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PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Improvements in and relating to Shut-Off and Pressure Regulating Valves, especially for Liquefied Gas Containers

We, A/S TEKNOVA, of Nivaa, Denmark, a company organised under the laws of Denmark, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a shut-off and pressure regulating valve, especially for liquefied gas containers, of the type comprising a valve body and a main valve closure member having a front face which is urged towards an annular valve seat in the valve body by a closing spring together with the fluid pressure acting upon the rear face of the main valve closure member. Movement of this main valve closure member in its opening direction is determined by the fluid inlet pressure acting upon a portion of said front face surrounding the valve seat and by the fluid discharge pressure acting via a pressure transmitting pin controlled by the delivery pressure of the valve.

Such shut-off and pressure regulating valves are known in which the pressure transmitting pin engages the front face of a valve closure member and is carried by a diaphragm which on one side is loaded by the delivery pressure of the valve and is loaded in the opposite direction by one or more pressure springs tending to open the valve. When the valve is to be closed the pressure transmitting pin is withdrawn against the action of the pressure spring, and the closing spring acting directly on the rear face of the valve closure member then, together with the fluid pressure on this rear face, urges the valve closure member against its valve seat. The diaphragm and its loading spring is usually housed in a separate control or regulator housing which may also contain a pressure reduction valve and is attached to the valve body in such a way as to be easily removable therefrom.

In these known liquefied gas container

valves the valve closure member rear face is permanently exposed to the total fluid pressure prevailing in the container. Accordingly, the spring loading acting on the diaphragm in the opening direction of the valve must be relatively heavy, and the diaphragm *per se* must have a rather great diameter. The dimensions of the control or regulator housing must be correspondingly large so that it becomes rather expensive in manufacture and unhandy in use. Furthermore, the control operation produced by the diaphragm will be rather imprecise so that a further control valve may be needed, for example in connection with the pressure reduction valve.

Theoretically, these drawbacks or disadvantages could be overcome by reducing the dimensions of the shut-off and pressure regulating valve proper as, in such case, the total closing force which is exerted upon the rear face of the valve closure member by the fluid pressure and must be counteracted by the force exerted through the pressure transmitting pin, would be correspondingly reduced. For other reasons, however, such a solution is not practicable mainly because the throughflow capacity of the valve may be too small. In this respect it is not always sufficient to consider only the desired maximum delivery per unit of time as in the case of storage containers, such as liquefied gas containers, it may be of great economical importance that the container may rapidly be filled through the valve which, in this situation, acts as a non-return or check valve.

Accordingly, practical considerations exclude the possibility of reducing the size of the valve closure member to such a degree that the closing force resulting from the fluid pressure on the rear face of the valve closure member is reduced to a reasonably low value. In other words, the control or regulating mechanism, i.e. the diaphragm and its loading

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spring, for example must be designed so as to operate in the desired manner against a closing force which is not only relatively high, but also varies considerably depending on the fluid pressure at the inlet of the valve. Thus, in the case of a liquefied gas container the closing force will depend on the contents within the container and on the temperature.

The main purpose of the invention is to provide a shut-off and pressure regulating valve, which is primarily intended to be used in connection with liquefied gas containers and in which the disadvantages of the known valves of the same kind are eliminated. In other words, the valve shall be of such arrangement that, on one hand, it has a reasonably high throughflow capacity and, on the other hand, minute forces will be sufficient for opening and controlling the valve operation.

With this purpose in mind, the pressure transmitting pin of the valve according to the invention extends through a bore in the main valve closure member and engages a pilot valve member cooperating with a pilot valve seat surrounding the main valve closure member rear face end of the bore, said pilot valve member being loaded towards the pilot valve seat by said closing spring and being housed in a pressure relief chamber formed by said main valve closure member and a cooperating guide member carried by the valve body, said pressure relief chamber communicating with the valve inlet through at least one throttled passage, the pressure transmitting pin serving to move the pilot valve closure member against the action of the closing spring to release the pilot valve seat whereby fluid within the pressure relief chamber is able to escape through the bore to the discharge passage thereby releasing the pressure upon the rear face of the main valve closure member to open the valve.

