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(54) Pumping device

(57) The invention relates to a pumping device comprising a first low pressure plunjer with a first plunjer surface area and which is up and down moveable in a first cylinder, and a functionally coupled second, high pressure plunjer with a second, smaller plunjer area and which is moveable in a second cylinder, which first plunger in operation drives the second cylinder causing in operation an amplification of the compressor force for pumping a fluid, wherein further a breathing segment is provided between both plungers, in which the space of the breathing segment is in fluid connection coupled with an inlet of the fluid which needs to be pumped, like a gas, and is provided with a regulator for in operation maintaining a small overpressure on the breathing segment.

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Description

Background of the invention

[0001] The invention relates to a pumping device. Especially for pumping fluids which have been purified usually membrane pumps are applied. The advantages of a membrane pump are that there is a gas tight sealing or separation from the surrounding; because of that no contamination with foreign (gas) molecules will occur. The pumping systems are expensive and complex.

[0002] Alternatively, in some applications positive displacement pumps are applied. Known in the art are amongst others the DLE series pumps from Maximator, or pumps from Haskel. However, due to the reciprocating movements of the plunger in these plunger pumps or booster pumps, alternatively underpressure and overpressure will occur. There is a possibility that this underpressure will draw in unwanted molecules through the plunger sealings and past the cylinder sealings. It is even very well possible to draw in air, which in combination with highly ignitable media may potentially leads to explosion risk.

[0003] In order to reduce this risk to a minimum, manufacturers of pumps prescribe to only use a selection of pumpable media for their pumps, and to operate these pumps at a high pressure bandwidth.

[0004] In actual practice, it was found that (unwanted) too low prepressure can easily occur. Pumping pure media and small molecules are therefore not recommanded. Unfortunately, due to these facts the choice will fall on the more expensive membrane booster pump for many applications.

[0005] A liquid and/or gas booster pump which works according to the plunger principle generates heat at the compression cycle. When pumping larger molecules, so much heat may here be generated that overheating can lead to unwanted situations. A lubrication film which may be present in order to protect sealing rings may bum, resulting in the break-down of amongst others the plunger sealing, cylinder sealing, damage to the plunger and the cylinder wall, check valves and the like. Furthermore, the combustion products will gas out in the medium which is to be pumped and leads to contamination. With heavy loads on the booster pump, this risk will increase even further.

[0006] In order to remedy this problem, those booster pumps are equipped with cooling ribs or cycle air of the booster will be led into a double wall around the high pressure cylinder wall to allow it to cool down. Under standard circumstances this can be sufficient and it is defined that the operational temperatures of those systems remain within a band width of 30 to 90 degrees Celsius. There are however many situations in which an active control of the compression chamber temperature and also of the medium to be pumped is important. For instance medium which become instable at higher temperature, which can reach an ignition temperature or which can come outside set boundaries.

[0007] There is therefore room for improvements of the well-known pumps.

Summary of the invention

[0008] The invention seeks to provide improved pumping devices.

[0009] The invention seeks or additionally aims to provide a pumping device which is suitable for pumping purified fluids like gases.

[0010] The invention therefore provides a pumping device according to claim 1. The invention further provides a pumping device according to claim 5.

[0011] We have implemented a number of modifications to the pumping device, in this document also indicated as plunger booster pump, which modification will prevent contamination from the medium which is to be pumped.

[0012] The basic principle of the plunger booster pump is a composition of two rod coupled plungers, in which a large compressed air driven plunger drives the coupled smaller cylinder. The amplification of the compression force will be used to pump medium at the other side of the booster.

[0013] As the plungers go back and forth there is a breathing segment provided between both systems; this chamber in an embodiment is pressure controlled coupled to the fluid which need to be pumped.

[0014] In summary

[0015] The above explained cooling provides temperature control having the effect of:

- preservation and lifespan of the pump
- broader application for larger molecules which cause increased friction
- keeping sensitive media within process temperature
- preventing unwanted gassing products (combustion products) from entering the media stream
- preventing softening of sealing rings

[0016] The above explained gas ballast provides control of leaking in, having the effect of

- retaining the purity of the medium which is to be pumped
- broader application with larger molecules (which can easier leak past sealing)
- preventing potentially dangerous gas mixtures to occur
- indicating that sealings of the media pumping system deteriorates in functionality

[0017] And because of this unwanted disasters can be prevented.

[0018] A commercially broadened application of plunger booster pump devices in the direction of membrane pumps can be realized.

[0019] The basic principle of the pumping device, here also called plunger booster pump, comprises as explained an assembly of two rod coupled plungers, in which a larger, compressed air driven ("low pressure") plunger drives a smaller, coupled ("high pressure") plunger.

[0020] The amplified compression force is used to pump a fluid of the pumping device.

[0021] As the plungers go back and forth, a breathing segment is peovided between both systems, we can fill this breathing segment or chamber with a part of the medium to be pumped, like a gas, and keep (and maintain) it at a small overpressure (by means of a regulator). Due to this, pressure fluctuations which may occur can be facilitated using a relatively small expansion vessel.

[0022] On balance - when plunger sealing fails - sucking in of for instance air through the high pressure plunger will effectively be ruled out.

[0023] A second leaking in could be possible because of failure of sealings at the compression side of the high pressure cylinder tube, and due to this false air can be sucked in.

[0024] This can be solved by a (all or not existing) second tube which will normally be surrounded with compressed air, and blind this at one side and connect this chamber which occurs to the above referenced low pressure fluid buffer barrel and via an active pressure control, an effective guarding of the functionality of the pumping seals can be obtained.

