Title: COMPRESSED-GAS REGULATOR APPARATUS

Abstract: Compressed-gas regulator apparatus (10) for controlling a pressurised OFN supply, comprises a regulator housing (20) having a regulator gas inlet (24), a regulator gas outlet (16) and a flow path therebetween. The gas inlet (24) is releasably connectable to an outlet (26) of the OFN supply (28). An electrically-operable regulator valve (30) in the housing for controlling a flow of gas along the flow path is also provided, along with a pressure sensing device in the housing for sensing a backpressure at or from the gas outlet (16). A regulator user-interface (36) for inputting a backpressure value, a local regulator controller for automatically closing the valve when the user-selected backpressure is reached, a wireless regulator receiver in the housing (20) for remotely controlling the local regulator controller, and a remote regulator controller (18) having a remote user-interface (80) and a wireless transmitter for wirelessly transmitting a control signal to the wireless regulator receiver are also included. Preferably, a splitter device (14) is also included. The splitter device (14) comprises a splitter housing (48) having a splitter gas inlet (50) which is connectable to the regulator gas outlet (16), at least a suction gas outlet (52) for connection to a suction line of an air conditioning system and a liquid gas outlet (56) for connection to a liquid line of an air conditioning system, a local splitter controller having a splitter user-interface (60) on the splitter housing (48), at least one electrically-operable splitter valve controllable by the splitter controller for selectively connecting the splitter gas inlet (50) to the suction gas outlet (52) or the liquid gas outlet (56), and a wireless receiver in the housing for remotely controlling the splitter controller via the said remote controller (18). The splitter device (14) may also be provided independently of the regulator device. In this case, the wireless receiver and the remote controller (18) may be optional.
Compressed-Gas Regulator Apparatus

The present invention relates to regulator apparatus, particularly for but not limited to controlling a pressurised oxygen-free nitrogen (hereinafter, OFN) supply typically in a gas cylinder.

A mechanical regulator is presently used on a gas cylinder of OFN during purging and testing of an air-conditioning system or a refrigerant system. However, since it is mechanical, one person is constantly required to operate the regulator to ensure a suitable backpressure is reached and maintained, while another person performs the work on the system, such as brazing a line or testing for leaks. This is an inefficient use of manpower and increases costs.

Furthermore, once one line of the system has been brazed and/or tested, the connection to the regulator has to be manually transferred to the next line of the system. Again, this is time consuming.

The present invention seeks to provide a solution to these problems.

According to a first aspect of the present invention, there is provided compressed-gas regulator apparatus for controlling a pressurised OFN supply, the apparatus comprising a regulator housing having a regulator gas inlet, a regulator gas outlet and a flow path therebetween, the gas inlet being releasably connectable to an outlet of the OFN supply, an electrically-operable regulator valve for controlling a flow of gas along the flow path, a pressure sensing device in the housing for sensing a backpressure at or from the gas outlet, a regulator user-interface for inputting a backpressure value, a local regulator controller for automatically closing the valve when the user-selected backpressure is reached, a wireless regulator receiver for remotely controlling the local regulator controller, and a discrete remote controller having a remote user-interface and a wireless transmitter for wirelessly transmitting a control signal to the wireless regulator receiver.

Preferable and/or optional features of the first aspect of the invention are set forth in claims 2 to 16, inclusive.
According to a second aspect of the invention, there is provided a splitter device for directing a gas input to any one of a plurality of gas outputs, the splitter device comprising a splitter housing having a splitter gas inlet which is connectable to a regulator gas outlet, and at least a suction gas outlet for connection to a suction line of an air conditioning system and a liquid gas outlet for connection to a liquid line of an air conditioning system, an on-board splitter controller having a splitter user-interface on the splitter housing, and at least one electrically-operable splitter valve controllable by the splitter controller for selectively connecting the splitter gas inlet to the suction gas outlet or the liquid gas outlet.

Preferable and/or optional features of the second aspect of the invention are set forth in claims 18 to 22, inclusive.

The invention will now be more particularly described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a perspective view of one embodiment of regulator apparatus, in accordance with the present invention and showing a regulator device, a splitter device, and a remote controller;

Figure 2 is a side elevational view of the regulator device;

Figure 3 is a top plan view of the splitter device; and

Figure 4 is a top plan view of the remote controller.

