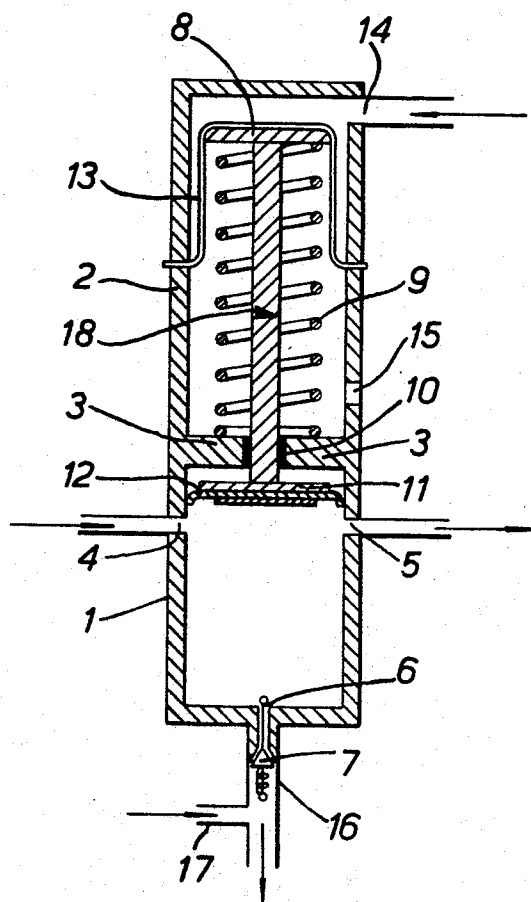


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W. H. TOPHAM
SAMPLE INJECTION VALVE
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SAMPLE INJECTION VALVE

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This invention relates to sample injection valves. It is more particularly, but not exclusively, concerned with a sample injection valve suitable for use with process chromatographs which require the injection of an accurately constant volume sample at repeated time intervals into the chromatographic column.

Injection valves at present used for the injection of gaseous or liquid samples into commercial chromatographs and other instruments are precisely engineered, and consequently costly, components. They may be manufactured from stainless steel and polytetrafluoroethylene, designed for maximum versatility, and capable of operation under extremes of temperature and pressure, possibly with corrosive sample materials.

It is an object of the present invention to provide a simple yet efficient sample injection valve which is robust in construction, is economical to manufacture, and is easy to maintain.

It is a further object of the present invention to provide a sample injection valve which is sufficiently precise in operation to permit it to be used for the injection of gaseous or liquid samples into the packed column of a chromatograph. The valve according to the present invention is of particular application to chromatographs of the type described in co-pending application Serial No. 471,938, filed July 14, 1965, in the name of the applicant.

The valve in accordance with the present invention is completely safe for operation in hazardous atmospheres, as required for many process analyzers.

A sample injection valve in accordance with the present invention comprises a chamber having an inlet port for the introduction of sample material into the chamber, an outlet port for the emergence of unwanted sample material from the chamber, and a port arranged to permit samples of the material to be expelled from the chamber when the inlet and outlet ports are shut off and pressure is applied to the material trapped in the chamber, and means for shutting off the inlet and outlet ports from the sample material in the chamber and for applying pressure thereto.

Preferably, the port through which the sample is expelled includes a non-return valve.

According to a preferred embodiment of the invention the means for shutting off the ports and applying pressure to the sample material in the chamber comprises a piston valve located in the first chamber, said piston valve being coupled to a piston rod extending into a second chamber sealed from the first chamber.

In order that the invention may be more readily understood, an embodiment thereof will now be described in detail by way of example and with reference to the accompanying drawing which shows a longitudinal sectional view taken through a sample injection valve according to the present invention.

Referring now to the drawing, the sample injection valve shown therein comprises two chambers of any convenient cross-sectional shape, preferably circular, a first or primary chamber 1 and a second chamber 2, separated by a dividing wall 3. The first chamber 1 is provided with an inlet port 4 through which sample material is arranged to be passed into the chamber, an outlet port 5 located diametrically opposite the inlet port 4 and at the same distance from the base of the chamber for the emergence

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of unwanted sample material from the chamber, and an opening 6 in the base of the chamber 1 controlled by a non-return valve 7.

The second chamber 2 contains a piston 8 which is biased in a direction away from the first chamber 1 by a spring 9. The piston 8 is secured to one end of a piston rod 18 which projects through a gland 10 formed in the dividing wall 3 separating the two chambers and terminates in a piston valve 11 which is situated within the first chamber 1. The piston valve 11 incorporates a flexible resilient cup washer 12 which is arranged to form a seal with the walls of the chamber. This washer 12 may be formed of any suitable material, one such material being neoprene which is resistant to corrosive attack. The piston 8 is arranged to abut against a rolling diaphragm actuator 13 which is operated by an actuating gas, e.g. air, supplied by way of an inlet 14 located at the end of the chamber 2. The rolling diaphragm 13 provides a completely positive seal against the possible ingress of hazardous gas into the driving system, e.g. a solenoid valve in an external electrical enclosure. However, the use of a cup-washer secured to the piston 8 in place of the rolling diaphragm may provide a sufficient seal for many circumstances. The chamber 2 is also provided with a vent 15 in the side wall positioned between the dividing wall 3 and the diaphragm 13.