[0025] A controller can be included which monitors if the set pressure values in the breathing segments of the double cylinder wall of the high pressure cylinder does not become too high or too low. This can indicate starting sealing problems and can be reported before unwanted situations occur.

[0026] This modification will therefore not only provide a preservation of the purity of the medium to be pumped, it also prevents potentially dangerous mixtures (which will furthermore be compressed), it allows to monitor and report the mechanical status of the plunger booster pump.

[0027] An active temperature control will allow a broader application of these pumping systems. In order to realize this we provided a cooling spiral around the high pressure cylinder. This cooling spiral will be able to actively cool the compression chamber and the plunger.

[0028] The end part of the high pressure cylinder comprises a plate with several additional channels which are provided by us and because of which (with the help of some special coupling pieces, we can lead a second cooling conduit through; also the high pressure exit traject can be cooled because of this.

[0029] The first mentioned inner spiral cooling is to be applied tightly around the inner tube, in order to improve transmission of heat.

[0030] In the above-mentioned booster end plate, a temperature sensor (and possible redundant second sensor) are inserted. This will control a cooling valve in order to maintain the desired operating temperature through a programmable temperature controller.

[0031] For the completion of the cooling system there is a (locally provided) cooling machine; In an embodiment it thus provides a stand alone cooling application or cooling device and does not need to be connected to an external cooling.

[0032] The invention further relates to a temperature control device for a pumping device as described above. In particular this device provides a reconstruction kit for an existing pump of the described type. This kit comprises a cooling spiral, a casing for the high pressure cylinder, a temperature sensor and a control or monitoring unit as described above. Via the casing it is easy to notice leakage in the pump.

[0033] The invention further relates to a gas purifying device, especially for noble gasses like neon, krypton, xenon and the like, comprising a pumping device as described in the description. In particular it relates to a device as described in earlier patent application PCT/NL2008/050332 of the current applicant. This patent application is referred to as if fully set forth in this description. It may be clear that there are several aspects mentioned in this patent application which can be combined and/or separately qualified for a divisional patent application.

Brief description of the drawings

[0034] In the drawings an embodiment of the pumping device according to the invention in which is shown in:

Figure 1 a systematic overview of the pumping device according to the invention;
Figure 2 a side view of the pumping device according to the invention;
Figure 3 a further side view of the pumping device of figure 2;
Figure 4 an exploded view of the pump of figure 2;
Figure 5 a further exploded view of figure 4 in more detail;
Figure 6 a detail of the end plate of figure 4;
Figure 7 an exploded side view of figure 4;
Figure 8 a top view of figure 6;
Figure 9 a series of pumps taken apart;
Figure 10 a further detail of figure 8;
Figure 11 a side view with outer tube;
Figure 12 an inner view of the pumping device of figure 2;
Figure 13 a further inner view of figure 2;
Figure 14 a detail of the connection of the pumping device of figure 2.

Description of embodiments

[0035] Figure 1 shows a schedule of a pumping device with a the cooling provision. A first low pressure plunger pump is provided with a first plunjer in a first cylinder

which is here mechanically coupled to a second plunger with a smaller surface area and which is moveable in the second cylinder. The casing of the second cylinder is provided with a jacket or casing. This jacket or casing is provided with an inlet for the fluid which need to be pumped, usually a gas, under pressure.

[0036] An active temperature controll will allow a broader application of such a pumping system.

[0037] In order to provide this we have provided a cooling spiral as is shown in Figure 6 around the high pressure cylinder, see Figure 9. This cooling spiral will be able to actively cool the compression chamber and the plunjer.

[0038] The end part of the high pressure cylinder comprises a plate in which a number of additional channels, as is shown in Figures 5 and 10, are provide by us in order to provide a second cooling conduit, as is shown in Figure 8 and 7 (using special coupling parts, see Figure 14). Also, the high pressure outlet can be cooled through this.

[0039] The first mentioned inner cooling spiral is in the embodiment provided tightly around the inner tube or inner housing, see Figures 13 and 11, in order to optimize heat transmission.

[0040] In the previously mentioned booster end plate a temperature sensor (and possibly a redundant second sensor for securing purposes) have been provided, see Figure 3 and 9. This will, through a programmable temperature controller, control a cooling valve in order to maintain the operational temperature within desired limits.

[0041] To complete the cooling system a small (locally provided) cooling device is provided; this thus relates to a stand alone cooling device and needs no connection to an external cooling, see Figure 4.

[0042] We have been able to reduce and keep stable an uncontrolled temperature of more than 120 degrees Celsius to 20 degrees Celsius using a 6 degrees cooling medium.

[0043] The mentioned gas ballast can facilitate gas qualities up to 6.0 (99,9999%) purity.

[0044] In order to improve the sealing between the booster end plate (Figure 11) and the rim of the outer tube of the gas ballast a ceiling is provided, not shown in the Figures. In an embodiment the end plate can functionally be provided with a circumferential groove provided with a ceiling ring, for instance made of PTFE. The rim of the outer tube can be provided with a groove which connects to the sealing ring. Alternatively, one of the parts plate or outer tube can be provided with a sharp rim or edge which, when the parts are screwed tight or drawn tight, cut into one another and does provide sealing.

[0045] It may be clear that the description above is included to illustrate functioning of the preferred embodiments of the invention, and not to limit the scope of protection. Starting with the above explanation many variations will be evident to a person skilled in the art, which variations will be covered by the scope of the current invention.

