。

[0003] 在本领域中需要改进泵灌注操作,以便去除上述缺点中的一个或多个。

发明内容

[0004] 通过发明适于用在色谱系统中的泵灌注系统,本发明解决了以上讨论的困难和问题中的一部分。由于优于常规的色谱操作的以下优点中的一个或多个,所公开的泵灌注系统使得能够实现更高效、多产和/或一致的泵灌注操作,即:(1)消除了(i)手动打开机械阀、(ii)手动准备注射器以及(iii)手动利用注射器使液体移动通过泵直至管道和泵被液体充满所需的工时;(2)潜在地去除了与(i)手动打开机械阀、(ii)手动准备注射器以及(iii)手动利用注射器使液体移动通过泵直至管道和泵被液体充满相关的人为错误;(3)潜在地去除了关于给定的泵灌注操作的有效性的不确定性;以及(4)潜在地去除了从一个泵到另一个泵的泵灌注操作之间的不一致。

[0005] 在一个示例性实施例中,本发明的泵灌注系统包括:灌注装置,其与(i)至少一个溶剂储存器、(ii)至少一个溶剂泵、(iii)位于每个溶剂储存器和每个溶剂泵之间的可选的溶剂选择装置以及(iv)位于所述灌注装置和所述至少一个溶剂泵之间的阀流体连通;以及具有用户接口的可选的微处理器,所述微处理器被编程为(i)接收来自用户的输入,并且响应于接收到来自用户的输入,(ii)启动泵灌注过程,其中,来自所述至少一个溶剂储存器中的至少一个的流体通过所述灌注装置来移动通过所述至少一个溶剂泵。

[0006] 本发明还涉及包括自动泵灌注系统的色谱系统。在一个示例性实施例中,本发明的色谱系统包括:至少一个溶剂储存器;至少一个溶剂泵,其中每一个与所述至少一个溶剂储存器流体连通;位于每个溶剂储存器和每个溶剂泵之间的可选的溶剂选择装置;灌注装置,其与(i)所述至少一个溶剂储存器、(ii)所述至少一个溶剂泵以及(iii)位于每个溶剂储存器和每个溶剂泵之间的所述可选的溶剂选择装置流体连通;位于所述灌注装置和所述至少一个溶剂泵之间的阀;以及具有用户接口的可选的微处理器,所述微处理器被编程为(i)接收来自用户的输入,并且响应于接收到来自所述用户的输入,(ii)启动泵灌注过程,

其中，来自所述至少一个溶剂储存器中的至少一个的流体通过所述灌注装置来移动通过所述至少一个溶剂泵。

[0007] 本发明甚至还涉及灌注泵的方法。在一个示例性实施例中，所述灌注泵的方法包括通过灌注装置使来自至少一个溶剂储存器的泵灌注流体移动通过至少一个溶剂泵。所公开的灌注泵的方法还可以包括一个或多个附加步骤，例如，可选地打开位于所述至少一个溶剂储存器中的一个与第一溶剂泵之间的溶剂选择装置；打开位于所述灌注装置和所述至少一个溶剂泵之间的阀；以及激活所述灌注装置。在一些实施例中，所公开的灌注泵的方法包括灌注色谱系统中的泵。

[0008] 本发明还涉及用于将泵灌注系统结合到现有的色谱系统中的套件。在一个示例性实施例中，用于将泵灌注系统结合到现有的色谱系统中的套件包括：灌注装置；位于所述灌注装置和所述现有的色谱系统的至少一个溶剂泵之间的阀；以及用于所述现有的色谱系统的微处理器的可选的软件更新，当装载到所述微处理器上时，所述软件更新使得所述微处理器能执行本文公开的灌注泵的方法中的一种或多种。

[0009] 本发明另外还涉及制作色谱系统的方法。在一个示例性实施例中，制作色谱系统的方法包括采用：(i)至少一个溶剂储存器；(ii)至少一个溶剂泵，其中每一个与所述至少一个溶剂储存器流体连通；(iii)位于每个溶剂储存器和每个溶剂泵之间的可选的溶剂选择装置；(iv)与所述至少一个溶剂储存器、所述至少一个溶剂泵以及所述可选的溶剂选择装置流体连通的灌注装置；(v)位于所述灌注装置和所述至少一个溶剂泵之间的阀；以及(vi)具有到所述色谱系统中的用户接口的可选的微处理器，其中，所述微处理器被编程为(1)接收来自用户的输入，并且响应于接收到来自所述用户的输入，(2)启动泵灌注过程，其中，来自所述至少一个溶剂储存器中的至少一个的流体通过所述灌注装置来移动通过所述至少一个溶剂泵。

[0010] 在审阅所公开的实施例的以下详细描述和所附权利要求之后，本发明的这些和其它的特征和优点将变得显而易见。

附图说明

[0011] 图 1 描绘了本发明的示例性自动泵灌注系统的视图；

图 2 描绘了包括图 1 中所示的示例性自动泵灌注系统的示例性色谱系统的视图；

图 3 描绘了适于用在图 2 中所示的示例性色谱系统中的示例性用户接口显示器的视图；以及

图 4A-4C 描绘了流程图，其示出了利用图 1 中所示的示例性自动泵灌注系统(图 4A-4B)和例如图 2 中所示的示例性色谱系统的色谱系统中的示例性自动泵灌注系统(图 4A 和图 4C)的示例性步骤。

具体实施方式

[0012] 为了促进理解本发明的原理，以下本发明的特定实施例的描述和特定的语言被用于描述特定的实施例。然而将会理解的是，特定语言的使用不意在限制本发明的范围。所讨论的本发明的原理的变更、进一步的修改以及这样的进一步应用是预期的，所述预期如对于本发明所属领域的一个普通技术人员来说通常将会发生的那样。

[0013] 必须注意到的是，如本文和所附的权利要求中所使用的，单数形式“一”和“所述”包括复数个所称对象，除非上下文清楚地指示其它。因此，例如，对“一氧化物”的提及包括多种这样的氧化物，对“氧化物”的提及包括对一种或多种氧化物、及其对本领域的那些技术人员来说已知的等同物的提及，等等。

[0014] 在所述公开内容的实施例的描述中使用的“大约”修改了例如合成物、浓度、体积、过程温度、过程时间、回收率或者产量、流率以及类似值及其范围，所述“大约”指的是例如在通常的测量和操纵(handling)程序中、在这些程序的疏忽错误中、在用于执行所述方法的成分的差异中、以及类似的近似考虑中可能发生的数字数量上的变化。术语“大约”还包括由于具有特殊的初始浓度或混合物的配方的老化而不同的量、以及由于混合或者处理具有特殊的初始浓度或者混合物的配方而不同的量。不管是否被术语“大约”修改，至此所附的权利要求包括这些数量的等同。

[0015] 如在此使用的，术语“色谱”意指使溶解在流动相中的混合物通过容纳在柱或者筒或者其它容器内的固定相(即，色谱媒介)的过程，所述过程将目标分子与混合物中的其它分子分开，且允许它被隔离。根据所使用的色谱的类型，目标分子可以在固定相上被吸收，而期望的成分通过装置，反之亦然。术语“液体色谱”是一种色谱的形式，其中液体被用作移动相，载体上的固体或者液体作为固定相。术语“快速柱色谱”意指在正压力(例如，多达300 psi)下执行的液体色谱。术语“高性能液体色谱”(HPLC)意指在高的正压力(例如，多达5000 psi)下执行的液体色谱。术语“预备色谱”意指用于隔离和纯化目标化合物和分子的HPLC。移动相可包括一种或多种溶剂，所述溶剂包括目标分子。

[0016] 如本文所使用的，术语“流体”意指在应用的剪切应力下流动或变形的任何物质。流体包括液体、气体、浆体及其组合(例如，超临界流体)。

[0017] 在本文所使用的，术语“泵”意指用于通过机械力移动流体的装置，例如直接提升、位移和重力泵。机械作用通常是往复的或旋转的，它可以由手动操作、电、引擎或者其它能量(例如风或者其它能量)产生。

[0018] 如本文所使用的，术语“阀”意指通过打开、关闭、限制或者移动流体来调节、引导或者控制流体的流动的装置，可以分类为被动阀和主动阀。被动阀操作不需要外部的能量源，而是使用系统中已经出现的能量(通常，压力差)。主动阀，另一方面，要求外部能量、以及促动原则，所述促动原则中，外部能量通常被转导为限制或者打开流体通道的机械作用。如本文所使用的，术语“分流阀”意指将流体流的流率分离或者将流体从一个流移动到另一个流的装置，且包括被动阀(例如，三通阀、分流阀等)，主动阀(例如，换向阀、分流泵等)。

[0019] 本发明涉及泵灌注系统和包含泵灌注系统的色谱系统。本发明还涉及制作泵灌注系统和色谱系统的方法以及使用泵灌注系统和色谱系统的方法。以下提供了对示例性泵灌注系统、示例性色谱系统、制作泵灌注系统和色谱系统的方法以及使用泵灌注系统和色谱系统的方法的描述。