Shut-off valves are previously known which include such pressure relief chamber, the effect of which is that although in the closing position the main valve closure member is loaded against the main valve seat by the full fluid pressure which, through the throttled passage, is transmitted to the pressure relief chamber, the main valve closure member after opening of the relatively small pilot valve will be loaded only by a substantially reduced fluid pressure so that a correspondingly small force will be sufficient for moving the main valve closure member in the opening direction. In the valve according to the invention this effect, known *per se*, is combined with a controlling or regulating operation which is exerted through the pilot valve and, accordingly, depends on only minute forces which by the pressure transmitting pin are exerted on the pilot valve. Accordingly, the delivery pressure responsive diaphragm or similar member associated with the pressure transmitting pin need only produce small forces and may be of small

dimensions so that the complete valve unit may form a compact structure.

The control operation of the valve according to the invention depends on the fact that in its open position the pilot valve member is permanently loaded in one direction, viz. towards its seat, by the closing spring and by the reduced fluid pressure prevailing in the pressure relief chamber, and in the opposite direction by the opening force exerted by the pressure transmitting pin in dependence upon the delivery pressure of the valve. If for some reason, for example variations in the consumption or pressure fluctuations at the inlet of the valve, the delivery pressure tends to exceed the value to which the valve has been set, the force exerted by the pressure transmitting pin upon the pilot valve member will be correspondingly reduced, and the pilot valve member will therefore move towards its seat and reduce the discharge passage from the pressure chamber. The reduced pressure within this chamber will then increase so that the main valve closure member is moved towards its seat for limiting the delivery of the valve until the delivery pressure has been reduced to the desired value. In an analogous way a reduction of the delivery pressure will result in a decrease of the pressure within the pressure relief chamber so that the main valve closure member in this case will be moved away from its seat to permit an increased delivery until the desired delivery pressure has been reached.

The invention will now be further explained with reference to the accompanying drawing in which

Fig. 1 shows a partly diagrammatic longitudinal section through an embodiment of the valve according to the invention, and

Fig. 2 a portion of the section of Fig. 1 on a larger scale.

The valve structure illustrated on the drawing comprises a valve body 1 having a threaded spigot 2 intended to be securely inserted in the neck portion of a liquefied gas container, not illustrated. On the upper end of the valve body 1 a regulator housing 3 may be mounted. Only the lower portion of such housing is indicated in Fig. 1.

In the valve body 1 a main valve chamber 4 is provided which extends upwardly to a main valve seat 5, see particularly Fig. 2, formed in the valve body 1. This annular valve seat 5 cooperates with a piston type main valve closure member 6 having a seal 7 in its front face. At the rear face the main valve closure member 6 has a tubular extension 8 which telescopically surrounds a valve guide member 9. This guide member 9 is firmly secured within the valve body 1. In the embodiment illustrated on the drawing the guide member is provided with a threaded foot portion 10 engaging an internal thread 11 in the lower end of the main valve chamber 4. Through a plurality of apertures 12 in the foot portion 10

the pressure fluid, i.e. gas from the container, has a free passage into the main valve chamber 4.

5 The main portion of the guide member 9 forms a plug which with a certain clearance fits into the main valve closure member extension 8 and on its peripheral surface is formed with a plurality of annular grooves 13 whose function is explained hereafter. A central bore 10 14 extends throughout the greater portion of the length of the guide member 9 and is open at its upper end in which a pilot valve member 15 is inserted. This pilot valve member 15 is loaded in the upwards direction by a closing spring 16 mounted in the bore 14. The pilot valve member 15 is provided with a seal 17 which cooperates with a pilot valve seat 18 provided on the rear face of the main valve closure member 6. The pilot valve member 15 20 contains a pressure transmitting pin 19 which extends freely through a bore 20 in the main valve closure member 6. With its upper end this pressure transmitting pin 19 may cooperate with a stem 21 carried by a diaphragm 25 22 which on its upper side is loaded by a pressure spring 23.

The function of the valve described is as follows.

