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ENCAPSULATED WATER TREATMENT SYSTEM

This application claims priority to U.S. Provisional Patent Application Serial No. 60/647,680, filed January 27, 2005.

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FIELD OF INVENTION

The present invention relates to water treatment systems and, in particular, to such systems having an encapsulated manifold head and a reverse osmosis cartridge and one or more filter cartridges.

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BACKGROUND OF THE INVENTION

Reverse osmosis systems are known. The main part of the system is a semi-permeable membrane through which the untreated water passes. Such systems typically include an additional carbon or ceramic filter which removes contaminants either prior to passing through the membrane or after. Such systems are often installed in residential applications.

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The prior art includes electronic systems which detect when the reverse osmosis membrane requires replacement. Typical prior art systems include

measuring the conductivity of the water entering the reverse osmosis cartridge, and then measuring the conductivity of the water at the outlet of the reverse osmosis cartridge. The conductivity of the water is proportional to the total dissolved solids. A ratio of the conductivity levels will provide an indication of the rejection efficiency
5 of the reverse osmosis membrane.

Prior art systems also include an application wherein a permeate pump is included in a factory installation. The permeate pump provides greater efficiency in the system. The permeate pump increases the net pressure across the reverse osmosis membrane by isolating the membrane pressure from the pressure in the products water
10 and thus reducing the permeate back pressure.

The prior art also includes systems which address reducing the spillage of fluid occurring during replacement of the cartridges.

SUMMARY OF THE INVENTION

15 It is an object of the present invention to provide an improved locking mechanism for a filter cartridge and manifold head.

It is a further object of the present invention to provide an improved method of monitoring the performance of a reverse osmosis membrane in a drinking water supply system.

20 It is further object of the present invention to provide a modular manifold head system.

It is an object of the present invention to provide a system for retrofitting a reverse osmosis filter system to include a permeate pump application.

It is an object of the present invention to provide a cartridge which has a
25 reduced inlet opening to reduce spillage during changing of the cartridge.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view of a water treatment system with a reverse osmosis cartridge and two filter cartridges.

5 Fig. 2 is a perspective view of a filter cartridge of Fig. 1.

Fig. 3 is a top view of the filter cartridge of Fig. 2.

Fig. 4 is an exploded view of the filter cartridge of Fig. 2.

Fig. 5 is a bottom perspective view of a manifold head incorporated in the water treatment system of Fig. 1.

10 Fig. 6 is a block diagram of a reverse osmosis membrane monitoring system.

Fig. 7 is a process flow chart for the system of Fig. 6.

Fig. 8 is a perspective view of a modular manifold head system.

Fig. 9 is top perspective view of a modular manifold head.

Fig. 10 is a schematic diagram of a reverse osmosis water treatment system
15 with a permeate pump.

Fig. 11 is a cross-sectional view of the modular manifold head and cartridges of Fig. 1.

Fig. 12 is a top perspective view of a modular manifold head in a permeate pump application.

20 **DETAILED DESCRIPTION OF THE INVENTION**

Fig. 1 shows one embodiment of a water treatment system in accordance with the present invention. The system includes a manifold head, (see Fig. 5) a first filter cartridge, a reverse osmosis cartridge and a second filter cartridge. A manifold cover is also shown.

Fig. 2 shows a filter cartridge in accordance with the present invention. The filter cartridge includes a housing having an annular collar with a double lead thread. An inner annular collar is also shown which includes an O ring to provide a seal. A connection fitting is shown extending through the annular collar.

5 Fig. 3 shows a top view of the filter cartridge and shows the cylindrical wall of the inner annular collar, as well as the longitudinal extending bead.

Fig. 4 shows the filter cartridge in an exploded view so as to more clearly show the longitudinal extending bead. It can be seen that the longitudinal extending bead includes a leading end.

10 Fig. 5 shows the manifold head having the filter cartridge connection fitting. The filter cartridge connection fitting includes a threaded outer annular collar and an inner annular collar. The inner annular collar having an annular lip and four longitudinal slots. The longitudinal slots are equally spaced apart from one another.

It will be appreciated that when the filter cartridge is rotated into a fully
15 secured position onto the connection fitting, the filter cartridge comes to rest with the longitudinal extending beads being received by the respective slot.