Referring to the drawings, there is shown compressed-gas regulator apparatus 10 which comprises an electronic regulator device 12 for releasable attachment to an outlet of a pressurised OFN cylinder, an electronic splitter device 14 for connection to a gas outlet 16 of the regulator device 12, and a handholdable portable remote controller 18 for remotely controlling either or both the regulator device 12 and the splitter device 14.

The regulator device 12 includes a regulator housing 20 which is preferably part-spheroid so as to be devoid of sharp corners, an OFN cylinder connector 22 defining a gas inlet 24 provided at a base of the regulator housing 20 for releasably connecting the
regulator device 12 to an outlet 26 of the OFN cylinder 28, the gas outlet 16 being spaced from the gas inlet 24, a flow path which is defined between and includes the gas inlet 24 and the gas outlet 16, and an electrically-operable regulator valve 30 on the flow path for controlling gas flow along the flow path.

The gas outlet 16 may beneficially include a screw-threaded regulator connector 32 for releasably engaging a mating threaded-connector of a flexible gas line or conduit 34.

The regulator valve 30 is electrically connected to a local control circuit within the regulator housing 20. A regulator user-interface 36 is provided as a panel on a top surface of the regulator housing 20, substantially opposite the gas inlet 24, for inputting commands to the control circuit, and a wireless regulator receiver is provided as part of the control circuit for receiving remote control signals from the remote controller 18. The wireless receiver may utilise any suitable wireless technology or protocol, such as radio frequency, microwave frequency, infra red, and Bluetooth RTM. Preferably, the receiver has a minimum range of operation of 100 metres.

The regulator device 12 also includes a wireless regulator transmitter for wireless communication with the splitter device 14 and the remote controller 18. Complementary wireless technology or protocol is utilised, along with a similar range of operation.

The regulator user-interface 36 comprises a plurality of buttons 38 for starting a purge or testing procedure, along with inputting a required system backpressure. A display 40 is also included for displaying at least a user-set backpressure and/or an automatically set backpressure, along with a real-time backpressure, and preferably also a connection status with the remote controller 18.

A pressure sensing device is provided within the regulator housing 20 for monitoring the backpressure at the gas inlet 24, the gas outlet 16 and/or the flow path and for outputting the detected backpressure to the regulator control circuit.

Preferably, electrical power is supplied to the regulator device 12 by one or more batteries, typically being rechargeable, and/or via a mains-electricity powered adapter
42. To accommodate one or more batteries, a battery compartment which is accessible via a removable exterior cover is provided in the regulator housing 20.

A nitrogen release outlet 43 is also provided on the regulator housing 20 so as to be spaced from the gas outlet 16. The release outlet 42 is controlled by a, preferably dedicated and discrete, electrically operable release valve within the housing. The release valve is operable by a release button 44 recessed into a side of the regulator housing 20. Preferably, the release button 44 must be operated in conjunction with a button, such as a start button 46, on the regulator user-interface 36 to ensure against accidental or unintentional activation. The release valve is provided on a separate flow path which interconnects the release outlet 42 with the gas outlet 16, thus allowing the back flow of gas from the gas outlet 16 to the release outlet 42 when the release valve is open and the regulator valve 30 is closed.

The splitter device 14 includes a splitter housing 48 having or defining therein a four way controllable manifold, a splitter gas inlet 50 connectable to the regulator gas outlet 16 via the disengagable flexible conduit 34, four splitter gas outlets 52, 54, 56, 58, and four separate splitter flow paths in the housing 48 between the splitter gas inlet 50 and the four splitter gas outlets 52, 54, 56, 58, respectively.

An electrically-operable splitter valve is provided in the splitter housing 48 for controlling a flow of gas on each splitter flow path, and a splitter control circuit is provided in the splitter housing 48 for controlling the splitter valve based on a user input. A wireless splitter receiver is also provided in the splitter housing 48 and connected to the splitter control circuit, a splitter user-interface 60 is included on one side of the splitter housing 48 and comprises four buttons 62, 64, 66, 68 each relating to one of the flow paths. To show a selection of one of the flow paths, a visual indicator 70, such as a light emitting element, for example, an LED, is preferably provided on or adjacent to each button 62, 64, 66, 68. It is feasible that an audible indicator could, additionally or alternatively, be provided.