30 In the closed position of the valve the stem 21 is raised from the pin 19 against the action of the spring 23 so that both the main valve closure member and the pilot valve member are urged against their respective seats by the closing spring 16 and the pressure fluid which 35 through the spigot 2 and the apertures 12 has free access to the main valve chamber 4, from where the pressure fluid by way of the throttled passage formed between the valve member extension 8 and the guide member 9 by means 40 of the grooves 13 may penetrate the chamber 24 on the rear side of the main valve closure member 6 at a rate of flow which is restricted by the grooves 13. From this chamber the pressure fluid may further penetrate the bore 45 14 under the pilot valve member 15. Thus, the rear face of the main valve closure member 6 as well as the rear face of the pilot valve member 15 will be urged in the closing direction by the fluid pressure and so is also the lower, annular end face 25 of the main valve closure member extension 8. An oppositely directed force is exerted by the fluid pressure upon the main valve closure member front face portion 26 surrounding the annular valve seat 55 5. In the embodiment illustrated on the drawing, the area of this front face portion 26 is somewhat greater than the area of the end face 25 of the tubular main valve closure member extension 8.

60 When the stem 21 is released by manual operation, the spring 23 will force the diaphragm 22 and thus the stem 21 downwardly until the stem contacts the pressure transmitting pin 19 of the pilot valve member 15. 65 Thereby the closing force acting upon this pi-

lot valve member 15 will be overcome so that pressure fluid within the chamber 24 may discharge through the bore 20 and through the outlet 27 of the valve. Consequently, the fluid pressure acting upon the rear faces of both valve members 6 and 15 is substantially reduced so that the downwardly directed fluid pressure tending to open the valve acting on the annular front face portion 26 exceeds the pressure tending to close the valve and moves the main valve closure member 6 in the opening direction. A condition of operation of the valve is, however, that the discharge rate of the gas as will usually be the case, must exceed the rate of flow of gas through the throttled passage between the tubular extension 8 and the guide member 9 and into pressure relief chamber 24 from which the gas is discharged through the bore 20 and the outlet 27.

The particular embodiment illustrated on the drawing may be modified or changed in several respects. By way of example, the main valve closure member 6 and the guide member 9 need not cooperate telescopically with one another but may be interconnected by means of a bellows. In such case the throttled passage for the pressure fluid into the pressure relief chamber 24 may be provided by a narrow bore between the valve chamber 4 and the bore 14 within the valve guide member 9.

It should also be noticed that the valve structure is not limited to use in connection with gaseous fluids. Thus, the principles of the invention may also be utilized in apparatus for controlling a liquid flow, such as a water flow.

WHAT WE CLAIM IS:—

1. A shut-off and pressure-regulating valve especially for liquefied gas containers, comprising a valve body and a main valve closure member having a front face which is loaded towards an annular valve seat, surrounding a discharge passage, by a closing spring and the fluid inlet pressure acting upon the rear face of the main valve closure member, the movement of the main valve closure member in its opening direction being determined by the fluid inlet pressure acting upon an annular portion of the front face thereof radially outside the valve seat and by the fluid discharge pressure action via a pressure transmitting pin controlled, in use, by a discharge pressure sensitive member, such as a diaphragm, said pressure transmitting pin extending through a bore in the main valve closure member and engaging a pilot valve member cooperating with a pilot valve seat surrounding the main valve member rear face end of the bore, said pilot valve member being loaded towards the pilot valve seat by said closing spring and being housed in a pressure relief chamber formed by said main valve closure member and a cooperating guide member carried by the valve body, said pressure relief chamber communicating with the valve inlet through at least one throttled passage, the pressure transmitting pin serving



the pressure fluid, i.e. gas from the container, has a free passage into the main valve chamber 4.

5 The main portion of the guide member 9 fits into the main valve closure member extension 8 and on its peripheral surface is formed with a plurality of annular grooves 13 whose function is explained hereafter. A central bore 10 14 extends throughout the greater portion of the length of the guide member 9 and is open at its upper end in which a pilot valve member 15 is inserted. This pilot valve member 15 is loaded in the upwards direction by a closing 15 spring 16 mounted in the bore 14. The pilot valve member 15 is provided with a seal 17 which cooperates with a pilot valve seat 18 provided on the rear face of the main valve closure member 6. The pilot valve member 15 20 contains a pressure transmitting pin 19 which extends freely through a bore 20 in the main valve closure member 6. With its upper end this pressure transmitting pin 19 may cooperate with a stem 21 carried by a diaphragm 25 22 which on its upper side is loaded by a pressure spring 23.

The function of the valve described is as follows.

