CLAIMS

What is claimed is:

1. A connection assembly, comprising:

a manifold including an upper plate and a lower plate; and

a connector pipe extending through the lower plate and the upper plate, the connector pipe including a flange disposed between the upper plate and the lower plate, wherein

the manifold is configured to attach a removable cartridge such that the connector pipe is inserted into a port of the removable cartridge and an O-ring is compressed between the connector pipe and an inner wall of the port, and

the flange is configured to satisfy the following relationship:

$$\frac{L \cdot h}{(C_U - C) \cdot T_O} \leq W \geq \frac{L \cdot h}{(C - C_L) \cdot T_O}$$

W being the width of the flange of the connector pipe,

C being a compression ratio of the O-ring,

C_L being the compression ratio lower limit of the O-ring,

C_U being the compression ratio upper limit of the O-ring,

T_O being a thickness of the O-ring without compression,

L being a length between the flange and the O-ring, and

h being a height of a gap provided between the flange and at least one of the upper plate and the lower plate of the manifold.

2. The connection assembly of claim 1, wherein the removable cartridge is a filter.

3. The connection assembly of claim 1 or claim 2, wherein the connector pipe when angled at the maximum tilt at least one of a) compresses the O-ring at the compression ratio upper limit and b) compresses the O-ring at the compression ratio lower limit.

4. The connection assembly of any of claims 1-3, wherein a gap is provided between the flange of the connector pipe and at least one of the lower plate and the upper plate of the manifold.

5. The connection assembly of claim 1, wherein the compression ratio of the O-ring is the compression ratio of the O-ring when connector pipe is inserted into the port and is aligned with the port.

6. The connection assembly of claim 1 or claim 5, wherein the compression ratio upper limit and the compression ratio lower limit of the O-ring are predetermined values based on the O-ring.

7. The connection assembly of any of claims 5 or 6, wherein the connector pipe is configured to be inserted and fluidly attached to the port with the single O-ring.

8. The connection assembly of any of claims 1-7, further comprising:

a second connector pipe extending through the lower plate and the upper plate, the second connector pipe including a flange disposed between the upper plate and the lower plate, wherein

the manifold is configured to attach the removable cartridge such that the second connector pipe is inserted into a second port of the removable cartridge and a second O-ring is compressed between the second connector pipe and an inner wall of the second port, and

the flange of the second connector pipe has a width configured to prevent tilting of the second connector pipe at greater than a maximum tilt angle, the maximum tilt angle based on at least one of a compression ratio upper limit and a compression ratio lower limit of the second O-ring.

9. A filter assembly, comprising:

a manifold including an upper plate and a lower plate;

a filter removably attached to the manifold and including a port with an inner wall;

a connector pipe extending through the lower plate and the upper plate of the manifold and inserted into the port of the filter, the connector pipe including a flange disposed between the upper plate and the lower plate; and

an O-ring compressed between the connector pipe and the inner wall of the port, wherein

the flange is configured to satisfy the following relationship:

$$\frac{L \cdot h}{(C_U - C) \cdot T_O} \leq W \geq \frac{L \cdot h}{(C - C_L) \cdot T_O}$$

W being the width of the flange of the connector pipe,

C being a compression ratio of the O-ring,

C_L being the compression ratio lower limit of the O-ring,

C_U being the compression ratio upper limit of the O-ring,

T_O being a thickness of the O-ring without compression,

L being a length between the flange and the O-ring, and

h being a height of a gap provided between the flange and at least one of the upper plate and the lower plate of the manifold.

10. The filter assembly of claim 9, wherein the connector pipe when angled at the maximum tilt at least one of compresses the O-ring at the compression ratio upper limit and compressed the O-ring at the compression ratio lower limit.

11. The filter assembly of claim 9 or claim 10, wherein a gap is provided between the flange of the connector pipe and at least one of the lower plate and the upper plate of the manifold.

12. The filter assembly of claim 9, wherein the compression ratio of the O-ring is the compression ratio of the O-ring when the connector pipe is inserted into the port and is aligned with the port.

13. The filter assembly of claim 9 or claim 12, the compression ratio upper limit and the compression ratio lower limit of the O-ring are predetermined values based on the O-ring.

14. The filter assembly of any of claims 10-13, wherein the connector pipe is fluidly connected to the port with the single O-ring.