Each splitter gas outlet 52, 54, 56, 58 is designated for connection to a line or pipe of an air-conditioning system or a refrigeration system. To this end, a first one 52 of the
splitter gas outlets is designated as 'suction', a second one 54 of the splitter gas outlets is designated as 'discharge', a third one 56 of the splitter gas outlets is designated as 'liquid', and a fourth one 58 of the splitter gas outlets is designated as 'other' for connection to any other line or pipe as requirement dictates.

Screw-threaded connectors 72 are provided at each splitter gas outlet 16 for connecting respective flexible conduits 74. Preferably, a free distal end of each conduit 74 includes an expandable connector, such as a rubber grommet or sleeve, to allow simple gas-tight connection of different diameter pipes or lines. Typically, pipes or lines in air-conditioning systems and refrigerant systems vary in bore diameter from 41.4 mm to 6 mm or 7 mm, and the expandable connector 76 should accommodate an outside diameter of around 5 mm to 50 mm.

As with the regulator housing 20, the splitter housing 48 is preferably moulded plastics, part-spheroid, and devoid of sharp corners to prevent or limit injury. The splitter device 14 may also be battery operable and/or mains operable, similar to the regulator device 12.

The remote controller 18 includes a control housing 78, a remote user-interface 80 on the housing 78, and a display 82 for displaying a backpressure, being one or more of a real-time backpressure on the regulator flow path, a user-selected backpressure at the regulator device 12 and an automatic backpressure set by the control circuit. The display 82 may also display a signal strength for connection with the regulator device 12 and/or the splitter device 14, and also a selected splitter flow path.

The user-interface 80 preferably provides a plurality of buttons 84 for selecting between purge and pressure testing, the splitter flow paths, operation of the regulator valve 30, operation of the release valve, and for inputting a numerical backpressure value.

To provide for wireless communication with the regulator receiver and the splitter receiver, the remote controller 18 includes a wireless remote transmitter and a remote receiver.
Furthermore, the remote controller 18 preferably includes a user connector 86 for releasably connecting the remote controller 18 to a user, such as a user's belt. The user connector may conveniently be a key ring or carabineer.

An alarm element is also preferably provided as part of the regulator device 12 and/or the remote controller 18. In this case, the alarm element is connected to the respective control circuit so that, once a set backpressure is reached, an alarm of the alarm element sounds. The alarm of the alarm element is preferably audible. However, additionally or alternatively, a visual alert can be utilised.

The above described regulator apparatus 10 is particularly useful during the installation of two-pipe air-conditioning systems and three-pipe air-conditioning systems. However, the regulator apparatus 10 can be used with any air-conditioning system and refrigeration system. The regulator device 12 and remote controller 18 alone can be used with any compressed gas supply.

During installation, the suction, discharge and/or liquid pipes or lines of the air-conditioning system or refrigeration system are installed and connections therebetween are formed typically by brazing. To prevent undesirable oxidation within the pipe or line bore, the regulator device 12 is connected to an outlet 26 of the OFN cylinder 28 via the cylinder connector 22. The splitter device 14 is connected to the regulator gas outlet 16, and one or all of the splitter gas outlets 52, 54, 56, 58 are connected to the respective suction, discharge and/or liquid pipes or lines of the system being installed.

The regulator user-interface 36 or remote user-interface 80 is used to select 'purge', and the regulator control circuit opens the regulator valve 30 whilst setting an automatically regulated backpressure to 15 psi or another suitable relatively low predetermined pressure suitable for preventing oxidation during installation of the system.

The splitter control circuit is, preferably simultaneously and automatically, controlled either via the regulator device 12 or via the remote controller 18 to open the corresponding suction, discharge or liquid flow path. Consequently, nitrogen is supplied at a predetermined low pressure from the cylinder, through the regulator device 12 and splitter device 14, to the refrigerant line being brazed or welded.
Once brazing is complete, the remote controller 18 or the regulator user-interface 36 is utilised to close the regulator valve 30 and thus shut the outlet of the cylinder. The next section of line can then be installed in a similar manner. Each line of the system can be installed without requiring repeated removal and reengagement of a flexible supply pipe from the splitter device 14, thus saving significant time.

