

SCROLL PUMP AND SCROLL PUMP INLET VALVE

FIELD OF THE INVENTION

The field of the invention relates to scroll pumps and in particular to inlet valves
5 for scroll pumps.

BACKGROUND

Scroll pumps may be provided with a non-return exhaust valve to inhibit backflow
of fluid into the pump from the exhaust which may be at atmosphere when the
10 scroll pump stops. Where a scroll pump is used as a vacuum pump then such
backflow may be particularly problematic. For example, where the scroll pump is
used to evacuate a semiconductor processing chamber and/or where it is used to
back a turbomolecular pump (TMP) such backflow can cause the pressure in the
TMP to change suddenly and cause damage to the pump and/or it may cause
15 contamination of the chamber.

This may be addressed by providing an inlet valve rather than an exhaust valve.
Such an arrangement inhibits fluid inside the scroll pump itself from leaking into a
low pressure environment, for example, the TMP or semiconductor processing
20 chamber. Such an inlet valve may be offered as an accessory that can be
mounted to an upstream side of the pump. This takes up valuable space and can
be expensive.

It is therefore desirable to provide apparatus which addresses one or more of the
25 drawbacks associated with the conventional valves.

SUMMARY

According to one aspect, there is provided a scroll pump inlet valve comprising: a
valve seat formed by at least one of a stator and an inlet cover of a scroll pump;
30 and a sealing mechanism, mounted to the stator or the inlet cover, comprising an
actuator configured to move the sealing mechanism between an open position in
which a scroll mechanism and an inlet port of the scroll pump are fluidly

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connected and a closed position in which the sealing mechanism engages the valve seat to seal the scroll mechanism from the inlet port.

5 In this way, an inlet valve that is at least partly formed within the pump itself is provided. This is a compact arrangement that obviates the need for an external inlet valve, thereby reducing the number of connection fittings and extra components required, thereby saving space and money, and enabling a less complex system. This may be particularly important where the scroll pump is used as part of a pumping system to evacuate a semiconductor processing
10 chamber, where space may be at a premium. Furthermore, reducing the number of connections reduces the number of potential leak sites, thereby reducing the chance of leaks.

15 Compared to an exhaust valve, providing a valve at the inlet inhibits backflow from the scroll pump into the environment being pumped such as a processing chamber and helps maintain the environment at a low pressure and free from contaminants such as tip seal dust from the scroll pump, particularly when the pump is turned off.

20 In some embodiments, the sealing mechanism may be configured to cooperate with the stator and/or inlet cover to define a portion of an inlet passage of the scroll pump when the sealing mechanism is in the open position, the inlet passage defining a flow channel between the inlet port and the scroll mechanism.

25 Using the sealing mechanism to help define the inlet passage provides an efficient way to incorporate a valve into the scroll pump with reduced additional components.

30 In some embodiments, the seat may be formed by a perimeter of a portion of the inlet passage. Creating the seat using the perimeter of a portion of the inlet passage allows the sealing mechanism to effectively seal over the entirety of an inlet passage defined by that perimeter.

In some embodiments, the actuator comprises a solenoid coil.

5 The inlet valve may be a simple open/close valve with a solenoid coil providing the force to move the sealing mechanism between the open and closed position.

10 In some embodiments, the inlet valve comprises a valve body and the valve seat, the valve body and valve seat being formed by at least one of the inlet cover and stator. Forming the valve body within the stator and/or inlet cover provides a compact arrangement with less need for additional components than would be required by an external inlet valve within an inlet passage. In this way the number of additional components necessary to realise an integrated valve at the inlet is reduced and a more compact pump may be provided.

15 In some embodiments, the valve body and the valve seat are formed by machining them into the metal forming the stator and/or the inlet cover.

20 According to a further aspect, there is provided a scroll pump comprising: an inlet port; a scroll mechanism formed by a stator and a rotor; an inlet cover; and an inlet valve according to the one aspect.

25 In some embodiments, the scroll pump comprises control circuitry configured to control the actuator to move the sealing mechanism between the open position and the closed position. The control circuitry may be separate circuitry to that controlling the motor and general operation of the pump, or it may be incorporated into the general control circuitry controlling the motor driving the pump.