[0020] 图1提供了本发明的示例性泵灌注系统10的视图。如图1中所示，示例性泵灌注系统10包括至少一个灌注装置11，其与(i)至少一个溶剂储存器12、(ii)至少一个溶剂泵13、(iii)位于每个溶剂储存器12和每个溶剂泵13之间的可选的歧管阀(未示出)以及(iv)位于至少一个灌注装置11和至少一个溶剂泵13之间的至少一个阀15流体连通。在一些期望的实施例中，灌注装置11包括真空泵、容积式泵、脉冲泵、无阀泵、速度泵等。即使图1

仅描绘了一个灌注装置 11、一个溶剂储存器 12、一个阀 15 和一个溶剂泵 13，但可存在多个灌注装置、溶剂储存器或者阀和溶剂泵，它们可以以串联或并联的配置彼此流体连通，或与溶剂选择装置流体连通，以便最小化泵灌注系统 10 中所需的部件的数量。

[0021] 示例性泵灌注系统 10 还可以包括具有用户接口 21 的微处理器 20，其中，微处理器 20 被编程为（i）接收来自用户（未示出）的输入，并且响应于接收到来自用户的输入，（ii）启动泵灌注过程，其中，来自至少一个溶剂储存器 12 中的至少一个的泵灌注流体（未示出）通过灌注装置 11 移动（例如，拉动或推动）通过至少一个溶剂泵 13。如图 1 中所示，一旦泵灌注流体（未示出）流动通过灌注装置 11，所述泵灌注流体就被收集在储存器 16（例如，废液储存器）中。即使在这个示例性实施例中利用了微处理器，也可以使用开关来手动操作泵灌注系统，以接通或断开泵以及打开和关闭阀。

[0022] 如图 1 中所示，示例性泵灌注系统 10 包括一个溶剂储存器 12；然而，应当注意的是，本发明的泵灌注系统可以包括至少一个溶剂储存器 12，通常包括两个或更多个溶剂储存器 12。此外，示例性泵灌注系统 10 包括单溶剂泵 13；然而，应当注意的是，本发明的泵灌注系统可以包括至少一个溶剂泵 13，通常包括两个或更多个溶剂泵 13。此外，灌注装置 11 可位于溶剂泵 13 的上游或之前，而不是如图 1 中描述的下游。在一个实施例中，系统为每个溶剂储存器包括至少一个溶剂泵。可替代地，系统可以包括与溶剂选择装置结合的至少一个溶剂泵，所述溶剂选择装置允许一种或多种溶剂被泵送通过每个溶剂泵。

[0023] 在利用微处理器 20 的实施例中，它可与可包括任何计算装置的用户接口 21 结合，并且可以被连接成使用已知的连接技术（例如，有线连接、无线连接等）与示例性泵灌注系统 10 相互作用。在接收到来自用户（未示出）的输入时，微处理器 20 被编程为（1）打开灌注装置阀（例如，电磁阀 15），（2）打开位于溶剂储存器和第一溶剂泵之间的第一歧管阀（例如，溶剂储存器 12 中的一个和溶剂泵 13 之间的歧管阀中的一个）以及（3）激活灌注装置 11。

[0024] 在一些实施例中，在接收到来自用户（未示出）的输入时，微处理器 20 还被编程为执行以下任务中的一个或多个：（4）运行灌注装置 11 持续期望的时间长度（例如，持续多达 60 秒或 120 秒）；（5）停用灌注装置 11；（6）关闭灌注装置阀 15；（7）关闭第一歧管阀（例如，在溶剂储存器 12 中的一个和溶剂泵 13 之间的歧管阀中的一个）；（8）启动用于溶剂泵 13 的泵灌注测试；并且如果溶剂泵 13 没有通过泵灌注测试，则（9）重复步骤（1）至步骤（8）或者警告用户。

[0025] 在其中存在第二溶剂泵的实施例中（参见例如图 2 中的示例性色谱系统 100），在接收到来自用户（未示出）的输入时，微处理器 20 还被编程为（10）打开灌注装置阀 15，（11）打开位于溶剂储存器（例如，溶剂储存器 12 中的任何一个）和第二溶剂泵（参见例如图 2 中的第二泵 131）之间的第二歧管阀（例如，歧管阀中的任何一个），（12）激活灌注装置 11，（13）运行灌注装置 11 持续期望的时间长度，（14）停用灌注装置 11，（15）关闭灌注装置阀 15，（17）启动用于第二溶剂泵的泵灌注测试，并且如果第二溶剂泵没有通过泵灌注测试，则（18）重复步骤（10）至步骤（17）或者警告用户。

[0026] 期望地，微处理器 20 被编程为通过用户接口，例如包括用户接口显示器 210（参见图 3）的用户接口 21，来给用户（未示出）提供一种或多种提示。用户接口显示器 210 可显示一种或多种提示，包括但不限于如下提示，所述提示包括：（1）自动灌注启动提示、（2）溶剂选择提示、（3）泵灌注测试启动提示、（4）溶剂泵或储存器选择提示、（5）泵灌注完成提示

或者(6)提示(1)至提示(5)的任何组合。

[0027] 图 1 中所示的示例性泵灌注系统 10 可以被结合到多种系统中,其中,来自至少一个溶剂储存器 12 的流体被泵送到如图 1 中所示的给定系统 17 中。在本发明的一个期望的实施例中,图 1 中所示的示例性泵灌注系统 10 被结合到色谱系统中,例如图 2 中所示的示例性色谱系统 100。

[0028] 如图 2 中所示,示例性色谱系统 100 包括以下部件 :灌注装置 11 ;溶剂储存器 12 ;第一溶剂泵 13 和第二溶剂泵 131 ;歧管阀 ;灌注装置阀 15 ;以及具有用户接口 21 的微处理器 20。示例性色谱系统 100 还包括色谱筒(chromatography cartridge)30、样品注射端口 31 ;样品注射阀 32 ;湿润器(dampener)33 ;UV 检测器 34 ;主动分流阀(例如,换向阀或分流泵)35 ;ELSD 36 ;流体源 37 ;馏分收集器 38 ;以及废液收集器 / 储存器 16。

[0029] 如图 2 中所示,例如示例性色谱系统 100 的本发明的色谱系统包括 :至少一个溶剂储存器 12(例如,示例性色谱系统 100 包括四个溶剂储存器 12);至少一个溶剂泵 13(例如,示例性色谱系统 100 包括两个溶剂泵 13 和 131),其中每一个与至少一个溶剂储存器 12 流体连通 ;位于每个溶剂储存器 12 与每个溶剂泵 13 和 131 之间的歧管阀(例如,示例性色谱系统 100 包括八个歧管阀);灌注装置 15,其与(i)至少一个溶剂储存器 12、(ii)至少一个溶剂泵 13 和 131 以及(iii)位于每个溶剂储存器 12 和每个溶剂泵 13 或 131 之间的歧管阀流体连通 ;位于灌注装置 11 和至少一个溶剂泵 13 或 131 之间的灌注装置阀 15 ;具有用户接口(例如,显示器 210)的微处理器 20,微处理器 20 被编程为(i)接收来自用户(未示出)的输入,并且响应于接收到来自用户的输入,(ii)启动泵灌注过程,其中,来自所述至少一个溶剂储存器 12 中的至少一个的流体通过灌注装置 11 来移动通过至少一个溶剂泵 13 或 131 ;以及与所述至少一个溶剂储存器 12 流体连通的至少一个色谱柱 / 筒 30。

[0030] 例如示例性色谱系统 100 的本发明的色谱系统可包括至少一个溶剂储存器 12。如图 2 中所示,示例性色谱系统 100 包括四个溶剂储存器 12。此外,本发明的色谱系统可包括至少一个溶剂泵 13 或 131。如图 2 中所示,示例性色谱系统 100 包括两个溶剂泵 13 和 131。

[0031] 在利用微处理器 20 的实施例中,在接收到来自用户(未示出)的输入时,示例性色谱系统 100 被期望地编程为执行(即,致使发生)以下步骤中的一个或多个 :(1)打开灌注装置阀 15 ;(2)打开位于溶剂储存器 12 和第一溶剂泵 13 之间的第一歧管阀 ;(3)激活灌注装置 11 ;(4)运行灌注装置 11 持续期望的时间长度(例如,多达 60 秒或 120 秒);(5)停用灌注装置 11 ;(6)关闭灌注装置阀 15 ;(7)关闭第一歧管阀 ;(8)启动用于第一溶剂泵 13 的泵灌注测试 ;并且如果第一溶剂泵 13 没有通过泵灌注测试,则(9)重复步骤(1)至步骤(8)或者警告用户。例如,微处理器 20 可被编程为重复步骤(1)至步骤(8)一次或多次,通常,重复至少两次(例如,多达 10 次),并且其后通知用户已发生错误或系统问题。