Fig. 6 shows a block diagram of a system for monitoring the performance of a reverse osmosis membrane. The system includes a microcontroller having a memory wherein a program resides. The system includes a single probe set which is located
20 downstream of the reverse osmosis membrane. The probe set includes a reference resistor and a thermal resistor. The microcontroller is coupled to a faucet LED for providing an indication to replace the reverse osmosis cartridge. The microcontroller is also coupled to an onboard LED for feedback during operation of an onboard push button also coupled to the microcontroller. A water flow sensor is also coupled to the
25 microcontroller.

Fig. 7 shows a block diagram which represents the functional steps as executed by the program resident in the memory.

Figure 8 is an embodiment of a modular water treatment system. The water treatment system shown in Fig. 8 includes a modular manifold, a manifold cover, a first filter cartridge, a reverse osmosis cartridge and a second filter cartridge. Also shown is a further modular manifold head and cover, as well as additional cartridge unit. The system of Fig. 8 provides a modular system wherein additional modular manifold units may be coupled to the water treatment system via a clip. The clip includes a plurality of arms extending from a planar body portion. Each arm includes a slot and a slanted leading edge. The clip also includes a tubular portion extending through the main body portion. The tubular portion includes a bore extending throughout the tubular portion.

Each manifold includes an end wall having four openings.

Fig. 9 shows a perspective view of the manifold including the two ends each having four openings. The openings are arranged in pairs, one above the other. For example, lower opening and upper opening comprise one pair. Each pair of openings includes a pair of upright walls in a spaced apart facing relationship. The upright walls are shown extending from the interior surface of the end wall and the lower surface of the manifold head. A flange extends from the inner surface of the end wall towards the interior compartment of the manifold head. The flange includes an upper ramp and a lower ramp. The flange includes a forward edge and first and second side edges. The forward edge is generally parallel to the end wall. The first side edge and second side edges form the upper ramp and lower ramp. The upper ramp and lower ramp diverge from one another in a direction away from the inner interior surface towards the interior compartment of the manifold head. One of the four

flanges is shown in phantom in Fig. 9. The ramps include a proximal end a distal end. The proximal end is located slightly away from the edge of the opening. The distal end is spaced in an interference relationship regarding alignment of the opening. Fig. 9A shows additional detail.

5 With reference to Fig. 8, it will be appreciated that as the clip is inserted into the openings of the manifold head to the right of the figure, the slanted edge of each of the resilient arms will be deflected by the respective ramp. Once the clip is fully inserted through the four openings, the slot will extend past the distal end and the two arm pairs will clamp about the respective distal end with the edge of the slot coming
10 into locking engagement with the distal end of the ramp. Meanwhile, the tubular portion will be received by the tube fitting connector for sealing engagement. The other modular manifold head will be coupled in similar manner.

Fig. 10 shows a graphical representation of a water treatment system wherein an automatic shut-off valve cover may be removed and replaced with another cover
15 adapted to accommodate a permeate pump application. With reference to Fig. 11, a cross-section of a water treatment system is shown including the modular manifold head, first cartridge, reverse osmosis cartridge and second filter cartridge. The manifold head is shown to include a connection fitting for receiving the respective connection fitting of the reverse osmosis cartridge. The manifold head includes a first
20 manifold access port for coupling to an output of a reverse osmosis cartridge, a second manifold access port coupled to an output of a reverse osmosis stage. A non-permeate pump cover is adapted to seal the first and second access ports for a non-permeate pump application. A permeate pump cover is adapted to also seal the first and second access ports and includes a permeate pump output port which receives a
25 tube fitting connector. The permeate pump cover includes a first access and a second

access port and a flow channel in communication with the first and second access ports, as well as the permeate pump output port. A check valve assembly is located in the first access port for coupling the output of the reverse osmosis cartridge. The second cover includes a substantially planer body portion which defines a first end
5 and a second end. Mounting holes are provided for fastening the cover to the manifold head.

The manifold includes a lower diaphragm receptacle portion having an opened upper portion. The second cover includes an upper diaphragm receptacle portion for mating with the opened upper portion to form a diaphragm cavity which receives a
10 diaphragm. The upper diaphragm receptacle portion includes an opening and fluid communication with the fluid channel. The manifold head includes a flow channel coupled to an output port of a pre-filter stage and an input port of the reverse osmosis stage, wherein the flow channel is in fluid communication with the lower diaphragm receptacle portion of the manifold head. It will appreciated that the water treatment
15 system may be assembled at the factory with a non-permeate pump cover, wherein the plug is provided at the permeate pump output port. A retrofit kit may be provided wherein the first cover is removed and replaced with the second cover having the tube fitting connector. A quarter inch tubing may then be coupled to the tube fitting connector and extend through a routing hole as shown in Fig. 12. The tubing extends
20 downward and to a permeate pump as shown in Fig. 10. The permeate pump has a permeate outport having a tubing which runs to a T-connector. The T-connector has a further tubing coupled to a storage tank, as well a tubing coupled back to the manifold head. The brine side of the permeate pump includes a brine end from the drain flow of the manifold head and a brine out tubing which couples to the drain point. For sake

of completeness, the tubing is also shown coming from the supply inlet and tubing is shown going to the faucet.