30 In some embodiments, the control circuitry is configured to control the actuator to move the sealing mechanism to the closed position in response to the scroll pump turning off. In this way, the scroll mechanism is no longer fluidly connected to the inlet port and any further pump or process chamber to which the pump is

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attached. This inhibits fluid in the scroll pump leaking to a lower pressure environment such as a further pump or process chamber to which the scroll pump is connected. It will be appreciated that it can also mitigate fluid flowing in the opposite direction into the scroll pump where the scroll pump is connected to
5 a higher pressure environment.

In some embodiments, the control circuitry may be configured to control the actuator to move the sealing mechanism to the open position in response to the pump turning on.

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In some embodiments, the control circuitry may be configured to control the actuator to move the sealing mechanism to the open position at a predetermined time after the pump turns on. Opening the inlet valve immediately at start up when the pressure in the scroll pump may be at atmosphere, may allow gas
15 within the scroll pump to flow through the inlet into the environment being evacuated, such as a further pump and/or process chamber. Opening the valve inlet after a predetermined time gives the scroll pump time to evacuate fluid inside the pump and reduce the pressure, thereby mitigating backflow to the environment being pumped. Control circuitry to provide a simple time delay is
20 low cost, reliable and straightforward.

In some embodiments the control circuitry may provide an adjustable time delay such that the predetermined time may be varied in response to an input. The input may be provided by an operator. In this regard the appropriate time delay
25 may vary depending on the system being pumped and other factors such as the presence or otherwise of an exhaust valve, being able to adjust the time delay provides a flexible pump that can be configured to operate effectively under different conditions.

30 In other embodiments, the control circuitry may be configured to control the actuator to move to the open position in response to receipt of a signal indicating that the pump is operating normally.

Some scroll pumps may comprise sensors and circuitry configured to generate a signal indicating that the pump is operating normally following start up. Such a signal can be used for safe operation of the scroll pump and to provide alerts if the pump is not operating correctly. For example, it may be used by control circuitry controlling the motor to stop it driving the pump before damage occurs if the signal is not received within a predetermined time. As this signal occurs after the pump has started and appears to be functioning normally it is a highly appropriate point in time for opening the inlet valve. Furthermore, by using this signal to control when the inlet valve is opened following start up, additional circuitry for generating an additional control signal for controlling opening of the inlet valve is not required reducing circuitry and decreasing costs, and potentially making the pump more reliable.

In some embodiments, the signal comprises an indication that said pump has reached a predetermined rotational speed. The predetermined rotational speed may be, for example, a normal operating speed. The pump reaching a certain speed is a highly appropriate point at which to open the inlet valve, as once the pump has reached a certain speed, the pressure within the pump will have fallen and opening the inlet valve will generate less backflow. The scroll pump may comprise a sensor for measuring the rotational speed, the sensor sending signals to the control circuitry.

In some embodiments, the scroll pump further comprises a first pressure sensor mounted in the inlet port and a second pressure sensor mounted between the inlet valve and the scroll mechanism, wherein said control circuitry is configured to control the actuator to move the sealing mechanism to the open position when the pressure measured by the second pressure sensor is equal to or below the pressure measured at the first sensor.

By providing pressure sensors flowback into a processing chamber or TMP to which the scroll pump is connected is mitigated because the inlet valve is only

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opened once the pressure is the scroll mechanism is equal to or below the pressure at the inlet port. This provides an effective way of reducing or eliminating backflow, but does require additional active components in the form of pressure sensors.

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In some embodiments, the control circuitry is configured to control a motor configured to drive said scroll mechanism. Control circuitry within a pump generates a control signal that it transmits to the motor indicating it should start, this control signal could also be used to control the opening of the inlet valve. In
10 this way consolidated control circuitry can be used to control both the motor and the inlet valve. This ensures good synchronisation between the two operations and reduces the need for additional components and increases reliability.

Although the control circuitry is described above with reference to control of an
15 inlet valve according to an embodiment, such control circuitry may be used to control other types of inlet valves located at the inlet of a scroll pump.

In some embodiments, the scroll pump is a vacuum pump. The vacuum pump may be used to evacuate a process chamber for semiconductor manufacturing.

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According to another aspect, there is provided a vacuum pump system comprising a scroll pump according to the further aspect and a turbomolecular pump, said scroll pump being arranged as a backing pump for said turbomolecular pump.