[0032] 当例如示例性色谱系统 100 的给定的色谱系统包括第二溶剂泵(例如,第二溶剂泵 131)时,在接收到来自用户(未示出)的输入时,微处理器 20 还被编程为执行(即,致使发生)以下步骤中的一个或多个 :(10)打开灌注装置阀 15 ;(11)打开位于溶剂储存器 12 (即,与用于灌注溶剂泵 13 相同的溶剂储存器 12 或不同的溶剂储存器 12)和第二溶剂泵 131 之间的第二歧管阀 ;(12)激活灌注装置 11 ;(13)运行灌注装置 11 持续期望的时间长度 ;(14)停用灌注装置 11 ;(15)关闭灌注装置阀 15 ;(17)启动用于第二溶剂泵 131 的泵灌注测试 ;

并且如果第二溶剂泵 131 没有通过泵灌注测试，则（18）重复步骤（10）至步骤（17）或者警告用户。例如，微处理器 20 可被编程为重复步骤（10）至步骤（17）一次或多次，通常，重复至少两次（例如，多达十次）。

[0033] 示例性色谱系统 100 的微处理器 20 还被期望地编程为通过用户接口 21（例如，计算机显示器 210）来给用户（未示出）提供一种或多种提示。所述一种或多种提示可以包括但不限于（1）自动灌注启动提示、（2）溶剂选择提示、（3）泵灌注测试启动提示、（4）溶剂泵或储存器选择提示、（5）泵灌注完成提示或者（6）提示（1）至提示（5）的任何组合。

[0034] 示例性色谱系统 100 的灌注装置 11 可以是使来自所述至少一个溶剂储存器 12 中的至少一个的泵灌注流体（未示出）移动通过所述至少一个溶剂泵 13 和 / 或 131（例如，顺序地，如上讨论的）的任何类型的泵。在一些期望的实施例中，示例性色谱系统 100 的灌注装置 11 包括真空泵、容积式泵、脉冲泵、无阀泵、速度泵等。

[0035] 本发明还涉及灌注泵（例如，图 1 或图 2 中所示的溶剂泵 13）的方法。在一个示例性实施例中，灌注泵的方法包括通过灌注装置 11 使来自至少一个溶剂储存器 12 的泵灌注流体（例如，溶剂）移动通过至少一个溶剂泵 13。所公开的灌注泵的方法还可以包括一个或多个附加步骤。合适的附加步骤包括但不限于：（1）打开位于所述至少一个溶剂储存器 12 中的一个与所述至少一个溶剂泵（即，至少一个溶剂泵 13 和 131）中的第一溶剂泵 13 之间的第一歧管阀；（2）打开位于灌注装置 11 和所述至少一个溶剂泵（即，第一溶剂泵 13）之间的灌注装置阀 15；以及（3）激活灌注装置 11。

[0036] 所公开的灌注泵的方法还可以包括一个或多个附加步骤，所述附加步骤包括但不限于：（4）在泵灌注期后停用灌注装置 11；（5）在第一溶剂泵 13 上启动泵灌注测试；并且如果第一溶剂泵 13 没有通过泵灌注测试，则重复步骤（1）至步骤（5）至少一次（例如，多达十次）。在一些实施例中，启动泵灌注测试的步骤被执行最多两次、三次、四次或更多次。

[0037] 所公开的本发明的灌注泵的方法还可以包括一个或多个附加步骤，所述附加步骤包括响应于接收到至微处理器 20 的用户接口 21 中的一个或多个输入的那些步骤。在一些实施例中，响应于接收到至微处理器 20 的用户接口 21 中的来自用户（未示出）的一个或多个输入，所公开的方法包括以下步骤中的一个或多个：（1）启动所述方法；（2）打开灌注装置阀 15；（3）打开第一歧管阀；（4）激活灌注装置 11；（5）运行灌注装置 11 持续期望的时间长度（例如，任何期望的时间段，例如 60 秒）；（6）停用灌注装置 11；（7）关闭灌注装置阀 15；以及（9）启动用于第一溶剂泵 13 的泵灌注测试；并且如果第一溶剂泵 13 没有通过泵灌注测试，则（10）重复步骤（2）至步骤（9）或者警告用户。

[0038] 当例如在示例性色谱系统 100 中给定的系统包括第二溶剂泵时，响应于接收到至微处理器 20 的用户接口 21 中的来自用户（未示出）的一个或多个输入，所公开的方法可包括以下附加步骤中的一个或多个：（11）打开灌注装置阀 15；（12）打开位于溶剂储存器 12（例如，图 2 中所示的溶剂储存器 12 中的任何一个）和第二溶剂泵 131 之间的第二歧管阀；（13）激活灌注装置 11；（14）运行灌注装置 11 持续期望的时间长度；（15）停用灌注装置 11；（16）关闭灌注装置阀 15；（18）启动用于第二溶剂泵 131 的泵灌注测试；并且如果第二溶剂泵 131 没有通过泵灌注测试，则（19）重复步骤（11）至步骤（18）或者警告用户。

[0039] 本发明的方法还可以包括通过微处理器 20 的用户接口 21 给用户（未示出）提供一种或多种提示。所述一种或多种提示可以包括但不限于（1）自动灌注启动提示、（2）溶剂选

择提示、(3)泵灌注测试启动提示、(4)溶剂泵或储存器选择提示、(5)泵灌注完成提示或者(6)提示(1)至提示(5)的任何组合。

[0040] 在本发明的一个期望的实施例中,灌注泵的方法包括灌注色谱系统中的泵,例如图 2 中所示的示例性色谱系统 100。在这些实施例中,方法可包括通过灌注装置 11 使来自所述至少一个溶剂储存器 12 中的一个的泵灌注流体(未示出 ;例如,溶剂)移动通过所述至少一个溶剂泵 13 或 131 中的一个。在这些实施例中,方法还可以包括使来自所述至少一个溶剂储存器 12 的溶剂(未示出)运行通过与所述至少一个溶剂储存器 12 流体连通的至少一个色谱柱 / 筒 30。

[0041] 本发明还涉及能够被用于将泵灌注系统(例如,图 1 中所示的示例性泵灌注系统 10)结合到现有的色谱系统中的套件。在一个示例性实施例中,用于将泵灌注系统结合到现有的色谱系统中的套件包括 :灌注装置 11 ;可位于灌注装置 11 和现有的色谱系统的至少一个溶剂泵(例如,溶剂泵 13 和 / 或溶剂泵 131)之间的灌注装置阀 15 ;以及用于现有的色谱系统的微处理器的软件更新,当装载到微处理器上时,所述软件更新使得微处理器能执行本文公开的灌注泵的方法和方法步骤中的一个或多个。这样的套件可被用于改型现有的色谱系统,例如从 Alltech Associates, Inc 可获得的 REVELERIS® Flash Chromatography System。

[0042] 本发明甚至还涉及制作色谱系统的方法,例如图 2 中所示的示例性色谱系统 100。在一些实施例中,制作色谱系统的方法包括将本文描述的泵灌注系统(例如,图 1 的示例性泵灌注系统 10)结合到现有的色谱系统中(例如,使用如上讨论的套件)。

[0043] 在其它实施例中,制作色谱系统的方法包括采用(i)至少一个溶剂储存器 12 ;(ii)至少一个溶剂泵 13 和 131,其中每一个与所述至少一个溶剂储存器 12 流体连通 ;(iii)位于每个溶剂储存器 12 与每个溶剂泵 13 和 131 之间的歧管阀 ;(iv)与所述至少一个溶剂储存器 12、所述至少一个溶剂泵 13 和 131 以及所述歧管阀流体连通的灌注装置 11 ;(v)位于灌注装置 11 与所述至少一个溶剂泵 13 和 131 之间的灌注装置阀 15 ;以及(vi)具有到色谱系统(例如,示例性色谱系统 100)中的用户接口 21 的微处理器 20,其中,微处理器 20 被编程为(1)接收来自用户(未示出)的输入,并且响应于接收到来自用户的输入,(2)启动泵灌注过程,其中,来自所述至少一个溶剂储存器 12 中的至少一个的流体(未示出)通过灌注装置 11 来移动通过所述至少一个溶剂泵 13 或 131。

[0044] 制作色谱系统的方法还可以包括将微处理器(例如,示例性微处理器 20)结合到色谱系统中,其中,微处理器被编程为执行以下任务 / 操作中的一个或多个 :(1)打开灌注装置阀 15 ;(2)打开位于溶剂储存器 12 和第一溶剂泵 13 之间的第一歧管阀 ;(3)在接收到来自用户的输入时,激活灌注装置 11 ;(4)运行灌注装置 11 持续期望的时间长度 ;(5)停用灌注装置 11 ;(6)关闭灌注装置阀 15 ;以及(8)在接收到来自用户的输入时,启动用于第一溶剂泵 13 的泵灌注测试 ;并且如果第一溶剂泵 13 没有通过泵灌注测试,则(9)重复步骤(1)至步骤(8)或者警告用户。通常,当重复时,步骤(1)至步骤(8)被重复一定最大的次数(例如,多达十次),例如最多两次。如果第一溶剂泵 13 在设定次数后没有通过泵灌注测试,则泵灌注循环 / 运行被停止,以调查泵灌注系统内可能的问题。