The installation kit includes at a minimum the second cover and further may include a replacement check valve, as well replacement O rings, tubing, fasteners and
5 installation instructions.

Fig. 11 also shows the filter cartridge having a reduced gap at the connection fitting in order to minimize spillage during changing of the filter cartridge. The novel features of the filter cartridge are explained below. However, it will be apparent that the features can be incorporated into the reverse osmosis cartridge as well.

10 The filter cartridge includes external cartridge housing having a cylindrical portion with a top portion and a bottom portion. The bottom portion has a closed end. The top portion includes a shoulder having a generally cylindrical neck portion extending upward from the shoulder. The cylindrical neck portion defines a portion of a connection fitting. The cylindrical neck portion defines a cylindrical bore having
15 a cylindrical bore wall which defines a first diameter. The cylindrical bore wall includes an annular ring protruding from the wall and defining a second diameter which is smaller than the first diameter. An internal cartridge housing includes a top portion with a shoulder, a tube portion extending upward from the internal shoulder, and the tube portion defining an outlet bore. The tube portion defines an outer
20 diameter having a third diameter, wherein the third diameter is smaller than the first and second diameter. The tube portion and the annular ring define a cartridge inlet having an annular gap. It will be appreciated that the annular gap is minimized by this design and thereby reduces the likelihood of spillage. The manifold head is adapted to conform with the filter cartridge. In particular, the manifold head includes
25 a connection fitting which includes an internal annular collar having a length defined

such that when the cartridge is assembled to the manifold, the internal annular collar extends around the tube portion and up to the annular ring, with a minimum spacing for tolerance.

CLAIMS

1. A locking mechanism for an encapsulated manifold and cartridge, the locking mechanism comprising:
- 5 an encapsulated manifold having a connection fitting, the connection fitting having a threaded outer annular collar and an inner annular collar, the inner annular collar having an annular lip and at least one longitudinal slot extending from the lip along a portion of the annular collar and
- a cartridge having a connection fitting, the connection fitting having a threaded outer annular collar for mating with the threaded outer annular collar of the manifold, the connection fitting of the
- 10 cartridge also having a cylindrical wall located within the threaded outer annular collar of the cartridge, the cylindrical wall having at least one longitudinal extending bead which is received by the respective slot upon the cartridge being threadingly fastened to the manifold to a fully secured position.
2. The locking mechanism of claim 1, wherein the longitudinal extending bead engages the annular
- 15 lip approximately $1/8$ of a turn prior to the fully secured position.
3. The locking mechanism of claim 1, wherein the longitudinal extending bead has a length and includes a leading end which is longitudinally spaced apart from the manifold a first distance with the cartridge in the fully secured position, and a second distance with the cartridge approximately $1/8$ of a
- 20 turn prior to the fully secured position, and wherein the difference between the first distance and the second distance is approximately the length of the longitudinal extending bead.
4. The locking mechanism of claim 1, wherein each connection fitting includes a double lead thread having a circumference, a first thread and a second thread, the first and second threads being interwoven
- 25 and extending around approximately of the circumference, wherein the first thread is offset from the second thread approximately 180 degrees.

5. The locking mechanism of claim 1, wherein the manifold includes four longitudinal slots extending from the lip along a portion of the annular collar and equally spaced apart circumferentially about the annular collar, and the cartridge includes four longitudinal extending beads extending along the cylindrical wall, the four longitudinal extending beads are equally spaced about the cylindrical wall, each of the longitudinal extending beads is adapted to be received by a respective slot with the cartridge in the fully secured position.
6. A computer-implemented method of monitoring the performance of a reverse osmosis membrane in a drinking water supply system, the method carried out by a computer program, the method comprising the steps of:
- initiating a reverse osmosis membrane recalibration;
 - determining the flow of a predetermined amount of water through the system; measuring the initial water conductivity downstream of the reverse osmosis membrane;
 - calculating, using the measured initial water conductivity, a threshold trip point which corresponds to a predetermined total dissolved solids rejection ratio;
 - storing the threshold trip point in memory of the system;
 - routinely measuring the water conductivity downstream of the reverse osmosis membrane;
 - determining whether the water conductivity, as routinely measured in the prior step, is below the threshold trip point; and
 - providing an indication upon determining when the water conductivity is below the threshold trip point.
7. The method of claim 6, wherein the step of initiating includes a power on routine.
8. The method of claim 7, wherein the step of initiating occurs after the reverse osmosis membrane has been replaced.