30 In the closed position of the valve the stem 21 is raised from the pin 19 against the action of the spring 23 so that both the main valve closure member and the pilot valve member are urged against their respective seats by the closing spring 16 and the pressure fluid which 35 through the spigot 2 and the apertures 12 has free access to the main valve chamber 4, from where the pressure fluid by way of the throttled passage formed between the valve member extension 8 and the guide member 9 by means 40 of the grooves 13 may penetrate the chamber 24 on the rear side of the main valve closure member 6 at a rate of flow which is restricted by the grooves 13. From this chamber the pressure fluid may further penetrate the bore 45 14 under the pilot valve member 15. Thus, the rear face of the main valve closure member 6 as well as the rear face of the pilot valve member 15 will be urged in the closing direction by the fluid pressure and so is also the lower, annular end face 25 of the main valve closure member extension 8. An oppositely directed force is exerted by the fluid pressure upon the main valve closure member front face portion 26 surrounding the annular valve seat 50 5. In the embodiment illustrated on the drawing, the area of this front face portion 26 is somewhat greater than the area of the end face 25 of the tubular main valve closure member extension 8.

60 When the stem 21 is released by manual operation, the spring 23 will force the diaphragm 22 and thus the stem 21 downwardly until the stem contacts the pressure transmitting pin 19 of the pilot valve member 15. 65 Thereby the closing force acting upon this pi-

lot valve member 15 will be overcome so that pressure fluid within the chamber 24 may discharge through the bore 20 and through the outlet 27 of the valve. Consequently, the fluid pressure acting upon the rear faces of both 70 valve members 6 and 15 is substantially reduced so that the downwardly directed fluid pressure tending to open the valve acting on the annular front face portion 26 exceeds the pressure tending to close the valve and moves 75 the main valve closure member 6 in the opening direction. A condition of operation of the valve is, however, that the discharge rate of the gas as will usually be the case, must exceed the rate of flow of gas through the throttled 80 passage between the tubular extension 8 and the guide member 9 and into pressure relief chamber 24 from which the gas is discharged through the bore 20 and the outlet 27.

The particular embodiment illustrated on 85 the drawing may be modified or changed in several respects. By way of example, the main valve closure member 6 and the guide member 9 need not cooperate telescopically with one 90 another but may be interconnected by means of a bellows. In such case the throttled passage for the pressure fluid into the pressure relief chamber 24 may be provided by a narrow bore between the valve chamber 4 and the bore 14 95 within the valve guide member 9.

It should also be noticed that the valve structure is not limited to use in connection with gaseous fluids. Thus, the principles of the invention may also be utilized in apparatus for 100 controlling a liquid flow, such as a water flow.

WHAT WE CLAIM IS:—

1. A shut-off and pressure-regulating valve especially for liquefied gas containers, comprising a valve body and a main valve closure member having a front face which is loaded 105 towards an annular valve seat, surrounding a discharge passage, by a closing spring and the fluid inlet pressure acting upon the rear face of the main valve closure member, the movement of the main valve closure member in its opening direction being determined by the 110 fluid inlet pressure acting upon an annular portion of the front face thereof radially outside the valve seat and by the fluid discharge pressure action via a pressure transmitting pin controlled, in use, by a discharge pressure sensitive 115 member, such as a diaphragm, said pressure transmitting pin extending through a bore in the main valve closure member and engaging a pilot valve member cooperating with a pilot valve seat surrounding the main valve member rear face end of the bore, said pilot valve member being loaded towards the pilot valve seat by said closing spring and being housed 120 in a pressure relief chamber formed by said main valve closure member and a cooperating guide member carried by the valve body, said pressure relief chamber communicating with the valve inlet through at least one throttled passage, the pressure transmitting pin serving 125 130

- to move the pilot valve closure member against the action of the closing spring to release the pilot valve closure member from the pilot valve seat whereby fluid within the pressure relief chamber is able to escape through the bore to the discharge passage thereby releasing the pressure upon the rear face of the main valve closure member to open the valve.
- 5 2. A shut-off and pressure regulating valve,

especially for liquefied gas containers, substantially as described in the foregoing with reference to the accompanying drawing.

For the Applicants,
FRANK B. DEHN & CO.,
Chartered Patent Agents,
Imperial House,
15/19 Kingsway,
London, W.C.2.

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