Following installation, the system must be pressure tested to check for leaks especially at the brazed joints. The regulator device 12 can be connected directly to the refrigerant system using a flexible conduit from the regulator gas outlet 16, or indirectly via the splitter device 14. The regulator user-interface 36 or the remote user-interface 80 is then used to select 'test' and the user is prompted to input a required backpressure value, which is a typically much higher value of around 100 psi or greater. The regulator valve 30 is then operated to allow the discharge of nitrogen into the refrigerant system. Once the set backpressure is reached as determined by the pressure sensing device, the alarm of the alarm element is activated to alert the installer, and the regulator control circuit closes or regulates the regulator valve 30 for a predetermined period, such as 10 minutes, to maintain the user-selected backpressure whilst the system equalises. Following this period, the alarm preferably sounds again, and the regulator valve 30 is fully closed. The pressure in the system is monitored by the installer, and if a drop is noticed, it is determined that a leak is present and checking is undertaken.

For pressure testing, the connection of the regulator device 12 to the system typically occurs at or in the vicinity of the condensing unit, which is often outside. Consequently, control of the regulator device 12 via the remote controller 18 is extremely beneficial, thereby allowing the installer to be remote from the regulator device 12, such as indoors.

If, at any time, nitrogen needs to be released from the system, the release button 44 or a similar release button 88 on the remote controller 18 along with and the user-interface 36, 80, either on the remote controller 18 or the regulator device 12, are utilised to open the release valve on the regulator device 12.
The regulator device can be utilised with or without the splitter device. However, the remote controller is essential to enable remote single-person operation of at least the regulator device.

Similarly, the splitter device can be utilised with or without the regulator device. In this case, the splitter device may be solely manually operable via its on-board user-interface, or may include a remote controller to enable remote operation. The splitter device could be purchased and used in conjunction with a traditional analogue mechanical non-electronic regulator. Although not nearly as beneficial as being used with the regulator device of the invention described above, it is a possibility.

Although of particular use with a pressurised OFN supply, the regulator device can be conveniently utilised with any compressed gas supply or cylinder.

It is thus possible to provide compressed-gas regulator apparatus for controlling a pressurised oxygen-free nitrogen supply. By providing a remote controller, the apparatus can be operated and controlled by a single installer working remotely from the OFN supply or cylinder. Furthermore, by utilising a splitter device, each line of the system can be independently supplied with nitrogen at the discretion of the installer without requiring disconnection and reconnection of the nitrogen supply. Automatic regulation of the gas supply to meet a predetermined and/or user-selected backpressure also dispenses with the need of a second installer. Providing a purge function for automatically setting a specific, preferably lower than normal system, backpressure is also highly beneficial.

The embodiments described above are provided by way of examples only, and various other modifications will be apparent to persons skilled in the art without departing from the scope of the invention as defined by the appended claims.
Claims

1. Compressed-gas regulator apparatus (10) for controlling a pressurised OFN supply, the apparatus (10) comprising a regulator housing (20) having a regulator gas inlet (24), a regulator gas outlet (16) and a flow path therebetween, the gas inlet (24) being releasably connectable to an outlet of the OFN supply, an electrically-operable regulator valve (30) for controlling a flow of gas along the flow path, a pressure sensing device in the housing (20) for sensing a backpressure at or from the gas outlet (16), a regulator user-interface (36) for inputting a backpressure value, a local regulator controller for automatically closing the valve when the user-selected backpressure is reached, a wireless regulator receiver for remotely controlling the local regulator controller, and a discrete remote controller (18) having a remote user-interface (80) and a wireless transmitter for wirelessly transmitting a control signal to the wireless regulator receiver.

2. Compressed-gas regulator apparatus as claimed in claim 1, further comprising a purging controller in the housing (20) for automatically setting a purging backpressure and for automatically controlling the valve when the purging backpressure is reached.

3. Compressed-gas regulator apparatus as claimed in claim 1 or claim 2, further comprising an OFN release valve in or on the regulator housing (20) for releasing OFN to atmosphere.