9. The method of claim 8, wherein the step of initiating includes sending an initiate recalibration signal to a microcontroller of the system.
10. The method of claim 6, wherein the step of initiating includes a user activated switch to signal a reverse osmosis membrane change and to initiate a recalibration.
11. The method of claim 6, wherein the predetermined amount of water is in a range of 10-30 gallons.
12. The method of claim 6, wherein the predetermined amount of water is gallons.
13. The method of claim 6, wherein the step of measuring the water conductivity includes the step of averaging a range of 10-50 measurements.
14. The method of claim 6, wherein the step of measuring the water conductivity includes the step of averaging 20 measurements.
15. The method of claim 6, wherein the step of measuring the initial water conductivity downstream of the reverse osmosis membrane and the step of routinely measuring the water conductivity includes measuring product water.
16. The method of claim 6, wherein the step of calculating includes associating the initial measured water conductivity with an assumed percentage rejection of total dissolved solids.
17. The method of claim 16, wherein the total dissolved solids rejection ratio is in a range of 80-100%.

18. The method of claim 16, wherein the total dissolved solids rejection ratio is 90%.

19. The method of claim 6, wherein the threshold trip point corresponds to a predetermined total dissolved solids rejection ratio in the range of 60-80%.

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20. The method of claim 6, wherein the threshold trip point corresponds to a predetermined total dissolved solids rejection ratio of 75%.

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21. The method of claim 6, wherein the step of providing an indication includes illuminating a light emitting diode.

22. The method of claim 6, wherein the memory is a nonvolatile memory.

23. A modular system for coupling water filter manifold heads, the system comprising:

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a first and second manifold head, each manifold head having a first side and a manifold head cavity, the first side including a pair of ramps, each ramp having a first end and a second end, with a ramp edge defined between the first end and second end, the pair of ramps arranged in an opposed and outwardly facing relationship, with the first ends adjacent the first side and the second ends extending away from the first side inward within the manifold head cavity, the first ends of the pair of ramps defining a distance D1, and the second ends of the pair of ramps defining a distance, wherein the distance is greater than the distance D1, the pair of ramps each defining, at the second end, a locking edge extending in a direction which diverge; and

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a clip having a body, a first pair of arms extending from the body in a generally first direction, and a second pair of arms extending from the body in a generally opposite direction, each pair of arms having a latch at a distal end, each pair of latches define a distance D2, wherein D1 is less than or equal to D2 which is less than or equal to D3.

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24. The system of claim 23 wherein each pair of ramps is defined by a flange extending from the first side inward within the cavity, each flange defining a forward edge and first and second side edges, wherein the forward edge is generally parallel to the first side and the first and second side edges diverge from one another in the direction away from the first side and inward within the cavity,

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25. The system of claim 24 wherein each pair of ramps include an upper ramp and a lower ramp; the first side of each manifold includes a manifold wall, the wall having an upper opening adjacent each upper ramp, the upper opening having a lower edge and an upper edge, the lower edge generally aligned with the first end of the upper ramp, and the upper edge extends above the second end of the upper ramp, the wall having an lower opening adjacent each lower ramp, the lower opening having a lower edge and an upper edge, the upper edge generally aligned with the first end of the lower ramp, and the lower edge extends below the second end of the lower ramp.

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26. The system of claim 25, wherein each arm has a thickness with a dimension, and the upper edge extends beyond the second end of the ramp by at least the thickness dimension.

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27. The system of claim 23 wherein the body of the clip has a planar shape.

28. The system of claim 23 wherein the arms of the clip include a slot which defines the latch; the distal end of each arm has a slanted face to mate with the respective ramp, and the arms are made of a resilient material.

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29. The system of claim 23 wherein the first side of the first and second manifold heads includes a tube fitting, and the body of the clip includes a tube portion having a first end and a second end, wherein the first end of the tube portion couples to the tube fitting of the first manifold head, and the second end of the tube portion couples to the tube fitting of the second manifold head.