[0045] 当给定的色谱系统包括两个或更多个溶剂泵时,制作色谱系统的方法还可以包括将微处理器(例如,示例性微处理器 20)结合到色谱系统中,其中,微处理器被编程为执行以

下附加的任务 / 操作中的一个或多个 :(10)打开灌注装置阀 15 ;(11)打开位于溶剂储存器 12 和第二溶剂泵 131 之间的第二歧管阀 ;(12)激活灌注装置 11 ;(13)运行灌注装置 11 持续期望的时间长度 ;(14) 停用灌注装置 11 ;(15) 关闭灌注装置阀 15 ;(17) 启动用于第二溶剂泵 131 的泵灌注测试 ;并且如果第二溶剂泵 131 没有通过泵灌注测试,则(18) 重复步骤(10) 至步骤(17) 或者警告用户。

[0046] 制作色谱系统的方法还可以包括将微处理器(例如,示例性微处理器 20)结合到色谱系统中,其中,微处理器被编程为通过用户接口(例如,具有显示器 210 的接口 21)给用户(未示出)提供一种或多种提示。所述一种或多种提示可包括但不限于(1)自动灌注启动提示、(2) 溶剂选择提示、(3) 泵灌注测试启动提示、(4) 溶剂泵或储存器选择提示、(5) 泵灌注完成提示或者(6) 提示(1) 至提示(5) 的任何组合。

[0047] 本发明甚至还涉及使用色谱系统中的泵灌注系统的方法。在一个示例性实施例中,使用色谱系统中的泵灌注系统的方法包括,响应于接收到来自用户(未示出) 的输入,启动泵灌注程序,所述泵灌注程序包括通过灌注装置 11 使来自至少一个溶剂储存器 12 的泵灌注流体(未示出) 移动通过至少一个溶剂泵 13 或 131。

[0048] 使用色谱系统中的泵灌注系统的方法还可以包括以下步骤中的一个或多个 :打开位于所述至少一个溶剂储存器 12 中的一个与所述至少一个溶剂泵(例如,泵 13 和泵 131)中的第一溶剂泵 13 之间的第一歧管阀 ;打开位于灌注装置 11 和所述至少一个溶剂泵 13 之间的灌注装置阀 15 ;激活灌注装置 11 ;在泵灌注期后停用灌注装置 11 ;在第一溶剂泵 13 上启动泵灌注测试 ;并且如果第一溶剂泵 13 没有通过泵灌注测试,则重复从打开歧管阀的步骤至停用步骤的步骤至少一次(例如,启动重复泵灌注测试的步骤最多两次,多达最多十次)。

[0049] 使用色谱系统中的泵灌注系统的方法还可以包括以下步骤中的一个或多个 :响应于接收到至微处理器 20 的用户接口 21 中的一个或多个输入,(1) 启动泵灌注方法 ;(2) 打开灌注装置阀 15 ;(3) 打开第一歧管阀 ;(4) 激活灌注装置 11 ;(5) 运行灌注装置 11 持续期望的时间长度 ;(6) 停用灌注装置 11 ;(7) 关闭灌注装置阀 15 ;(9) 启动用于第一溶剂泵 13 的泵灌注测试 ;并且如果第一溶剂泵 13 没有通过泵灌注测试,则(10) 重复步骤(2) 至步骤(9) 或者警告用户。

[0050] 在具有两个或更多个溶剂泵的色谱系统中,使用色谱系统中的泵灌注系统的方法还可以包括,响应于接收到至微处理器 20 的用户接口 21 中的一个或多个输入的一个或多个附加步骤,例如 :(11) 打开灌注装置阀 15 ;(12) 打开位于溶剂储存器 12 和第二溶剂泵 131 之间的第二歧管阀 ;(13) 激活灌注装置 11 ;(14) 运行灌注装置 11 持续期望的时间长度 ;(15) 停用灌注装置 11 ;(16) 关闭灌注装置阀 15 ;(18) 启动用于第二溶剂泵 131 的泵灌注测试 ;并且如果第二溶剂泵 131 没有通过泵灌注测试,则(19) 重复步骤(11) 至步骤(18) 或者警告用户。

[0051] 使用色谱系统中的泵灌注系统的方法还可以包括响应通过微处理器 20 的用户接口 21 提供的一种或多种提示。所述一种或多种提示可包括 :(1) 自动灌注启动提示、(2) 溶剂选择提示、(3) 泵灌注测试启动提示、(4) 溶剂泵或储存器选择提示、(5) 泵灌注完成提示或者(6) 提示(1) 至提示(5) 的任何组合。此外,使用色谱系统中的泵灌注系统的方法还可以包括使来自所述至少一个溶剂储存器 12 的溶剂运行通过与所述至少一个溶剂储存器 12 流体连通的至少一个色谱柱 30。

[0052] 为了提供用户(未示出)和给定的泵灌注系统之间的相互作用,泵灌注系统可包括用户接口,例如具有如图 3 中所示的显示器 210 的微处理器 20 的用户接口 21。如图 3 中所示,显示器 210 包括具有用户在操作系统(例如,图 2 中所示的示例性色谱系统 100)之前可选择的各种参数 / 选项 23 (例如,流率、持续时间单位、运行长度等)的主菜单显示 22。主菜单显示 22 还包括溶剂选项 24,其中,用户能够输入与给定的溶剂储存器(例如,图 2 中所示的溶剂储存器 12)相对应的一种或多种溶剂类型。

[0053] 尽管在图 1-3 中未示出,但应当理解的是,除显示器 210 外,微处理器 20 的用户接口 21 还可以包括其它用户接口部件,包括但不限于键盘、鼠标、笔记本电脑、台式电脑、无线路由器等。此外,显示器 210 可包括触摸屏,其使得用户能与微处理器 20 相互作用,而在选择例如图 3 中的主菜单显示 22 上所示的一个或多个选项时无需键盘和 / 或鼠标。

[0054] 如本文所公开的,使用所公开的本发明的泵灌注系统的方法可包括各种步骤的组合。图 4A-4C 描绘了示出了用于利用泵灌注系统的多种示例性步骤的流程图。应当注意的是,尽管图 4A-4C 中所示的流程图描绘了彼此按照顺序的示例性方法 40 的许多步骤,但使用所公开的本发明的泵灌注系统的方法可包括单独的或与图 4A-4C 中未示出的其它步骤组合的示例性方法 40 中所示的步骤中的两个或更多个步骤的任何一个或任何组合。

[0055] 如图 4A 中所示,示例性方法 40 开始于开始框 42 处并且继续进行至步骤 44,其中,用户被提示选择溶剂。例如,微处理器 20 的用户接口 21 可能显示如图 3 中所示的用户接口屏幕截图 22。一旦用户选择溶剂 A-D (如图 3 中的溶剂选项 24 所示)中的一种,一种或多种提示 25 就可出现在用户接口显示器 210 上。一旦用户利用选项 26 选择了溶剂,用户就能选择“AUTO PRIME”选项 27 来启动泵灌注,即,示例性方法 40 的步骤 46。

[0056] 从示例性方法 40 的步骤 46,示例性方法 40 继续进行至步骤 48,其中,用于所选的溶剂的歧管阀(例如,图 2 中所示的用于溶剂 A 的歧管阀中的一个)被打开。然后,示例性方法 40 继续进行至步骤 50,其中,灌注装置阀(例如,图 2 中所示的电磁阀 15)被打开。示例性方法 40 随后继续进行至步骤 52,其中,灌注装置(例如,图 2 中所示的灌注装置 11)被激活。

[0057] 从步骤 52,示例性方法 40 继续进行至步骤 54,其中,灌注装置被运行持续期望的时间段。通常,取决于系统的流体配置,灌注运行时间少于 120 秒,或者更通常地少于 60 秒。但是,任何灌注运行时间可由用户输入至微处理器(例如,微处理器 20)中。然后,示例性方法 40 继续进行至步骤 56,其中,灌注装置被停用。从示例性方法 40 的步骤 56,示例性方法 40 继续进行至步骤 58,其中,为被灌注的泵启动泵灌注测试。在一个实施例中,泵灌注测试可包括确定泵是否被灌注的任何测试,例如,压力指示器、流量指示器或检测泵中是否存在液体的其它传感器。

[0058] 从示例性方法 40 的步骤 58,示例性方法 40 继续进行至决定框 43,其中,确定被灌注的泵是否通过泵灌注测试。如果在决定框 43 处确定被灌注的泵没有通过泵灌注测试(例如,泵呈现这些特性 :不存在压力、不存在流量或不存在液体),则示例性方法 40 继续进行至决定框 45,其中,确定被灌注的泵是否在本灌注循环 / 运行期间已被灌注最大次数。如果在决定框 45 处确定被灌注的泵在本灌注循环 / 运行期间已被灌注最大次数,则示例性方法 40 继续进行至步骤 60,其中,示例性方法 40 停止,使得泵灌注系统能够被评估。如果在决定框 45 处确定被灌注的泵在本灌注循环 / 运行期间还未被灌注最大次数,则示例性方法