Claims

1. Pumping device comprising a first low pressure plunjer with a first plunjer surface area and which is up and down moveable in a first cylinder, and a functionally coupled second, high pressure plunjer with a second, smaller plunjer area and which is moveable in a second cylinder, which first plunger in operation drives the second plunger causing in operation an amplification of the compression force for pumping a fluid, wherein further a breathing segment is provided between both plunjers, in which the space of the breathing segment is in fluid connection coupled with an inlet of the fluid which needs to be pumped, like a gas, and is provided with a regulator for in operation maintaining a small overpressure on the breathing segment.

2. Pumping device according to claim 1, wherein the breathing segment for in operation absorbing pressure fluctuations is in fluid connection with an expansion vessel.

3. Pumping device according to claim 1 or 2, in which the second cylinder is provided with a second, casing tube which is one end blinded, thus providing a chamber which is in fluid connection with the buffer vessel.

4. Pumping device according to claims 1-3, further comprising a controller for monitoring if a set pressure value in the breathing segment and/or the cased space remains within boundary values.

5. Pumping device comprising a first low pressure plunjer having a first plunjer surface and which is up and down moveable in a first cylinder, and a functionally coupled second, high pressure plunjer having a second, smaller plunjer surface area and which is moveable in a second cylinder, which first plunjer in operation drives the second plunjer causing in operation an amplification of the compression force for pumping a fluid, further comprising an active temperature control device.

6. Pumping device according to the previous claim, wherein the active temperature control device comprises a cooling spiral applied around the second cylinder for in operation actively cooling the compression chamber in the second cylinder and of the second plunjer.

7. Pumping device according to claims 5 of 6, further comprising an end part on the high pressure cylinder, comprising a plate in which a number of channels through which a second cooling conduit is led and which is in fluid coupling with the cooling spiral.

8. Pumping device according to claims 5-7, wherein the cooling spiral is applied tightly around the inner tube in order to optimize heat transmission.

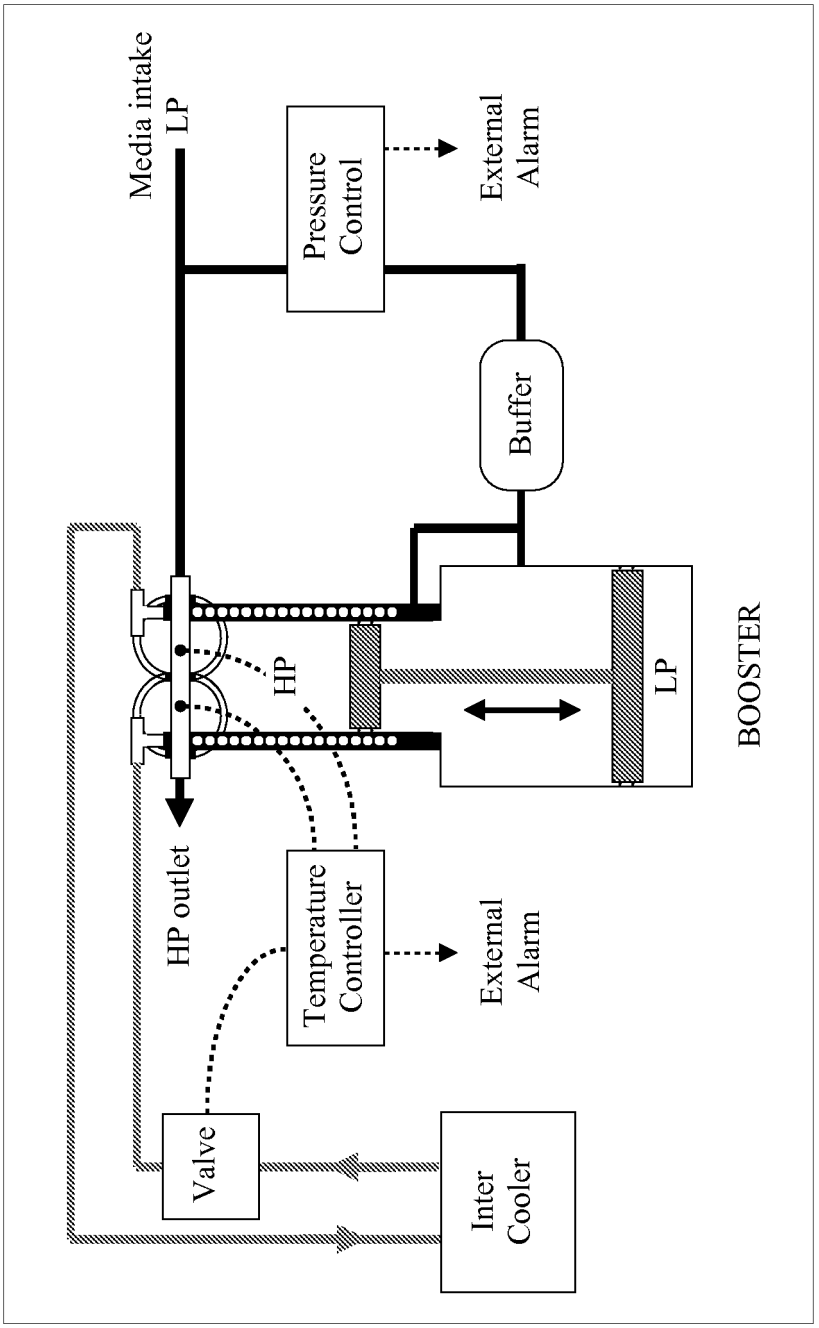
9. Pumping device according to claims 5-8, further comprising a temperature sensor positioned for recording a temperature which is an indication for the temperature of the second cylinder or the second plunjer, and which is operationally coupled to a temperature controller, and a cooling valve, operationally coupled to and controllable by the temperature control device for in operation maintaining a set temperature of the second cylinder.