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30. The system of claim 23, wherein each of the first and second manifold heads includes a first pair of ramps and a second pair of ramps, and the clip includes a first pair of arms and a second pair of arms.

31. A system for retrofitting a water treatment system to include a permeate pump, the retrofitting
5 system comprising:

a manifold head having a first manifold access port for coupling to an output of a reverse osmosis cartridge, a second manifold access port coupled to an output of a reverse osmosis stage;

a first cover adapted to seal the first and second access ports for non-permeate pump application;

a second cover adapted to seal the first and second access ports, and having a permeate pump
10 output port with a tube fitting connector for permeate pump application.

32. The system of claim 31, wherein the first cover includes a cover first access port and a cover second access port, and a flow channel in fluid communication with the cover first access port and the cover second access port.

33. The system of claim 31, wherein the second cover includes a cover first access port and a cover second access port, and a flow channel in fluid communication with the cover first access port, the cover second access port and the permeate pump output port.

34. The system of claim 33, further comprising a check valve assembly located in the cover first access port for coupling to the output of the reverse osmosis cartridge.

35. The system of claim 33, wherein the second cover includes a substantially planar body portion having the fluid channel which extends longitudinally within the planar body portion, wherein one end of
25 the body portion includes the permeate pump output port with the tube fitting connector, wherein the cover second access port is adjacent the tube fitting connector and the cover first access port is adjacent

the cover second access port on a side opposite from the tube fitting connector.

36. The system of claim 31, wherein the second cover includes mounting holes for receiving a fastener to secure the second cover to the manifold head.

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37. The system of claim 31, wherein the manifold includes a lower diaphragm receptacle portion having an opened upper portion, and the second cover includes another end having an upper diaphragm receptacle portion for mating with the opened upper portion to form a diaphragm cavity which receives a diaphragm, the upper diaphragm receptacle portion includes an opening in fluid communication with the
10 fluid channel.

38. The system of claim 37, wherein the manifold head includes a flow channel coupled to an output port of a pre-filter stage and an input port of the reverse osmosis stage, wherein the flow channel is in fluid communication with the lower diaphragm receptacle portion of the manifold head.

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39. An installation kit for replacing an automatic shutoff valve cover previously assembled on a manifold head of a water treatment system, wherein the manifold head includes a first access port adapted to be coupled to an output of a reverse osmosis cartridge, a second access port coupled to an output of the reverse osmosis stage, the kit comprising:

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a cover having a cover first access port, a cover second access port, and having a permeate pump output port with a tube fitting connector for permeate pump application.

40. The installation kit of claim ³⁹, further comprising a check valve assembly adapted to be received in the cover first access port.

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41. The installation kit of claim 39, wherein the cover (164) includes a substantially planar body

portion having a fluid channel which extends longitudinally within the planar body portion, wherein one end of the body portion includes the permeate pump output port with the tube fitting connector, the cover second access port adjacent the tube fitting connector and the cover first access port is adjacent the cover second access port on a side opposite from the tube fitting connector.

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42. The installation kit of claim 39, further comprising replacement O-rings for the cover first and second access ports.

43. The installation kit of claim 39, further comprising installation instructions.

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44. The installation kit of claim 39, further comprising tubing and fasteners.

45. A water treatment system comprising:

a cartridge having;

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an external cartridge housing, the housing having a cylindrical portion with a top portion and a bottom portion, the bottom portion having a closed end, the top portion having a shoulder with a generally cylindrical neck portion extending upward from the shoulder, the cylindrical neck portion defining a portion of a connection fitting, the cylindrical neck portion defining a cylindrical bore having a cylindrical bore wall which defines a first diameter, the cylindrical bore wall having an annular ring protruding from the wall and defining a second diameter which is smaller than the first diameter;

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an internal cartridge housing within the external cartridge housing and having a top portion with a shoulder, a tube portion extending upward from the internal shoulder, the tube portion defining an outlet bore, the tube portion defining an outer diameter having a third diameter, the third diameter is smaller than the first and second diameters, the tube portion and the annular ring define a cartridge inlet having an annular gap.

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46. The system of claim 45, further comprising a manifold head having a connection fitting which includes an internal annular collar having a length defined such that with the cartridge assembled to the manifold, the internal annular collar extends around the tube portion and extends adjacent the annular
5 ring.