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Inhibiting backflow is particularly important when the scroll pump is used as a backing pump for a turbomolecular pump because exposing a turbomolecular pump to higher pressure, for example, atmospheric pressure, dramatically slows the turbomolecular pump which is detrimental to its pumping and can damage the
30 pump.

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According to a yet further aspect there is provided a method of controlling an inlet valve of a scroll vacuum pump comprising the steps of: powering up a motor driving the rotor of the scroll pump; determining whether an inlet valve opening condition has been met, said inlet valve opening condition comprising one of the following: a predetermined time having elapsed or a control signal indicating said rotor has reached a predetermined speed has been received; in response to said condition being met, opening said inlet valve of said scroll pump.

In some embodiments the inlet valve is an inlet valve according to one aspect.

According to a still further aspect there is provided a computer program comprising instructions which when executed by a processor on a scroll pump are operable to control said scroll pump to perform the steps of a method of a yet further aspect.

Further particular and preferred aspects are set out in the accompanying independent and dependent claims. Features of the dependent claims may be combined with features of the independent claims as appropriate, and in combinations other than those explicitly set out in the claims.

Where an apparatus feature is described as being operable to provide a function, it will be appreciated that this includes an apparatus feature which provides that function or which is adapted or configured to provide that function.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the present invention will now be described further, with reference to the accompanying drawings, in which:

- Figure 1 shows a cross-section of a scroll pump inlet valve in a closed position according to an embodiment;
- Figures 2A and 2B shows a cut-away view of the scroll pump inlet valve of Figure 1 in the open position and closed position respectively;
- Figure 3 shows a vacuum pump system according to an embodiment and

Figure 4 shows a flow diagram illustrating steps in a method according to an embodiment.

DESCRIPTION OF THE EMBODIMENTS

- 5 Before discussing the embodiments in any more detail, first an overview will be provided.

Embodiments provide a scroll pump inlet valve where the valve body is integrated into the pump stator or inlet cover to save cost and space. The scroll pump inlet
10 valve comprises a valve seat and a sealing mechanism or means for selectively sealing against the valve seat to block an inlet passage defined between the inlet and the scroll mechanism of the scroll pump. The valve seat is formed out of at least one of a stator and an inlet cover of a scroll pump. The sealing mechanism is mounted to the stator or the inlet cover and comprises an actuator configured
15 to move the sealing mechanism between an open position in which the scroll mechanism and inlet port of the scroll pump are fluidly connected and a closed position in which the sealing mechanism engages the valve seat to seal the scroll mechanism from the inlet port.

- 20 By integrating the body of the inlet valve within the scroll pump, at least some connection fittings are eliminated, and the extra space required for the valve is reduced. A solenoid may be used to drive the valve due to its simple operation and low cost. The valve body and valve seat may be machined into the scroll stator or inlet cover. The sealing mechanism that may comprise a solenoid
25 actuator coil and armature may be mounted on the stator / inlet cover to complete the assembly.

In use the valve is opened when the pump is running and closes when the pump stops. The valve coil may be connected to the motor power supply. A time delay
30 circuit may be included to delay the opening of the valve by a few seconds to allow the pump to accelerate to full speed and to pump out the inlet space of the pump itself before opening.

Figure 1 shows a portion of a scroll pump 1 comprising an integrated inlet valve 10. The inlet valve 10 is positioned downstream of an inlet port 18 of the scroll pump 1 and upstream of a scroll mechanism of the scroll pump 1 formed by a rotor 14 and a stator 12 as known in the art. The inlet valve 10 is configured when in the open position to permit fluid to enter the scroll pump as indicated by arrow A. The scroll mechanism is enclosed by an inlet cover 15 mounted to the stator 12. The scroll pump 1 is a vacuum pump which can be used as a backing pump for a turbomolecular pump (TMP).

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The inlet valve 10 comprises a valve seat 11, a valve body 16, and a sealing mechanism 13 comprising an actuator configured to move the sealing mechanism between an open position (shown in Figure 2A) in which the scroll mechanism and the inlet port 18 of the scroll pump 1 are fluidly connected and a closed position (shown in Figure 1 and 2B) in which the sealing mechanism 13 engages the valve seat 11 to seal the scroll mechanism from the inlet port 18.