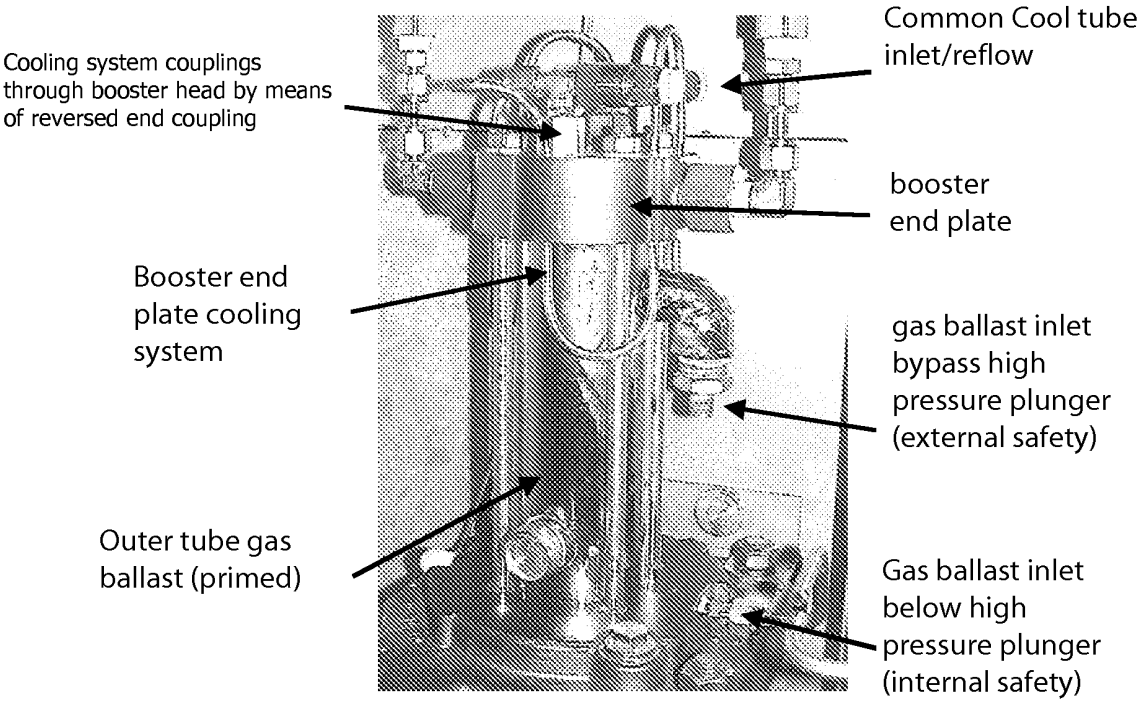
10. Pumping device according to claims 5-9, further comprising a cooling machine for cooling a fluid, which cooling machine is operationally coupled to the temperature control device and is in fluid connection with the cooling spiral, in order to in operation provide cooling fluid in the cooling spiral.

11. Temperature control device for a pumping device according to anyone of the preceding claims.

12. Gas purifying device, in particularly for noble gasses like neon, xenon or krypton, comprising a pumping device according to one of the preceding claims.

Fig 1

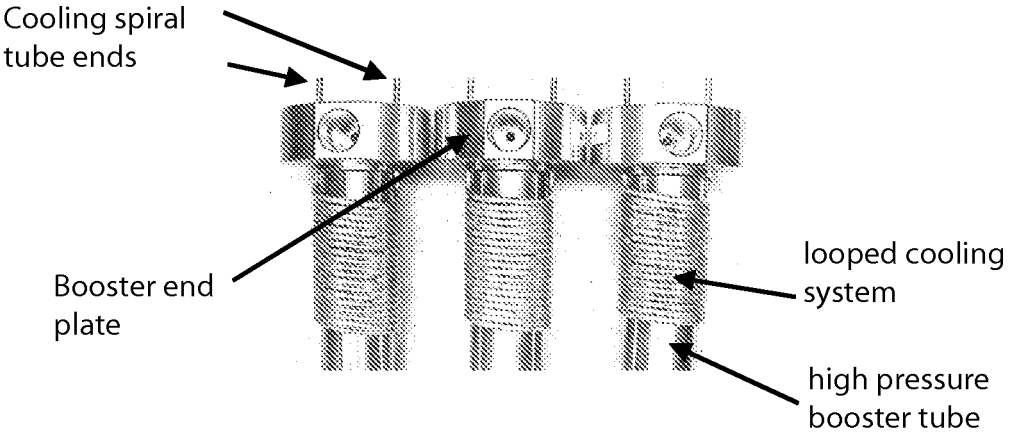

Media intake
LP
Pressure
Control
External
Alarm
Buffer
HP
LP
BOOSTER
HP outlet
Temperature
Controller
External
Alarm
Valve
Inter
Cooler