In use, the injection valve is normally in the position as shown in the drawing whereby the sample material flows continuously through the first chamber 1 by way of the inlet port 4 and the outlet port 5, the non-return valve 7 being closed under these conditions.

When it is desired to eject a sample from the valve, pneumatic pressure is suddenly applied via the inlet 14 to the rolling diaphragm actuator 13 to overcome the action of the spring 9 and to cause the piston rod 18 to be driven down into the first chamber 1. As the piston valve 11 moves sharply downwards the washer 12 seals off a fixed volume, for example 0.5-2.0 ml., of sample material contained in the lower part of chamber 1 from the inlet and outlet ports 4 and 5, compresses it, and expels it as a slug through the non-return valve 7 when the pressure limit of the valve 7 is exceeded by the applied force. The actual volume of sample ejected is adjustable in dependence on the dimensions of the chamber and the length of the piston stroke which may be made variable. Air or gas from beneath the diaphragm 13 is expelled through the vent 15 to prevent back-pressure building up within the second chamber 2. Also, any slight leakage of the sample across the gland 10 does not affect the safety or operation of the valve since it also is vented to atmosphere through the vent 15. After the sample has been expelled the pneumatic pressure on the actuator 13 is reduced and the spring 9 returns the piston 8 to its normal position.

It will be noted that the sample material is able to flow continuously through the sample injection valve before, during, and after injection of a sample. Thus, no interruption of the flow is necessary and this means that the valve can be connected directly into a pipe-line without the need for any auxiliary apparatus.

When the valve is to be used in connection with a process chromatograph the non-return valve outlet is preferably connected directly by way of a conduit 16 to the packed column used for the analysis. A further conduit 17 carrying a continuously flowing carrier gas or liquid can then be connected to the first-mentioned circuit 16 so that when a sample is ejected from the non-return valve it is entrained by the carrier and conveyed to the chromatograph column. Any slight leakage of carrier gas through the non-return valve into the valve chamber does not affect the operation of the valve since it is simply

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entrained by the sample and removed through the outlet port 5.

Various modifications may be made to the sample injection valve hereinbefore described without exceeding the scope of the appended claims. For example, although pneumatic actuation of the piston has been described the valve can be arranged for manual and/or electromagnetic operation, or alternatively, for pneumatic or electromagnetic operation with a manual override.

Although the inlet and outlet ports 4 and 5 have been described and illustrated as being diametrically opposed it may be preferable for certain circumstances to provide them in some other relative position so that mixing and turbulence of the gas or liquid is created in the chamber. This could be provided, for example, by arranging the inlet and outlet ports substantially tangentially to the chamber 1 and on opposite sides thereof. Moreover, the inlet and outlet ports need not necessarily be provided at the same distance from the base of the chamber which is provided with the non-return valve.

Other constructional and dimensional changes may also be desirable to suit particular applications of the valve, and all such embodiments are also intended to fall within the scope of the invention.

I claim:

1. A sample injection valve comprising a cylindrical casing, the interior of which is sealingly divided into four discrete, axially spaced chambers by transverse partitioning means, said partitioning means comprising firstly, a flexible diaphragm secured to said casing and in continuous operative connection with a piston rod which is enclosed within said casing and is movable axially therein, secondly, a wall extending perpendicular to said casing axis through which said piston rod extends in sealing relationship, and thirdly, a flexible resilient element secured to the end of the piston rod remote from said diaphragm and movable in sealing contact with the internal wall surface of the casing, whereby a first chamber is formed between said diaphragm and one end of the casing, a second chamber is formed between said diaphragm and said wall, a third chamber is formed between said wall and said flexible element, and a fourth chamber is formed between said flexible element and the other end of the casing; spring means in said second chamber normally biasing said diaphragm away from said wall; a first port formed in said casing into said first chamber for the supply of pressurized actuating fluid to said diaphragm; an inlet port formed in said casing between said wall and said other end of the casing for the introduction of a continuous stream of sample fluid; an outlet port

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formed in said casing at the same transverse level as said inlet port for the emergence of unsampled fluid; and, a further port formed in said casing into said fourth chamber at a position further from said wall than said inlet and outlet ports for the passage of samples of said fluid from the casing, wherein said flexible resilient element is movable between a first terminal position in which said third chamber is closed and said fourth chamber receives fluid through said inlet port, loses fluid through said outlet port, and has said further port closed, and a second terminal position in which said third chamber receives fluid through said inlet port and loses fluid through said outlet port and said fourth chamber is ported only by said further port, through an intermediate position in which said inlet and outlet ports are simultaneously closed off by said resilient element from said further port to define a fixed-volume sample of fluid to be expelled through said further port upon movement of said resilient element to said second terminal position.

2. A sample injection valve according to claim 1, in which said further port through which the sample is expelled includes a non-return valve.

3. A sample injection valve according to claim 1, in which said flexible diaphragm is a rolling diaphragm.

4. A sample injection valve according to claim 3, in which a vent is provided in said first chamber on the side of the rolling diaphragm remote from said first port.

5. A sample injection valve according to claim 1, which is adapted for operation with gaseous sample material introduced into said fluid chamber through said inlet port.

6. A sample injection valve according to claim 1, wherein said further port is provided with a conduit to inject samples into a chromatographic column and wherein a further conduit is connected to said injection conduit for continuously supplying a carrier fluid to said injection conduit.

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