4. Compressed-gas regulator apparatus as claimed in claim 3, further comprising a safety release element (46) for activating the OFN release valve in conjunction with a user input via the regulator user-interface (36) or the remote user-interface (80).

5. Compressed-gas regulator apparatus as claimed in claim 3 or claim 4, wherein the safety release element (46) is recessed into an exterior surface of the regulator housing (20).

6. Compressed-gas regulator apparatus as claimed in any one of the preceding claims, further comprising an electronic display (40) for displaying at least the user-settable backpressure.
7. Compressed-gas regulator apparatus as claimed in any one of the preceding claims, wherein the regulator housing (20) is devoid of sharp corners.

8. Compressed-gas regulator apparatus as claimed in any one of the preceding claims, wherein the regulator housing (20) is part-spheroid.

9. Compressed-gas regulator apparatus as claimed in any one of the preceding claims, wherein the remote controller (18) includes a second electronic display (40) for displaying at least the user-settable backpressure.

10. Compressed-gas regulator apparatus as claimed in any one of the preceding claims, wherein the remote controller (18) includes a connector for releasable connection to a user.

11. Compressed-gas regulator apparatus as claimed in any one of the preceding claims, further comprising an alarm element in the regulator housing (20) and/or in the remote controller (18) for alerting a user that the or each backpressure has been reached.

12. Compressed-gas regulator apparatus as claimed in any one of the preceding claims, further comprising a splitter device (14) including a splitter housing (48) having a splitter gas inlet (50) which is connectable to the regulator gas outlet (16), and at least a suction gas outlet (52) for connection to a suction line of an air conditioning system and a liquid gas outlet (56) for connection to a liquid line of an air conditioning system, a local splitter controller having a splitter user-interface (60) on the splitter housing (48), at least one electrically-operable splitter valve controllable by the splitter controller for selectively connecting the splitter gas inlet (50) to the suction gas outlet (52) or the liquid gas outlet (56), and a wireless receiver in the housing (48) for remotely controlling the splitter controller via the said remote controller (18).

13. Compressed-gas regulator apparatus as claimed in claim 12, further comprising a discharge gas outlet (54) for connection to a discharge line of an air conditioning system.
14. Compressed-gas regulator apparatus as claimed in claim 12 or claim 13, further comprising a supplementary gas outlet for connection to another line of an air conditioning system.

15. Compressed-gas regulator apparatus as claimed in any one of claims 12 to 14, further comprising an expandable connector for gas-tightly connecting at least the suction gas outlet (52) and the liquid gas outlet (56) to different diameters of pipe.

16. Compressed-gas regulator apparatus (10) as claimed in any one of claims 12 to 15, wherein the splitter housing (48) is part-spheroid.

17. A splitter device (14) for directing a gas input to any one of a plurality of gas outputs, the splitter device comprising a splitter housing (48) having a splitter gas inlet (50) which is connectable to a regulator gas outlet (16), and at least a suction gas outlet (52) for connection to a suction line of an air conditioning system and a liquid gas outlet (56) for connection to a liquid line of an air conditioning system, an on-board splitter controller having a splitter user-interface (60) on the splitter housing, and at least one electrically-operable splitter valve controllable by the splitter controller for selectively connecting the splitter gas inlet (50) to the suction gas outlet (52) or the liquid gas outlet (56).

18. A splitter device as claimed in claim 18, further comprising a wireless receiver in the splitter housing (48) and a remote controller (18) for remotely controlling the splitter controller via the wireless receiver.

19. A splitter device as claimed in claim 18 or claim 19, wherein the splitter housing (48) further comprises a discharge gas outlet (54) for connection to a discharge line of an air conditioning system.

20. A splitter device as claimed in any one of claims 18 to 20, wherein the splitter housing (48) further comprises a supplementary gas outlet for connection to another gas line.
21. A splitter device as claimed in any one of claims 18 to 21, further comprising an expandable connector for directly or indirectly gas-tightly connecting at least the suction gas outlet and the liquid gas outlet to different diameters of pipe.

22. A splitter device as claimed in any one of claims 18 to 22, wherein the splitter housing (48) is part-spheroid.