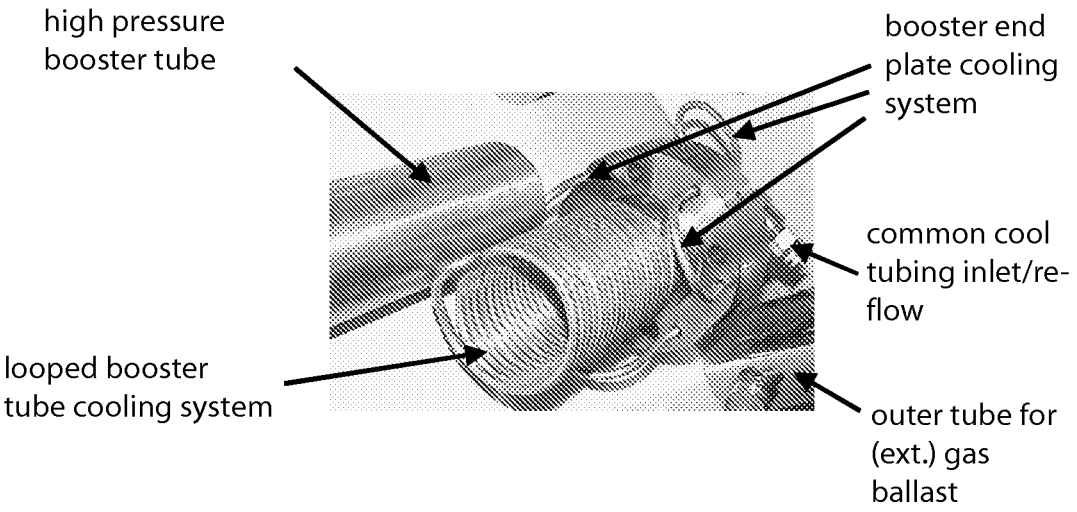
Overview assembly double gas balast and duo coolingsystem on booster pump