40 继续进行至步骤 62，其中，示例性方法 40 返回到步骤 48 以执行另一 AUTO PRIME 运行。

[0059] 返回到示例性方法 40 的决定框 43，如果在决定框 43 处确定被灌注的泵确实通过了泵灌注测试，则示例性方法 40 继续进行至决定框 47，其中，确定被灌注的泵系统是否具有另一个溶剂泵(即，在这次运行期间尚未被灌注的)。如果在决定框 47 处确定被灌注的泵系统没有另一个溶剂泵(例如，参见图 1 中的示例性泵灌注系统 10)，则示例性方法 40 继续进行至步骤 64，其中，“DONE”选项(例如，参见图 3 中所示的完成选项 29) 被示出给用户。此时，用户(未示出)能够选择完成选项来结束示例性方法 40，如步骤 88 中所示。如果在决定框 47 处确定被灌注的泵系统确实具有另一溶剂泵(例如，参见图 2 中的示例性泵灌注系统 10)，则示例性方法 40 继续进行至步骤 66，其中，示例性方法 40 继续进行至图 4B 和图 4C 中所示的决定框 49。

[0060] 应当注意的是，在替代性实施例中，微处理器 20 可给用户(未示出) 提供询问用户是否被灌注的泵系统具有另一个溶剂泵的提示。在其它实施例中，微处理器 20 做出这个确定，而不需要来自用户的输入(例如，来自先前由用户使用图 3 中所示的显示器 210 的主菜单显示 22 所提供的溶剂泵输入)。

[0061] 如图 4B 和图 4C 中的任一个中所示，示例性方法 40 继续进行至决定框 49，其中，确定是否改变用于下一次泵灌注运行的溶剂。如果在决定框 49 处确定改变用于下一次泵灌注的溶剂，则示例性方法 40 继续进行至步骤 68，其中，示例性方法 40 返回到步骤 44，并且如上讨论地继续进行。如果在决定框 49 处确定不改变用于下一次泵灌注的溶剂，则示例性方法 40 继续进行至步骤 70，其中，示例性方法 40 返回到步骤 48，并且如上讨论地继续进行(即，用于所选溶剂的第二歧管阀 12 将打开，并且如上讨论地继续进行)。

[0062] 图 4C 描绘了当泵灌注系统是色谱系统的一部分时可能的方法步骤。如图 4C 中所示，示例性方法 40 继续进行至决定框 49。如果在决定框 49 处确定不改变用于下一次泵灌注运行的溶剂，则示例性方法 40 继续进行至步骤 72，其中，一个或多个运行参数被改变和 / 或选择来为色谱样品运行做准备。从步骤 72，示例性方法 40 继续进行至步骤 74，其中，使样品运行通过色谱筒(例如，图 2 中所示的示例性色谱筒 30)。在运行期间，可以进行步骤 76 中的泵灌注测试，以确定溶剂泵中的一个或多个是否仍然被完全灌注。如果在决定框 82 中确定一个或多个溶剂泵确实通过了灌注测试，则色谱运行在步骤 84 中完成，其中，示例性方法 40 结束。如果在决定框 82 中确定一个或多个溶剂泵没有通过灌注测试，则色谱运行在步骤 78 中被暂停，并且一个或多个泵依照步骤 48-58 被灌注。

[0063] 从步骤 78，示例性方法 40 继续进行至决定框 86，其中，在决定框 86 中确定一个或多个被灌注的溶剂泵确实通过了灌注测试，色谱运行在步骤 92 中完成，其中，示例性方法 40 结束。如果在决定框 86 中确定一个或多个被灌注的溶剂泵没有通过灌注测试，则所述方法继续进行至步骤 94，其中，泵在步骤 78 中被重新灌注(直至达到最大次数)或者继续进行至步骤 76 并且另一个溶剂泵被选择和灌注，或者如果没有一个或多个泵能够被灌注，则方法 40 结束，并且发送错误消息给用户。

[0064] 在一些实施例中，微处理器 20 可给用户(未示出) 提供提示，例如图 3 中所示的提示 25，询问用户是否用户想要启动另一个 AUTO PRIME 运行。如果用户想要启动另一个 AUTO PRIME 运行，则用户简单地选择如上讨论的 AUTO PRIME 选项 27。如果用户不想启动另一个 AUTO PRIME 运行，则用户简单地选择图 3 中所示的 CANCEL 选项 28。

[0065] 应当注意的是，虽然以上描述的泵灌注系统、色谱系统、套件和方法被描述为“包括”一个或多个部件或步骤，但以上描述的泵灌注系统、色谱系统、套件和方法可“包括”、“由…组成”、或者“基本由…组成”：任何以上描述的泵灌注系统、色谱系统、套件和方法的部件或步骤。因此，本发明或者其一部分已经采用开放式术语（例如“包括”）来描述之处，应当理解的是（除非另外声明），本发明的描述，或者它的一部分，也应当被解释为使用术语“基本由…组成”或者“由…组成”或者如以下所讨论的其变形来描述本发明或者其一部分。

[0066] 如本文所使用的，术语“包括”、“包含”、“具有”、“含有”、“特征在于”或者其任何其它变形，意图用于包含所引用的部件的非排它包含，除非受到明确阐明的任何限制。例如，包含一个元件（例如，部件或者步骤）的列表的泵灌注系统、色谱系统、套件和 / 或方法不必仅限于那些元件（或者部件或步骤），而是可包括没有明确地列出或者对于泵灌注系统、色谱系统、套件和 / 或方法来说固有的其它元件（或部件或步骤）。

[0067] 如本文所使用的，转换措辞“由…组成”排除没有指明的任何元件、步骤或者部件。例如，除了与之普通相关联的杂质之外（即，指定部件内的杂质），在权利要求中所使用的“由…组成”将会将权利要求限制为在权利要求中特别列举的部件、材料或步骤。当措辞“由…组成”出现在权利要求的主体的从句中而不是紧随前序部分时，措辞“由…组成”仅限制在那个从句中列出的元件（或者部件或步骤）；其它元件（或部件）没有作为整体从权利要求中排除。

[0068] 如本文所使用的，转换措辞“基本由…组成”用于定义除了文字上公开的那些，包括材料、步骤、特征、部件或元件的泵灌注系统、色谱系统、套件和 / 或方法，假设这些附加的材料、步骤、特征、部件或元件不会实质上地影响所要求保护的权利要求的基本和新颖性特征。术语“基本由…组成”占据了“包括”和“由…组成”之间的中间立场。

[0069] 此外，应当理解的是，本文描述的泵灌注系统、色谱系统、套件和 / 或方法可包括任何在本文描述的部件和特征、基本由任何在本文描述的部件和特征组成、或者由任何在本文描述的部件和特征组成，在本文描述的部件和特征如图所示，且具有或者不具有在图中未示出的任何特征。换句话说，在一些实施例中，本发明的泵灌注系统、色谱系统、套件和 / 或方法除了在图中示出的那些之外不具有任何附加的特征，且没有在图中示出的这样的附加特征，明确地从泵灌注系统、色谱系统、套件和 / 或方法中排除。在其它的实施例中，本发明的泵灌注系统、色谱系统、套件和 / 或方法具有在图中没有示出的一个或多个附加特征。

[0070] 本发明还由以下的示例进行阐述，以下的示例不会以任何方式构造为对其范围强加限制。相反，将会清楚地理解，可以对其采取各种其它实施例、修改和等同，在阅读本文的描述以后，各种其它实施例、修改和等同可以将它们自己建议给本领域的技术人员，而不脱离本发明的精神和 / 或所附的权利要求的范围。

[0071] 示例

如图 2 中所示的色谱系统内的泵灌注系统被准备和用于依照以下示例 1 和示例 2 来分析一个或多个样品。系统包括四个溶剂储存器和两个溶剂泵、灌注泵、微处理器、平板显示器、色谱柱、馏分收集器以及如图 2 中所示的其它系统部件。

[0072] 示例 1

在初始设置中，色谱系统中的泵需要被灌注，并且使用以下程序：将管道 1-4 插入到适

当的溶剂瓶中。使用微处理器软件和显示器，通过点击 Tools，Solvent Loading 在顶部菜单栏处访问溶剂装载页面。通过从 Solvent Loading 框点击 Load 来选择溶剂管道(示出了1-4)。选择溶剂名称框右侧上的箭头，这示出了下拉菜单。从这个列表，选择对应于期望的管道的溶剂的名称。Auto prime 标签(tab)被选择，并且系统自动灌注泵。在整个过程期间自动灌注的状态被显示在框的左下角中。当自动灌注完成时，选择“Close”以关闭用于当前溶剂管道的框。这使用户返回至示出了用于所有 4 个单个管道的 Solvent Loading 的原始框。如果有必要，用户现在能够选择不同的管道来重复所述过程，或者如果不需要其它管道的灌注则关闭。在所有要求的管道被灌注后，所有框被关闭，并且系统现在准备好色谱运行。

