venous blood line for connecting to a patient's vein for returning blood to a patient, a reusable dialysis machine and a disposable cartridge wherein said disposable cartridge is connectable and disconnectable to said reusable dialysis machine; said disposable cartridge including: a dialyzer; a blood flow path connected to said arterial blood line and said venous blood line for transporting blood from a patient through said dialyzer and back to a patient; a dialysate flow path, isolated from the blood flow path, for transporting a dialysate from a reservoir to said dialyzer and back to the reservoir; a first pump actuator connected to said dialysate flow path upflow from said dialyzer for pumping dialysate through said dialysate flow path; a second pump actuator connected to said dialysate flow path downflow from said dialyzer for pumping dialysate through said dialysate flow path; a third pump actuator connected to said blood flow path for pumping blood through said blood flow path; a filter connected to said dialysate flow path downflow from said dialyzer for removing uremic toxins from said a dialysate flow path, said filter positioned within a housing having a vapor membrane which permits ammonia to pass through said vapor membrane but not dialysate liquid; a first flow sensor connected to said dialysate flow path upflow from said dialyzer for detecting the fluid flow within said dialysate flow path; a second flow sensor connected to said dialysate flow path downflow from said dialyzer for detecting the fluid flow within said dialysate flow path; a third flow sensor connected to said blood flow path upflow from said dialyzer for detecting the blood flow within said blood flow path; a fourth flow sensor connected to said blood flow path downflow from said dialyzer for detecting the fluid flow within said blood flow path; a first pressure sensor connected to said dialysate flow path upflow from said dialyzer for detecting the pressure within said dialysate flow path; a second pressure sensor connected to said dialysate flow path downflow from said dialyzer for detecting the pressure within said dialysate flow path; a third pressure sensor connected to said blood flow path upflow from said dialyzer for detecting the pressure within said blood flow path; a fourth pressure sensor connected to said blood flow path down flow from said dialyzer for detecting the pressure within said blood flow path; and cartridge electrical terminals electrically connected to said disposable cartridge's first, second, third and fourth flow sensors and said disposable cartridge's first, second, third, and fourth pressure sensors; said reusable dialysis machine including: a first pump motor engaging and actuating the operation of said first pump actuator; a second pump motor engaging and actuating the operation of said second pump actuator; a third pump motor engaging and actuating the operation of said third pump actuator; a reservoir for storing a dialysate solution in fluid connection to said a dialysate flow path; a heater thermally connected to said reservoir for heating fluids in said reservoir; a temperature sensor for measuring the temperature of said fluid; a level sensor for detecting the level of fluid in said reservoir; a blood leak sensor for detecting blood in said dialysate flow path; an ammonia sensor adjacent to said vapor membrane for sensing ammonia released from said filter; a

venous blood line pressure sensor connected to said venous blood line for sensing pressure in said venous blood line; a bubble sensor connected to said venous blood line for detecting gaseous bubbles in said venous blood line; a pinch valve connected to said venous blood line for selectively permitting or obstructing the flow of blood through said venous blood line; dialysis machine electrical terminals for electrically connecting to said cartridge electrical terminals for transmitting electrical signals between said reusable dialysis machine and said disposable cartridge; and a processor connected to said first, second and third pump motors for controlling operation of said pump motors, said processor connected to said reservoir sensor, said temperature sensor, said blood leak sensor, said ammonia sensor, said venous blood line pressure sensor, and said bubble sensor for monitoring said dialysis machine sensors, said processor connected to said dialysis machine electrical terminals to connect to and monitor said disposable cartridge's flow sensors and said disposable cartridge's pressure sensors, and said processor connected to said pinch valve for controlling the opening and closing of said pinch valve. Embodiments of the present invention provide for a cartridge for use in a hemodialysis machine.

[015] The arterial blood line and venous blood line may be typical constructions known to those skilled in the art. For example, the arterial blood line may be traditional flexible hollow tubing connected to a needle for collecting blood from a patient's artery. Similarly, the venous blood line may be a traditional flexible tube and needle for returning blood to a patient's vein. Various constructions and surgical procedures may be employed to gain access to a patient's blood including an intravenous catheter, an arteriovenous fistula, or a synthetic graft.

[016] The disposable cartridge is intended for a single patient treatment and not reused. The disposable cartridge includes a dialyzer of a construction and design known to those skilled in the art. Suitable dialyzers can be obtained from Fresenius Medical Care, Baxter International, Inc., and Nipro Medical Corporation. Preferably, the dialyzer includes a large number of hollow fibers which form a semipermeable membrane.

[017] The disposable cartridge includes a blood flow path and a dialysate flow path. The blood flow path transports blood in a closed loop system by connecting to the arterial blood line and venous blood line for transporting blood from a patient to the dialyzer and back to the patient. Meanwhile, the dialysate flow path transports dialysate in a closed loop system from a reservoir to the dialyzer and back to the reservoir. Both the blood flow path and the dialysate flow path pass through the dialyzer, but are separated by the dialyzer's semipermeable membrane.

monitors each of the various sensors to ensure that hemodialysis treatment is proceeding in accordance with a preprogrammed procedure input by medical personnel into the user interface.

[029] The dialysis machine and disposable cartridge provide a hemodialysis system may be transportable, light weight, easy to use, patient friendly and capable of in-home use.

[030] Advantageously, the disposable cartridge and blood lines may be sterilized prior to presentation to a patient, and disposed of after hemodialysis treatment. Because the blood lines connect directly to the disposable cartridge and not to a reused machine, all components that are susceptible to contamination are disposed of after each treatment and replaced prior to a next treatment.

[031] Also, advantageously, the hemodialysis system may not utilize any flexible tubing other than the arterial blood line and venous blood line so as to reduce areas of potential danger to a patient.

[032] In addition, the hemodialysis system may provide an extraordinary amount of control and monitoring not previously provided by hemodialysis systems so as to provide enhanced patient safety.

[033] Other features and advantages of the present invention will be appreciated by those skilled in the art upon reading the detailed description which follows with reference to the drawings.