Fig 2

Fig 3

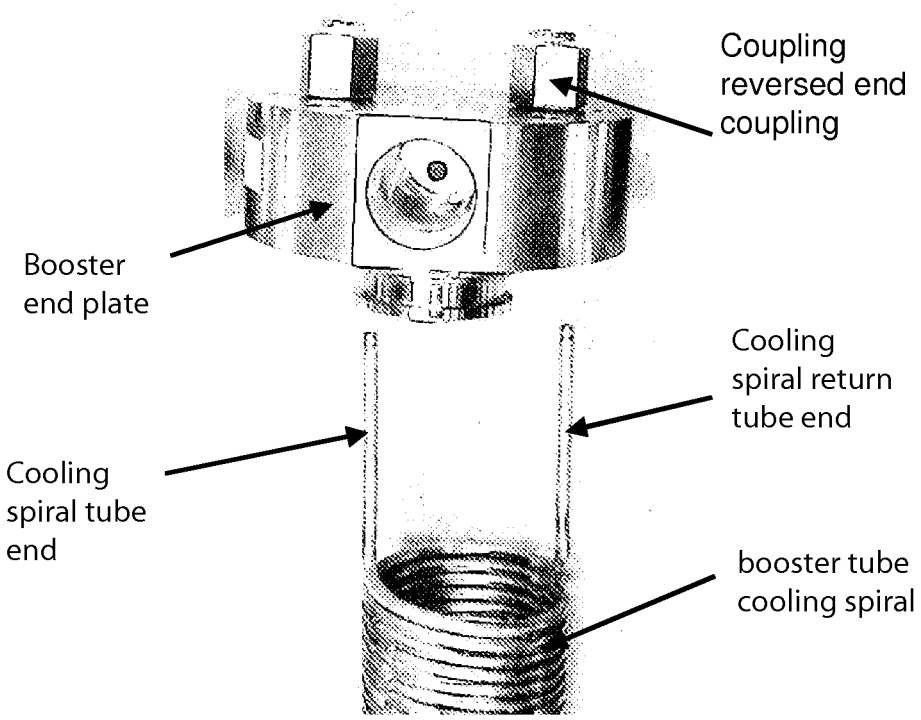


Cooling spiral booster tube systems



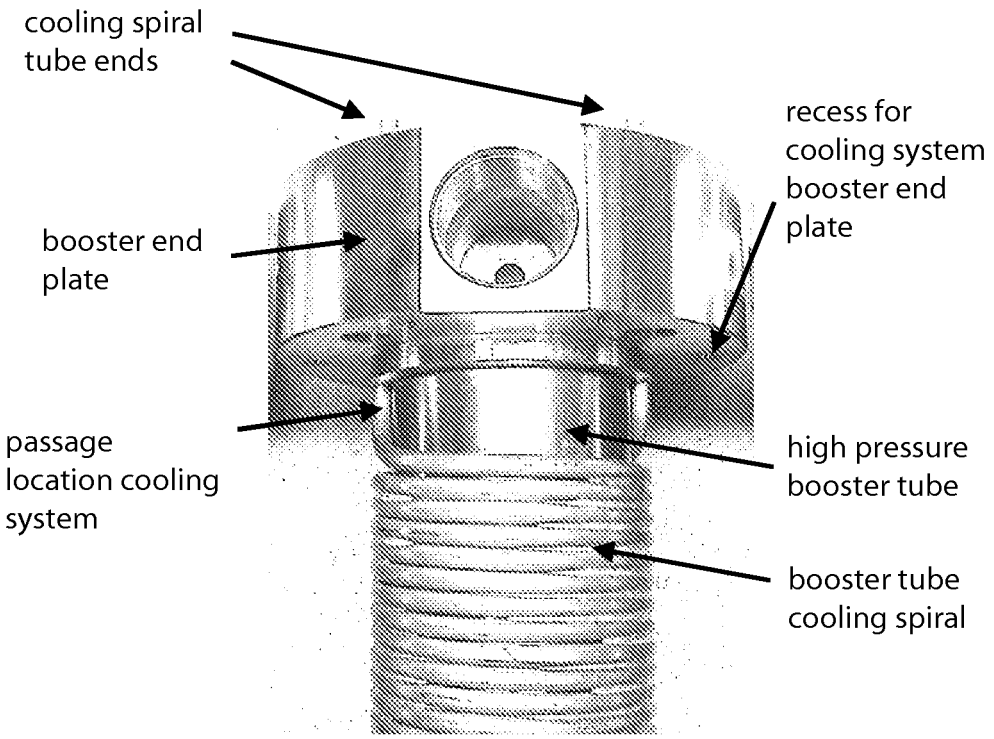
bottom view duo cooling system

Fig 4



Connection booster tube cooling system through and on the booster end plate

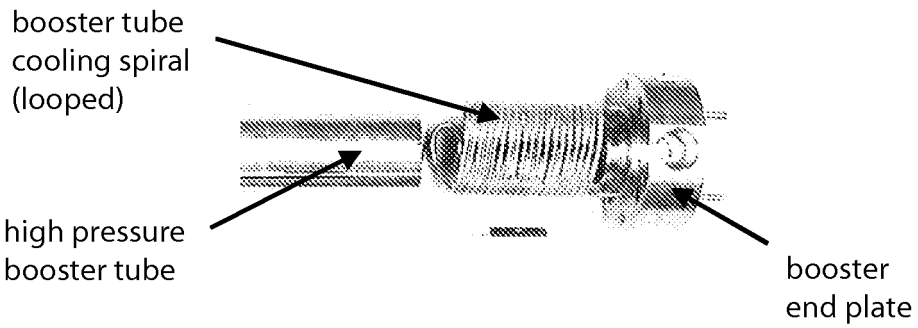
Fig 5



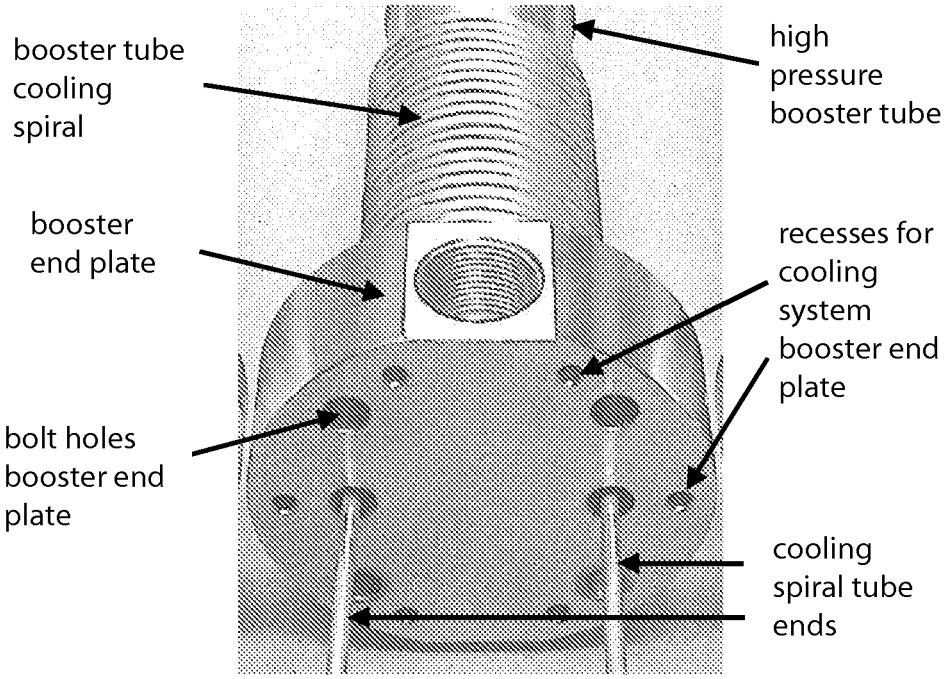
Cooling spiral booster tube system

Fig 6

Fig 7



booster tube cooling system side



booster tube cooling system tube end view

Fig 8

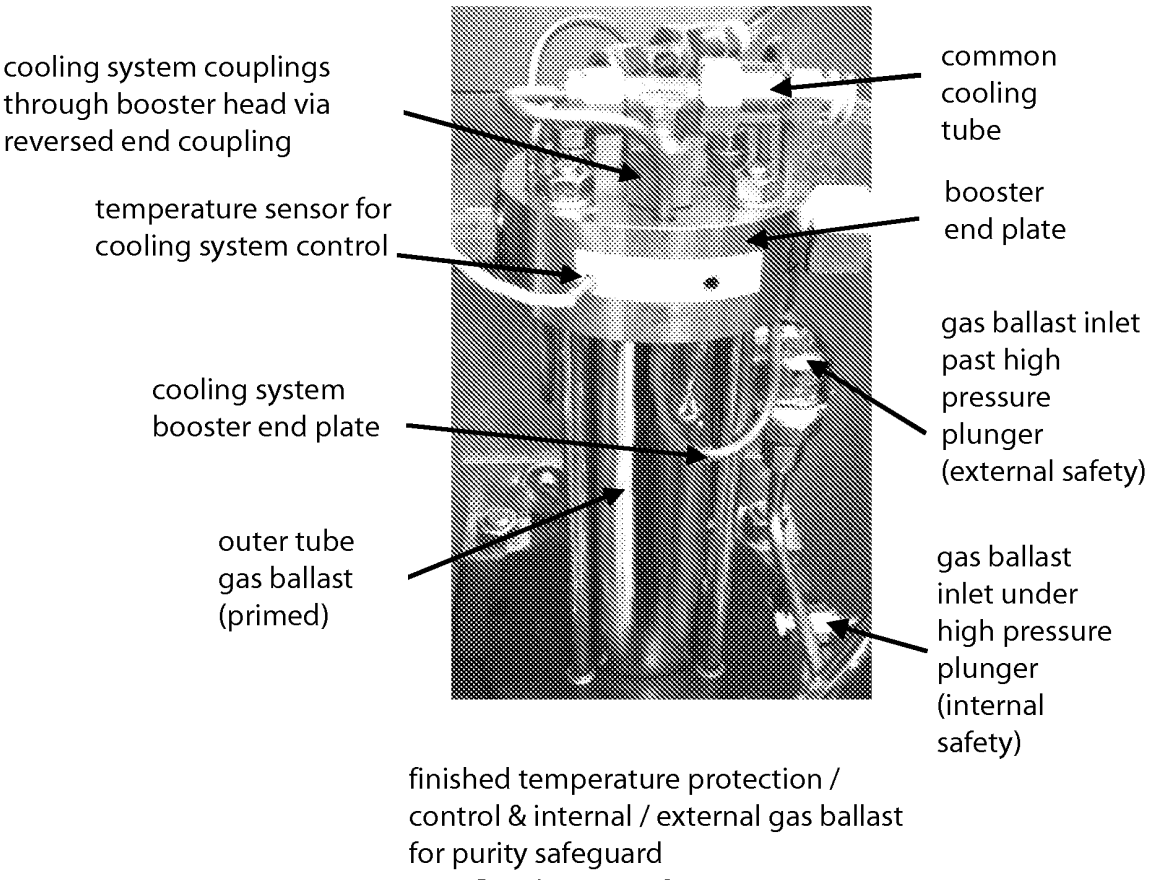
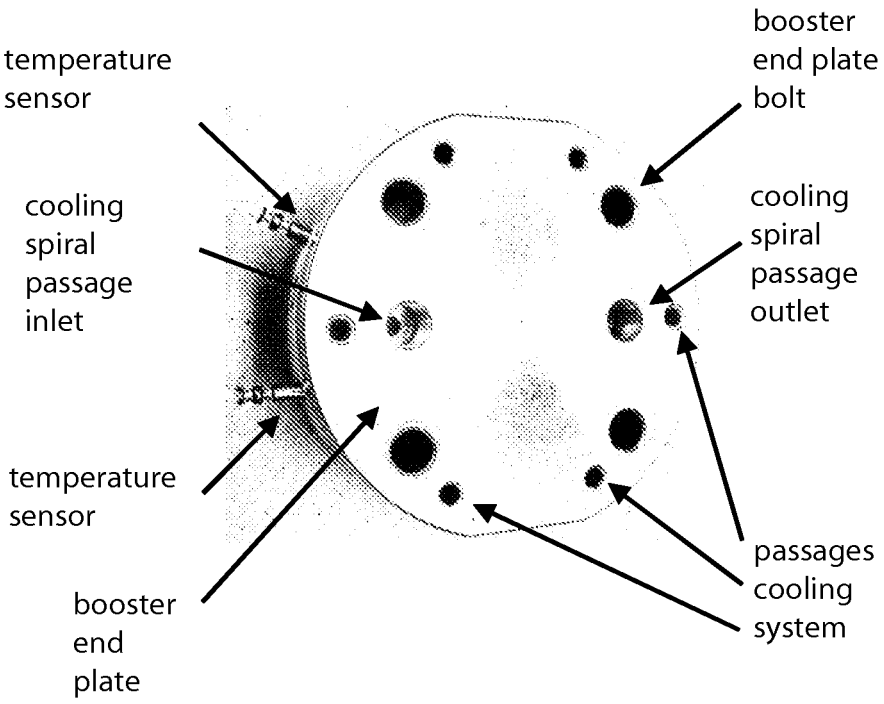

