

[014] Furthermore, it would be desirable to provide a hemodialysis system that employed pumps that did not squeeze blood in the blood flow path and did not incorporate flexible materials such as employed with peristaltic roller pumps.

[015] In still an additional aspect, it would be desirable to provide a hemodialysis system wherein pump components that came in contact with blood or dialysate could be disposed of after a single patient treatment, but that the pump motor could be reused.

[016] Aspects of the present invention fulfill these needs and provide further related advantages as described in the following summary.

SUMMARY OF THE INVENTION

[016a] According to an aspect of the present invention, there is provided a hemodialysis system comprising: an arterial blood line for connecting to a patient's artery for collecting blood from a patient; a venous blood line for connecting to a patient's vein for returning blood to a patient; a dialyzer; a blood flow path connected to said arterial blood line and said venous blood line for transporting blood from a patient to said dialyzer and back to a patient; a reservoir for storing a dialysate solution; a dialysate flow path, isolated from the blood flow path, for transporting a dialysate from said reservoir to said dialyzer and back to said reservoir; a filter connected to said dialysate flow path downflow from said dialyzer for removing uremic toxins from dialysate in said a dialysate flow path after said dialyzer and prior to returning said dialysate to said reservoir; a first pump including a first pump motor and a first pump actuator connected to said dialysate flow path upflow from said dialyzer for pumping dialysate through said dialysate flow path to said dialyzer, said first pump actuator including a sliding vane construction having non-deformable components including a housing having a central cavity forming an internal sidewall, a rotor eccentrically positioned within said cavity and said rotor having a plurality of radially aligned slots at said rotor's periphery, vanes slideably positioned in said slots to slide in and out of said slots so as to seal with the cavity's internal sidewall creating vane chambers that pump dialysate through said dialysate flow path; a second pump including a second pump motor and a second pump actuator connected to said dialysate flow path downflow from said dialyzer for pumping dialysate through said dialysate flow path, said second pump actuator including a

sliding vane construction having non-deformable components including a housing having a central cavity forming an internal sidewall, a rotor eccentrically positioned within said cavity and said rotor having a plurality of radially aligned slots at said rotor's periphery, vanes slideably positioned in said slots to slide in and out of said slots so as to seal with the cavity's internal sidewall creating vane chambers that pump dialysate through said dialysate flow path; and a third pump including a third pump motor and a third pump actuator connected to said blood flow path for pumping blood through said blood flow path, said third pump actuator including a sliding vane construction having non-deformable components including a housing having a central cavity forming an internal sidewall, a rotor eccentrically positioned within said cavity and said rotor having a plurality of radially aligned slots at said rotor's periphery, vanes slideably positioned in said slots to slide in and out of said slots so as to seal with the cavity's internal sidewall creating vane chambers that pump blood through said blood flow path; and a processor connected to said first, second and third pump motors for controlling operation of said pump motors.

[017] According to ~~a first aspect~~ embodiments of the invention, a hemodialysis system is provided including an arterial blood line for connecting to a patient's artery for collecting blood from a patient, a venous blood line for connecting to a patient's vein for returning blood to a patient, a reusable dialysis machine and a disposable cartridge. ~~In a second aspect~~ Embodiments of the invention, the present invention provides for a cartridge for use in a hemodialysis machine.

[018] 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.

CLAIMS

What is claimed is:

1. A hemodialysis system comprising:

an arterial blood line for connecting to a patient's artery for collecting blood from a patient;

a venous blood line for connecting to a patient's vein for returning blood to a patient;

a dialyzer;

a blood flow path connected to said arterial blood line and said venous blood line for transporting blood from a patient to said dialyzer and back to a patient;

a reservoir for storing a dialysate solution;

a dialysate flow path, isolated from the blood flow path, for transporting a dialysate from said reservoir to said dialyzer and back to said reservoir;

a filter connected to said dialysate flow path upflow from said dialyzer for removing uremic toxins from dialysate in said a dialysate flow path after said dialyzer and prior to returning said dialysate to said reservoir;

a first pump including a first pump motor and a first pump actuator connected to said dialysate flow path upflow from said dialyzer for pumping dialysate through said dialysate flow path to said dialyzer, said first pump actuator including a sliding vane construction having non-deformable components including a housing having a central cavity forming an internal sidewall, a rotor eccentrically positioned within said cavity and said rotor having a plurality of radially aligned slots at said rotor's periphery, vanes slideably positioned in said slots to slide in and out of said slots so as to seal with the cavity's internal sidewall creating vane chambers that pump dialysate through said dialysate flow path;

a second pump including a second pump motor and a second pump actuator connected to said dialysate flow path ~~upflow~~downflow from said dialyzer for pumping dialysate through said dialysate flow path, said second pump actuator including a sliding vane construction having non-deformable components including a housing having a central cavity forming an internal sidewall, a rotor eccentrically positioned within said cavity and said rotor having a plurality of radially aligned slots at said rotor's periphery, vanes slideably positioned in said slots to slide in and out of said slots so as to seal with the cavity's

internal sidewall creating vane chambers that pump dialysate through said dialysate flow path; and

a third pump including a third pump motor and a third pump actuator connected to said blood flow path for pumping blood through said blood flow path, said third pump actuator including a sliding vane construction having non-deformable components including a housing having a central cavity forming an internal sidewall, a rotor eccentrically positioned within said cavity and said rotor having a plurality of radially aligned slots at said rotor's periphery, vanes slideably positioned in said slots to slide in and out of said slots so as to seal with the cavity's internal sidewall creating vane chambers that pump blood through said blood flow path; and

a processor connected to said first, second and third pump motors for controlling operation of said pump motors.

2. The hemodialysis system of claim 1 further comprising:

a reusable dialysis machine and a disposable cartridge wherein said disposable cartridge is connectable and disconnectable to said reusable dialysis machine; and

said first, second and third pump motors are positioned with said reusable dialysis machine and said first, second and third pump actuators are positioned with said disposable cartridge.

3. The hemodialysis system of claim 1 further comprising at least one pressure sensor which measures pressure within the dialysate flow path and at least one pressure sensor which measures pressure within the blood flow path, and wherein said dialyzer includes a semipermeable membrane that separates said blood flow path and said dialysate flow path, and said processor monitors said pressure sensors and controls said pump motors so as to maintain a predetermined pressure differential across said semipermeable membrane.

4. The hemodialysis system of claim 3 wherein said processor maintains said pressure differential within the dialyzer of the blood flow path relative to dialysate flow path at about zero.

5. The hemodialysis system of claim 3 wherein said processor maintains said pressure differential within the dialyzer of the blood flow path relative to dialysate flow path above zero to provide ultrafiltration.

6. The hemodialysis system of claim 1 wherein said first, second and third pump motors are electric rotary motors.