[0073] 示例 2

在进行色谱运行之前，系统自动检查以查看泵是否被灌注。如果任何的泵的编程确认灌注过程失败，则系统将会停止并要求用户灌注泵。为了灌注泵，用户选择 Tools 标签，并且随后选择 Solvent loading 标签，以选择在色谱运行中使用的期望的溶剂管道。选择溶剂名称框的右侧上的箭头，这显示出下拉式的溶剂菜单。选择待用于色谱运行中的溶剂，并且随后选择 Auto prime 标签，由此系统自动地灌注泵。在整个过程期间自动灌注进展的状态被显示在框的左下角中。当自动灌注完成时，选择“Close”标签以关闭框，这关闭了所有其它框，并且系统准备好色谱运行。

[0074] 虽然已经采用有限数量的实施例描述了本发明，但这些特定的实施例并不用于限制本发明的范围，本发明的范围如其它所描述和本文所要求保护。对于本领域的普通技术人员来说很明显，一旦审阅本文的示例性实施例，进一步的修改、等同和变化是可能的。示例和说明书的剩余部分中的所有部分和百分比，都是重量，除非另外说明。此外在说明书或者权利要求中列举的任何数字范围，例如表示特殊的属性组、测量单位、条件、物理状态或者百分比的数字范围，用于通过引用或其它，将落入这样的范围的任何数字(包括位于所列举的任何范围内的数字的任何子集)字面上清楚地结合到本文中。例如，只要公开了具有下限 R_L 和上限 R_U 的数字范围，落入所述范围内的任何数字 R 都被具体地公开。特别地，位于所述范围内的以下数字 R 都被具体地公开：$R = R_L + k(R_U - R_L)$，其中 k 是具有 1% 增量的范围从 1% 至 100% 的变量，例如，k 是 1%、2%、3%、4%、5%、…50%、51%、52%、…95%、96%、97%、98%、99% 或 100%。此外，由任何两个 R 值表示的任何数字范围，如上所计算的，也被具体地公开。本发明的任何修改，除了本文示出和描述的之外，从之前的描述和附图中，对于本领域的技术人员来说是明显的。这样的修改落入所附的权利要求的范围内。本文所引用的所有公开通过引用整体地结合于本文中。

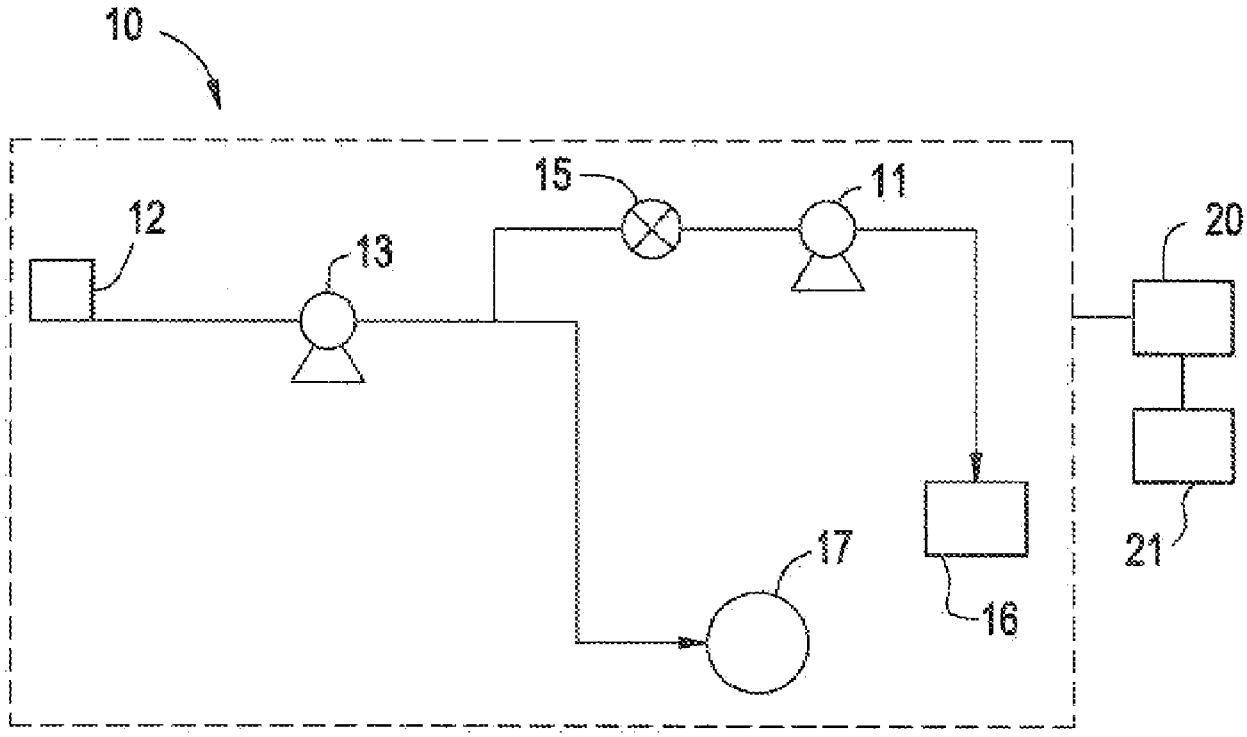


图 1

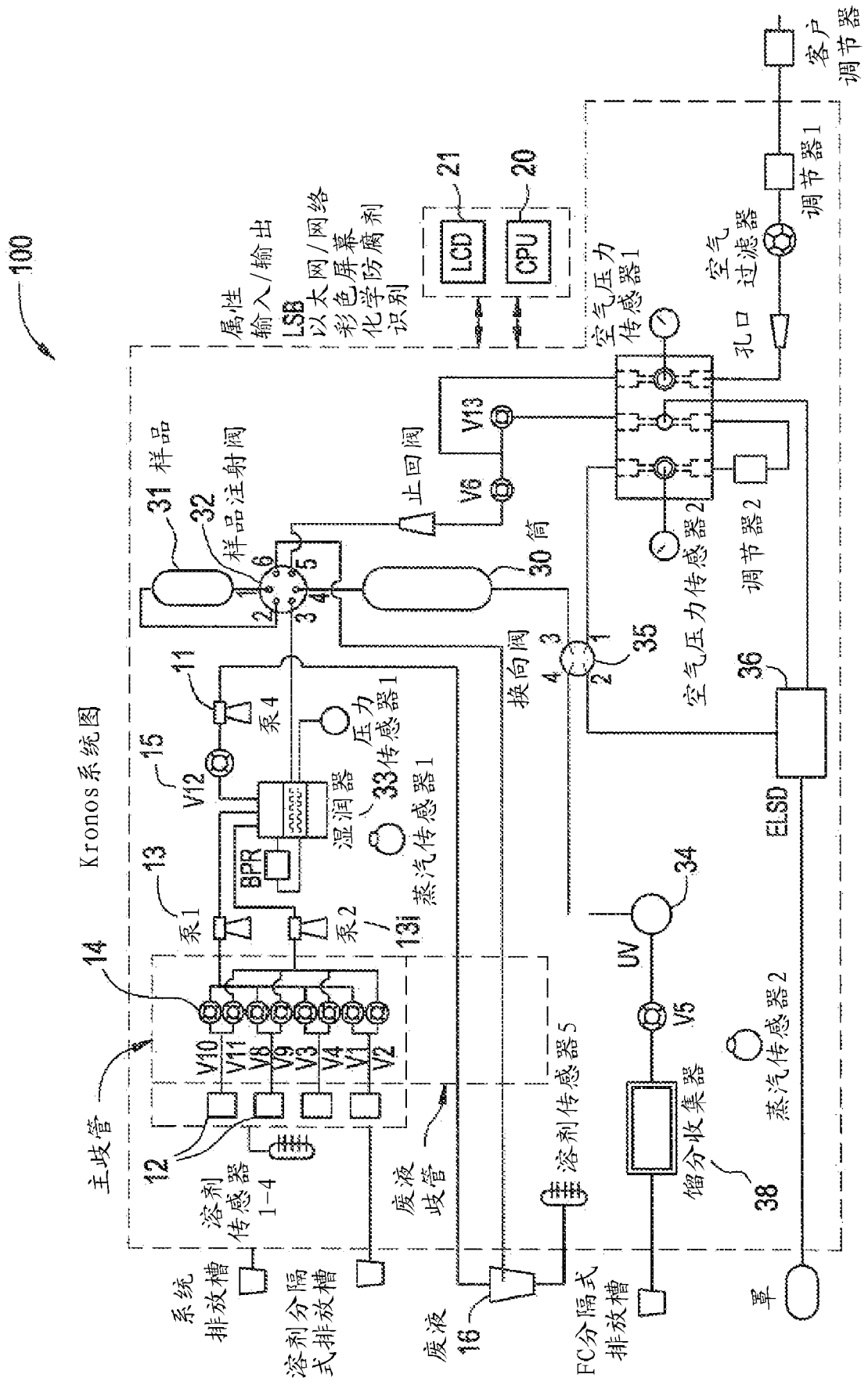

100
Kronos系统图
主歧管
溶剂传感器1-4
系统排放槽
溶剂分隔式排放槽
废液歧管
废液
FC分隔式排放槽
溶剂传感器5
馏分收集器
罩
蒸汽传感器2
ELSD
UV
蒸汽传感器1
湿润器
压力传感器1
BPR
泵1
泵2
泵4
换向阀
止回阀
样品注射阀
样品
筒
空气压力传感器2
空气压力传感器1
调节器2
调节器1
空气过滤器
孔口
客户调节器
LCD
CPU
LSB
以太网/网络
彩色屏幕
化学防腐剂
识别
扇性
输入/输出
V1
V2
V3
V4
V5
V6
V8
V9
V10
V11
V12
V13