cooling system couplings through booster head via reversed end coupling
temperature sensor for cooling system control
cooling system booster end plate
outer tube gas ballast (primed)
common cooling tube
booster end plate
gas ballast inlet past high pressure plunger (external safety)
gas ballast inlet under high pressure plunger (internal safety)
finished temperature protection / control & internal / external gas ballast for purity safeguard

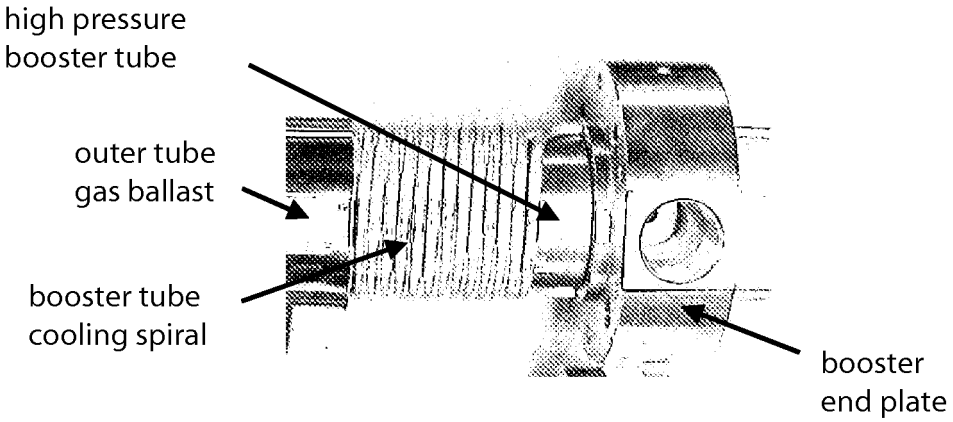
Fig 9



top view booster end plate recesses

Fig 10

Fig 11



detail booster tube cooling system side view (incl. external gas ballast tube)