In this embodiment the inlet valve 10 is integrated into the scroll pump 1 by forming the valve seat 11 and the valve body 16 within the stator 12. The valve seat 11 is formed by an outer perimeter of a portion of the inlet passage extending into a space 17 defined by the valve body 16 and the sealing mechanism 13. The space 17 forms a part of the inlet passage. The sealing mechanism 13 is configured to cooperate with the stator 12, particularly with the valve body 16, to define a portion of the inlet passage, including space 17, when the sealing mechanism 13 is in the open position. In the closed position, the sealing mechanism 13 is positioned within space 17 to seal against the valve seat 11.

The valve seat 11 and the valve body 16 are formed by machining into the stator 12. It will be appreciated that the valve seat 11 and valve body 16 need not be formed by machining but may be manufactured using any suitable technique such as additive manufacturing to create the flow channel between the inlet port

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18 and the scroll mechanism via the sealing mechanism 13. It will also be appreciated that the inlet port 18, valve seat 11 and valve body 16 can be defined partly or entirely in the inlet cover 15 rather than the stator 12.

5 The sealing mechanism 13 further comprises an attachment means 23 configured to mount the sealing mechanism 13 to the stator 12. The attachment means 23 may comprise a screw formation configured to mate with a complimentary formation defined on the stator 12. The attachment means 23 may comprise a seal, for example, an O-ring, to create a fluid tight attachment. It will
10 be appreciated that any attachment means that creates a fluid tight seal between the valve body 16 and the sealing mechanism 13 when the sealing mechanism is mounted to the valve body 16 may be used. For example, a push fit or snap fit attachment means could be used.

15 The inlet valve 10 is a magnetically actuated valve. The actuator of sealing mechanism 13 comprises a solenoid coil configured to move an armature 20 such that a rubber pad 22 (shown in Figure 2) attached to an end of the armature 20 engages the valve seat 11 when in the closed position and to distance the rubber pad 22 and armature 20 from the valve seat 11 in the open position to
20 create an inlet passage defining a flow channel between the inlet port 18 and the scroll mechanism.

In this embodiment there are also pressure sensors 26 and 27 for sensing the pressure on either side of the inlet valve 10. In some embodiments these may
25 send signals to control circuitry (not shown) that controls the valve opening. In this way the opening may be controlled to occur when the pressure on the pump side of the inlet valve 10 is the same as or below the pressure on the other side of the inlet valve 10.

30 Figure 2A shows that the armature supports the rubber pad 22 for sealing with the valve seat 11 when in the closed position to inhibit the flow of fluid between the inlet port 18 and the scroll mechanism. A portion of the armature 20

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comprising the rubber pad 22 is biased towards the valve seat 11 by a biasing member 21 comprising a coil spring to help create and maintain a fluid tight seal when the sealing mechanism 13 is in the closed position. It will be appreciated that the entire armature may be biased to achieve substantially the same effect.

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Figure 2B shows how the sealing mechanism 13 of the inlet valve is fixed with attaching means 23 to the pump. The valve seat 11 is within the stator 12. The sealing mechanism comprises an armature 20 for driving the sealing mechanism 13 towards an open position and a biasing means 21 for biasing the sealing
10 mechanism towards a closed position when the armature is not being driven. Figure 2B shows the sealing mechanism in the closed position.

Figure 3 schematically shows vacuum pumping system comprising a scroll pump 1 backing a turbomolecular pump 34. The scroll pump 1 has an inlet valve 10
15 incorporated within the scroll pump mechanism 36 which comprises at least the stator 12 and the rotor 14. Scroll pump 1 also comprises control circuitry 30 configured to control the actuator to move the sealing mechanism 13 of the inlet valve 10 between the open and closed positions. The control circuitry 30 also controls motor 32 to drive the rotor of the scroll pump. The control circuitry 30
20 may control the start-up of the motor and the opening of the inlet valve in a coordinated way. In some embodiments, the control circuitry 30 may receive signals from a sensor associated with the scroll pump that indicates when a predetermined speed of rotation of the rotor has been achieved following start-up. This signal may be used by the control circuitry 30 to determine that the pump is
25 operating normally and if it is not received within a predetermined time the control circuitry 30 may shut down the motor 32.

The motor 32 is configured to drive the rotor 14. Furthermore, the actuator of the sealing mechanism 13 may be connected to the power supply of the motor 32 or
30 it may have its own dedicated power source.