图 2

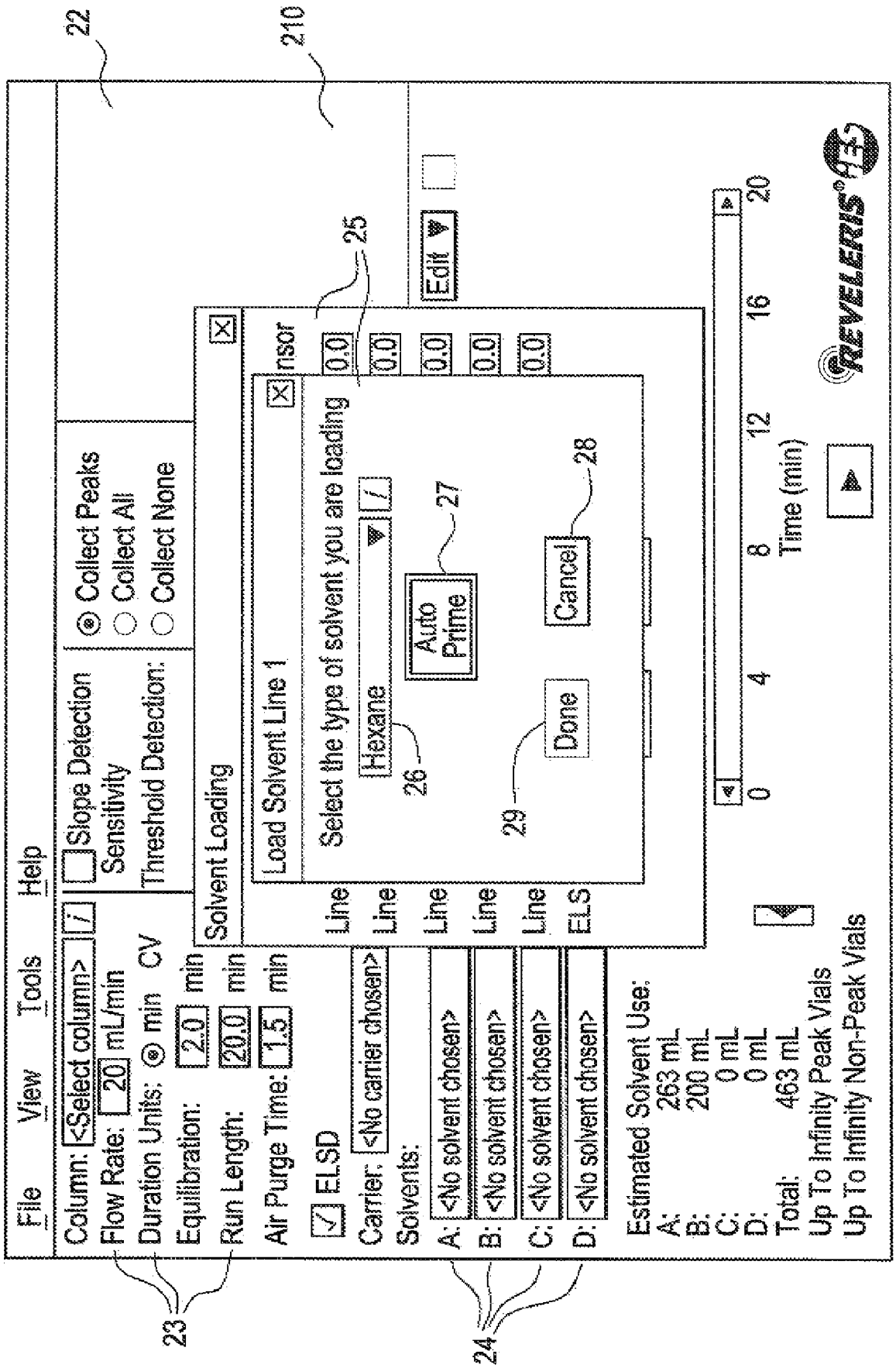

22
210
File View Tools Help
Column: <Select column>
Flow Rate: 20 mL/min
Duration Units: min CV
Equilibration: 2.0 min
Run Length: 20.0 min
Air Purge Time: 1.5 min
ELSD
Carrier: <No carrier chosen>
Solvents:
A: <No solvent chosen>
B: <No solvent chosen>
C: <No solvent chosen>
D: <No solvent chosen>
Slope Detection Sensitivity
Threshold Detection:
Collect Peaks
Collect All
Collect None
Solvent Loading
Load Solvent Line 1
Select the type of solvent you are loading
Hexane
Auto Prime
Done
Cancel
Line
Line
Line
Line
Line
ELS
Edit
Estimated Solvent Use:
A: 263 mL
B: 200 mL
C: 0 mL
D: 0 mL
Total: 463 mL
Up To Infinity Peak Vials
Up To Infinity Non-Peak Vials
0 4 8 12 16 20
Time (min)
REVELERIS
23
24
25
26
27
28
29

图 3

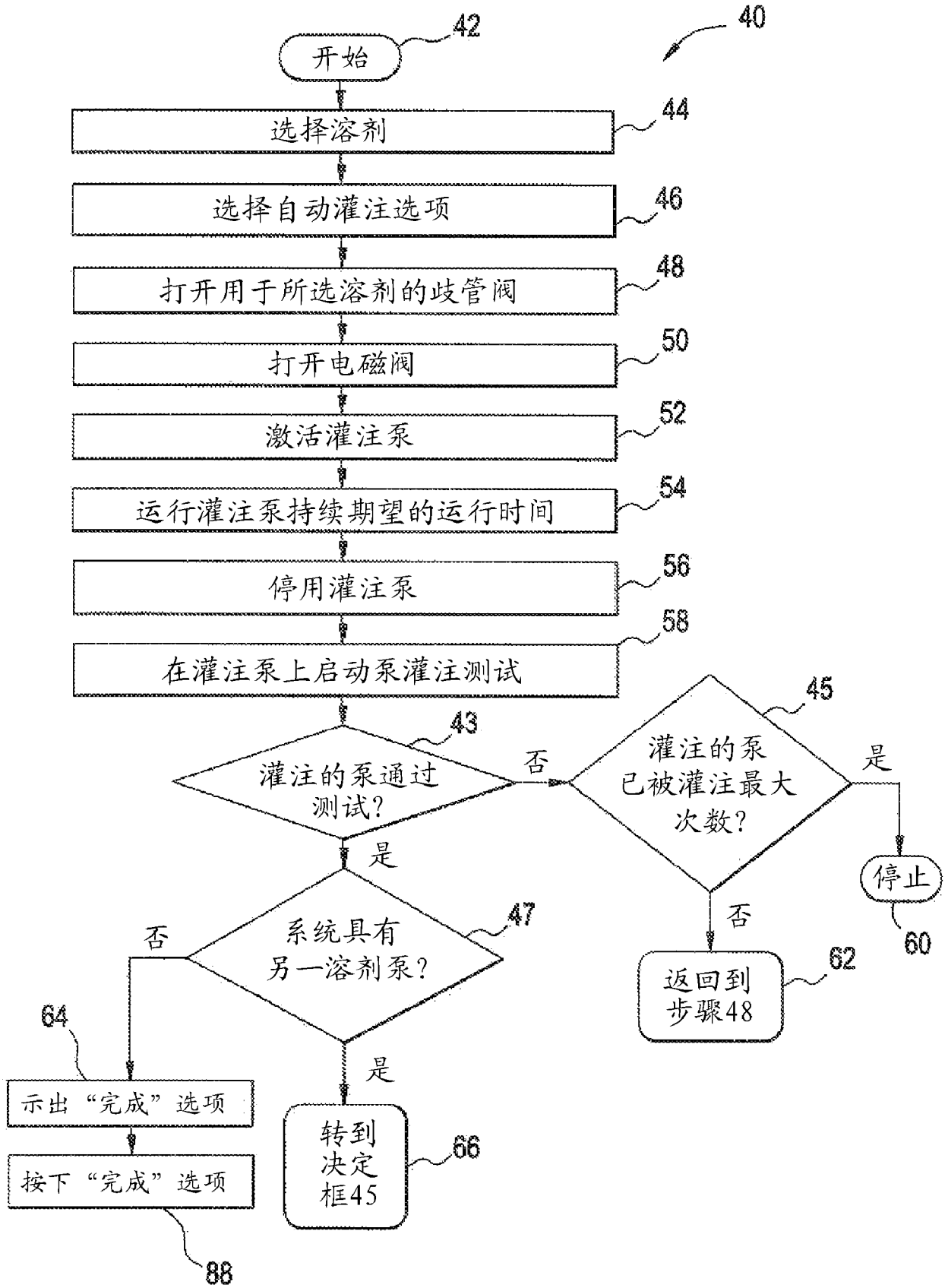

40
42
开始
44
选择溶剂
46
选择自动灌注选项
48
打开用于所选溶剂的歧管阀
50
打开电磁阀
52
激活灌注泵
54
运行灌注泵持续期望的运行时间
56
停用灌注泵
58
在灌注泵上启动泵灌注测试
43
灌注的泵通过测试?
否
45
灌注的泵已被灌注最大次数?
是
停止
60
是
否
47
系统具有另一溶剂泵?
否
62
返回到步骤48
64
是
示出“完成”选项
按下“完成”选项
88
转到决定框45
66