Fig 12

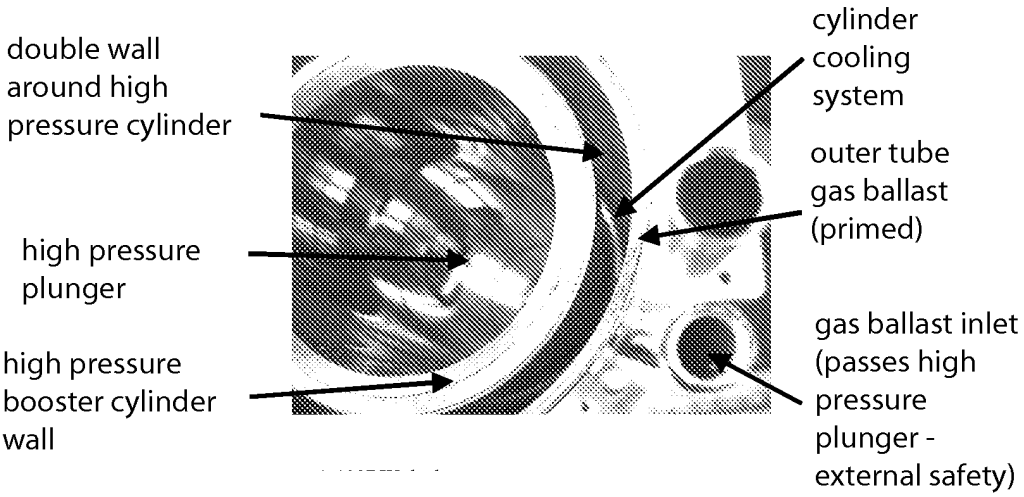
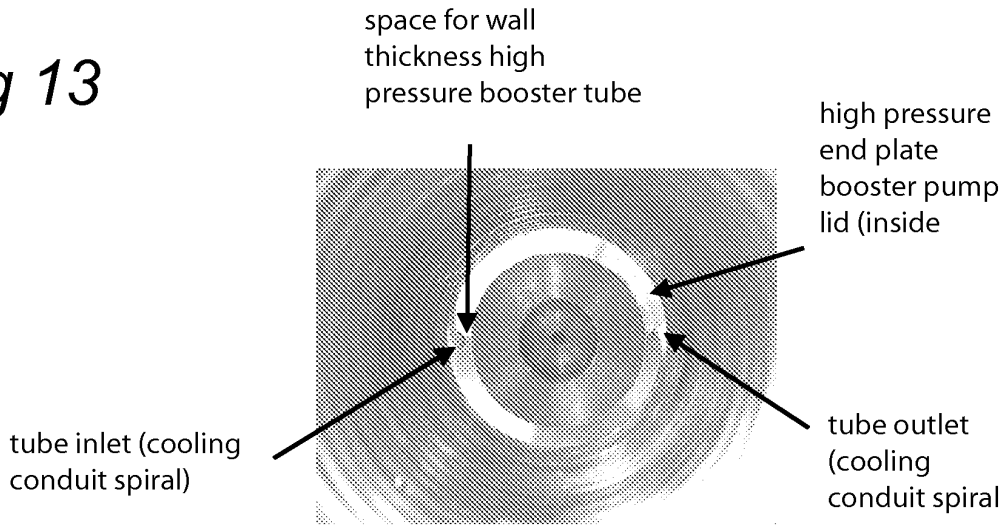
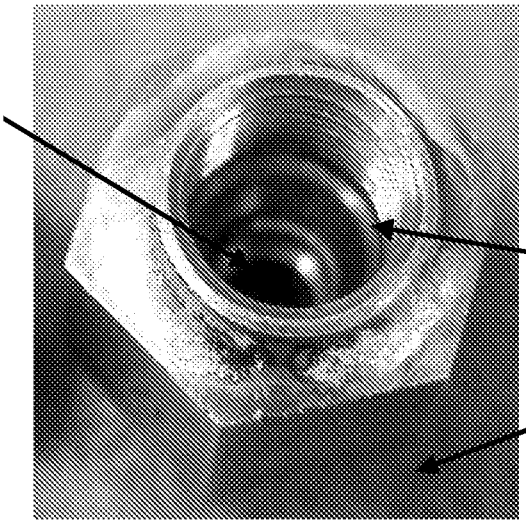

double wall around high pressure cylinder
high pressure plunger
high pressure booster cylinder wall
cylinder cooling system
outer tube gas ballast (primed)
gas ballast inlet (passes high pressure plunger - external safety)
external gas ballast / cooling space

Fig 13



bottom view double coiled cooling spiral inside (high pressure booster tube is removed, cooling system couplings through booster head)

Fig 14



special coupling cooling conduit system coupling through booster head via reversed end coupling (for tube inlet & outlet)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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