In this embodiment, the scroll pump 1 is used as a backing pump for a TMP 34.

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In use, the control circuitry 30 of the scroll pump 1 controls the actuator to move the sealing mechanism 13 to the open position in response to the pump 1 turning on such that normal pumping operation can take place. The inlet valve 10 may be
5 opened immediately in response to the pump 1 turning on or preferably sometime after the pump 1 is turned on to allow residual fluid inside the pump to be evacuated before the scroll mechanism is fluidly connected with a TMP or processing chamber to which the scroll pump 1 is attached. In this way, backflow to the TMP or processing chamber is mitigated. This may be achieved by
10 opening the inlet valve 10 a predetermined time after the pump 1 has turned on or after control circuitry 30 receives a signal indicating the pump 1 is operating normally. This signal could indicate that the pump 1 has reached a predetermined rotational speed. Alternatively, this may be achieved using pressure sensors such as those shown in the embodiment of Figure 1. In this embodiment the
15 scroll pump comprises a first pressure sensor 26 mounted in the inlet port 18 and a second pressure sensor 27 mounted in a portion of the inlet passage between the inlet valve 10 and the scroll mechanism (i.e. on the other side of the inlet valve to the first pressure sensor). The control circuitry 30 is configured to control the actuator to move the sealing mechanism 13 to the open position when the
20 pressure measured by the second pressure sensor 27 is equal to or below the pressure measured at the first sensor 26. This ensures the pressure inside the scroll mechanism is less than or equal to the pressure at the inlet port 18 before opening the inlet valve 10. In this way, fluid flow back through the inlet port 18 towards any connected processing chamber or TMP can be mitigated.

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When the scroll pump 1 is turned off, the control circuitry 30 controls the actuator to move the sealing mechanism 13 to the closed position to inhibit fluid movement between the TMP or process chamber and the scroll mechanism. In this way, backflow from the scroll mechanism to the TMP or process chamber at
30 lower pressure is inhibited.

Figure 4 shows a flow diagram illustrating steps in a method of operating the inlet valve in the scroll pump according to one embodiment. Initially at step S10 a control signal is received to start the pump. Then at S20 the motor of the pump is powered up. At step D5 it is determined if the inlet valve opening condition has
5 been met or not. The opening condition may be a predetermined time having elapsed, or a normal operating condition signal having been received. The normal operating condition signal may be generated in response to the rotor reaching a predetermined speed within a predetermined time following start up. In response to determining that this operating condition has been met, step S30
10 is performed of opening the inlet valve. The predetermined time may be adjustable so that in some embodiments there may be an initial step when setting the pump up of setting the predetermined time to a value suitable for the particular planned operation of the pump.

15 In other embodiments there may be no inlet valve opening condition as such, the inlet valve may simply be opened in response to the control signal starting the pump. This has the advantage of simplicity but has the drawback that the pump will be at or close to atmospheric pressure when initially connected to the chamber being pumped which may be at a high vacuum.

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The scroll pump will then operate normally until a signal is received to stop the motor at S40, in response to this the inlet valve may be closed at step S50.

Control circuitry 30 of Figure 3 may be configured to generate control signals to
25 control operation of the inlet valve according to the steps of the method described in Figure 4.

Various modifications to the embodiments described herein will be apparent to those skilled in the art. For example, the rubber pad 11 may be any surface
30 suitable for sealing with the valve seat 11. Also, the biasing member 21 need not be a coil spring and could be any suitable biasing member configured to urge the armature 20 towards the valve seat 11 when in the closed position.

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In summary a valve body 16 is integrated into the pump stator 12 to save cost and space. The body 16 of the inlet valve is integrated within the scroll pump 1, thus eliminating the connection fittings and the extra space required for a
5 separate external inlet valve. The inlet valve 10 may be a magnetically actuated valve such as a solenoid valve. A solenoid valve is used due to its simple operation and low cost. The valve body 16 and valve seat 11 are machined into the scroll stator 12 or inlet cover 15.

10 In use, the valve 10 is opened when the pump 1 is running and closes when the pump 1 stops. The valve coil (sealing mechanism 13) may be connected to the motor power supply of the pump 1. A time delay circuit, called control circuitry above, may be included to delay the opening of the valve 10 by a few seconds to allow the pump 1 to accelerate to full speed and to pump out the inlet space of
15 the pump 1 before opening the valve 10.