图 4A

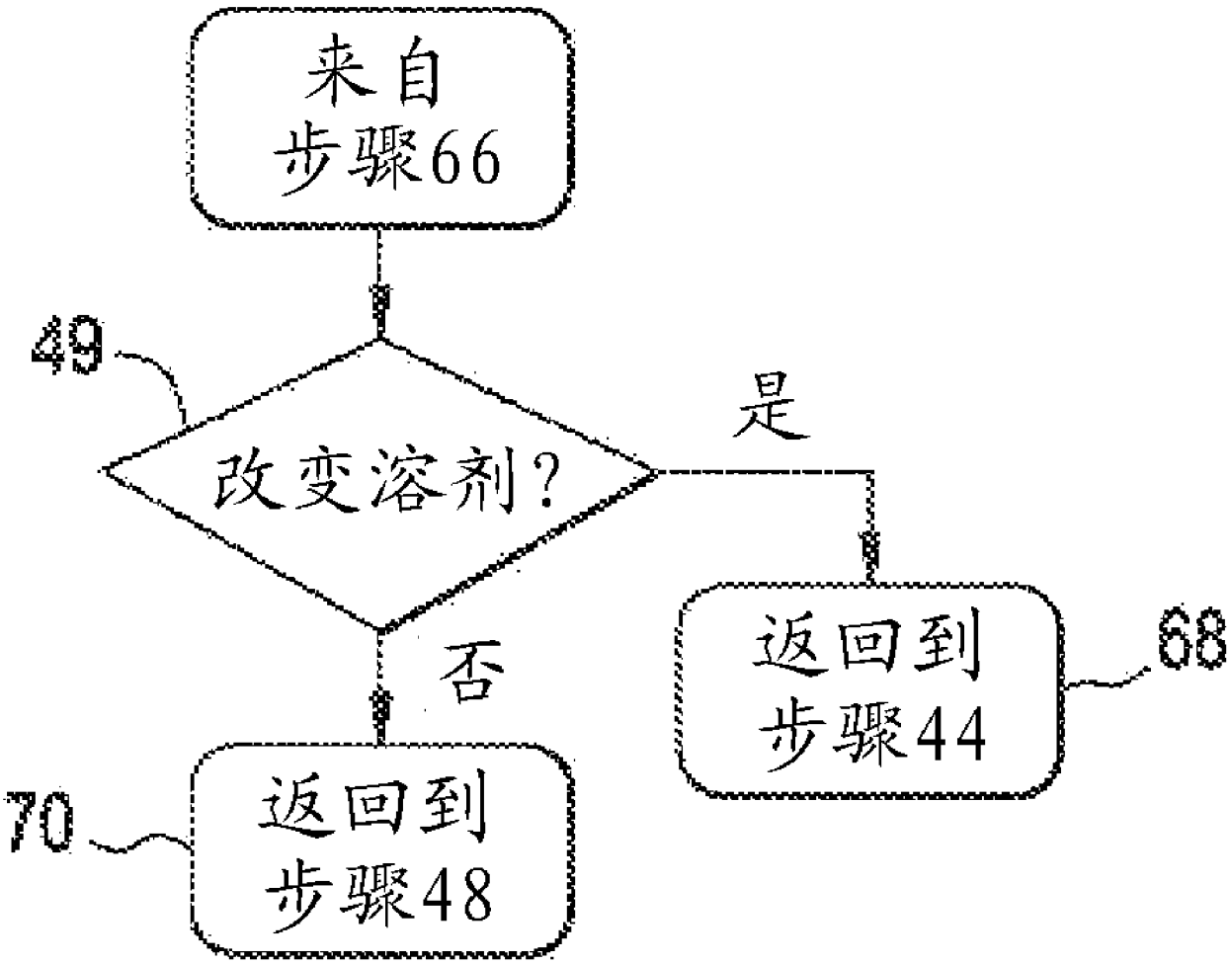


图 4B

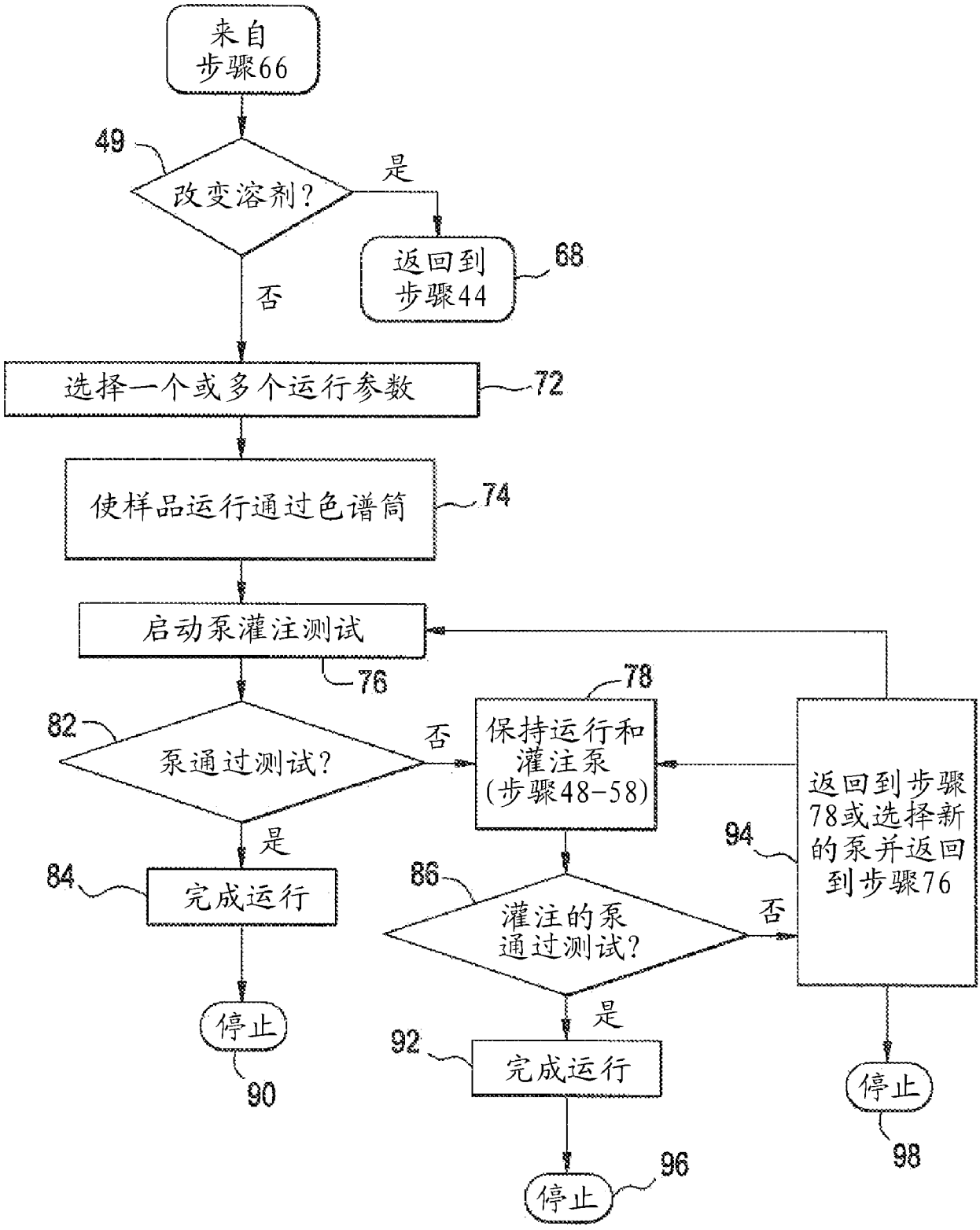

来自
步骤66
49
改变溶剂?
是
否
返回到
步骤44
68
选择一个或多个运行参数
72
使样品运行通过色谱筒
74
启动泵灌注测试
76
78
82
泵通过测试?
否
保持运行和
灌注泵
(步骤48-58)
返回到步骤
78或选择新
的泵并返回
到步骤76
94
是
84
完成运行
86
灌注的泵
通过测试?
否
停止
90
是
92
完成运行
停止
98
停止
96

图 4C