Although illustrative embodiments of the invention have been disclosed in detail herein, with reference to the accompanying drawings, it is understood that the invention is not limited to the precise embodiment and that various changes and
20 modifications can be effected therein by one skilled in the art without departing from the scope of the invention as defined by the appended claims and their equivalents.

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REFERENCE SIGNS

	1	Scroll pump
	10	Inlet valve
	11	Valve seat
5	12	Stator
	13	Sealing mechanism
	14	Rotor
	15	Inlet cover
	16	Valve body
10	17	Space
	18	Inlet port
	20	Armature
	21	Biasing member
	22	Pad
15	23	Attachment means
	25	Pump housing
	26, 27	Pressure sensor
	30	Control circuitry
	32	Motor
20	34	Turbomolecular pump
	36	Scroll pump mechanism

CLAIMS

1. A scroll pump inlet valve comprising:
a valve seat formed by at least one of a stator and an inlet cover of a scroll
5 pump; and
a sealing mechanism, mounted to the stator or the inlet cover, comprising
an actuator configured to move the sealing mechanism between an open position
in which a scroll mechanism and an inlet port of the scroll pump are fluidly
connected and a closed position in which the sealing mechanism engages the
10 valve seat to seal the scroll mechanism from the inlet port.
2. An inlet valve according to claim 1, wherein the sealing mechanism is
configured to cooperate with at least one of the stator and inlet cover to define a
portion of an inlet passage of the scroll pump when the sealing mechanism is in
15 the open position, the inlet passage defining a flow channel between the inlet port
and the scroll mechanism.
3. An inlet valve according to claim 2, wherein the seat is formed by a perimeter
of a portion of the inlet passage.
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4. An inlet valve according to any preceding claim, wherein the actuator
comprises a solenoid coil.
5. An inlet valve according to any preceding claim, wherein the inlet valve
25 comprises a valve body and the valve seat, the valve body and valve seat being
formed by at least one of the inlet cover and stator.
6. A scroll pump comprising:
an inlet port;
30 a scroll mechanism formed by a stator and a rotor;
an inlet cover; and
an inlet valve according to any preceding claim.

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7. A scroll pump according to claim 6, further comprising control circuitry configured to control the actuator to move the sealing mechanism between the open position and the closed position.

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8. A scroll pump according to claim 7, wherein the control circuitry is configured to control the actuator to move the sealing mechanism to the closed position in response to the scroll pump turning off.

10 9. A scroll pump according to claim 7 or claim 8, wherein the control circuitry is configured to control the actuator to move the sealing mechanism to the open position in response to the pump turning on.

15 10. A scroll pump according to any one of claim 7 to 9, wherein the control circuitry is configured to control the actuator to move the sealing mechanism to the open position at a predetermined time after the pump turns on.

20 11. A scroll pump according to any one of claim 7 to 9, wherein the control circuitry is configured to control the actuator to move the sealing mechanism to the open position in response to receipt of a signal indicating that the pump is operating normally.

25 12. A scroll pump according to claim 11, wherein said signal comprises an indication that said pump has reached a predetermined rotational speed.

13. A scroll pump according to claim 7 or claim 8, said scroll pump further comprising:

30 a first pressure sensor mounted in the inlet port and a second pressure sensor mounted between the inlet valve and the scroll mechanism, wherein said control circuitry is configured to control the actuator to move the sealing mechanism to the open position when the pressure measured by the second pressure sensor is equal to or below the pressure measured at the first sensor.

14. A scroll pump according to any one of claims 7 to 13, wherein said control circuitry is configured to control a motor configured to drive said scroll mechanism.

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15. A scroll pump according to any one of claims 6 to 14, wherein said scroll pump is a vacuum pump.

16. A vacuum pump system comprising a scroll pump according to any of
10 claims 6 to 15 and a turbomolecular pump, said scroll pump being arranged as a backing pump for said turbomolecular pump.

17. A method of controlling an inlet valve of a scroll vacuum pump comprising the steps of:

15 powering up a motor driving the rotor of the scroll pump;
determining whether an inlet valve opening condition has been met, said inlet valve opening condition comprising one of the following: a predetermined time having elapsed or a control signal indicating said rotor has reached a predetermined speed has been received;
20 in response to said condition being met, opening said inlet valve of said scroll pump.

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