

The invention relates to an apparatus for draining condensate from pressure systems or the like with the features of the preamble of Patent Claim 1.

In pressure systems, condensate consisting of water and oil for example is produced, which emanates essentially from for example the lubricant for the compressors and the moisture content of the gas. This condensate is generally very corrosive and must therefore be collected and from time to time drained from the closed compressed gas system, without appreciable quantities of the gas or compressed air being lost and the pressure in the system falling appreciably.

For the drainage of such condensates it is known to use float-type condensate traps, in this case the danger existing that sticking may occur and thus the condensate can no longer be drained or compressed gas losses caused thereby occur due to blowing-off of the compressed gas.

In a known apparatus of the aforementioned type (DE-A-31 49 830) these drawbacks are avoided, so that the apparatus has basically proved successful. When using this apparatus with only one sensor, it is necessary that the solenoid valve, actuated by a signal caused by means of this sensor, is time-controlled, so that the danger exists that in this case also, pressure losses and thus high energy costs may occur. When using this apparatus with at least two sensors, the drawback exists that on account of the space requirement of the sensors, the apparatus must have a relatively large construction and thus space-related drawbacks occur both at the time of handling as well as assembly and location.

In another apparatus (US-A-3 292 650), two sensors are arranged in parallel, at a distance apart, in a tube

which is closed on the under side. This construction also has the above-described drawbacks, since the tube receiving the sensors must be kept relatively wide.

Added to this is the fact that the diaphragm of the outlet valve is subject to relatively high stress at the time of actuation and that the construction as a whole is expensive.

It is the object of the invention to improve the apparatus for draining condensate of the aforementioned type so that on the one hand the diaphragm of the outlet valve is subject to less stress during operation and, on the other hand, the apparatus has a simpler construction, is more compact and is therefore more economical to produce.

This object is achieved in an apparatus of the aforementioned type with the features of the characterising part of Patent Claim 1. Further advantageous embodiments of the invention are the subject of the Sub-claims.

Due to the fact that the sensing element comprises at least two capacitive sensors monitoring different filling levels and is electrically connected to a control valve controlling a preliminary control outlet from the collecting chamber and that the sensors are located at a vertical distance apart in a tube projecting perpendicularly into the collecting chamber and which is closed at the outer end, it is possible to monitor effectively the filling level of the condensate which has run into the collecting chamber, effectively with only one container projecting into the chamber, in this case with only one tubular measuring element comprising two sensors and projecting perpendicularly into the chamber, which measuring element consists of an electrically non-conducting material (synthetic material or ceramic), in order to control the outlet valve.

When the filling level of the condensate in the collecting chamber reaches a predetermined maximum value or a predetermined maximum, the valve provided for controlling the diaphragm valve is set in operation, in order that the diaphragm valve opens, until the condensate located in the collecting chamber has drained out. The measuring element ascertains the drop in the liquid level in the collecting chamber and, when it has ascertained a minimum, initiates the closing of the diaphragm valve. In this case, the closing command for the diaphragm valve may be given with a predetermined time delay after ascertaining the lowest condensate level, so that the measuring element does not need to project into the collecting chamber up to the height of the lowest condensate level. The condensate level in the container is thus monitored electronically capacitively completely free from wear, so that the measuring system manages without moving parts and sticking is effectively prevented, the measuring element also monitoring pure oil and an adjustment to different condensates not being necessary.

Since the measuring element ascertains the maximum condensate level, a signal initiating the opening of the diaphragm valve is given. The time elapsing until the condensate level drops to the minimum level able to be ascertained by the sensor is monitored by the measuring electronics. When the minimum is reached, it is not necessary for a control signal once again closing the outlet valve to be issued. On the contrary, the time ascertained by the measuring element between the maximum and minimum can be multiplied in the measuring electronics by a factor, which results from the ratio of the height between the minimum and maximum and between the minimum and the desired lowest level in the collecting chamber. Due to this, the total opening time of the diaphragm valve is ascertained. After the expiration of this time, the measuring electronics issue the closing signal.

In this way it is possible to select the multiplication factor so that the valve remains open longer than is necessary for the drainage of the condensate. Consequently, towards the end of the opening time, compressed air or compressed gas from the pressure system flows through the diaphragm valve, in order to blow out impurities in the outlet region and in particular in the region of the diaphragm valve. In this case, the control is possible in such an exact and sensitive manner that no relatively large quantities of pressure medium escape from the system for the purpose of cleaning, since the sinking speed to the minimum point is monitored electronically and by means of the measured value, the maximum necessary valve-opening time is calculated.

If the sensing element tube comprises two capacitive sensors, then it is consequently ensured that the sensor measuring the maximum filling level as well as the second sensor delivering the final signal is arranged in a space-saving manner without having to provide a second opening in the housing facilitating the positioning of the second sensor.

If the tube surrounding the capacitive sensors is arranged to project perpendicularly into the collecting chamber, then it is thus ensured that the filling level of the condensate located in the housing can always be measured in an optimum manner.

If the sensors are arranged at a vertical distance apart, then it is possible to monitor a predetermined maximum or minimum of the condensate level, without requiring an arrangement of the sensors one beside the other, i.e. outside a coaxial alignment, so that an extremely space-saving arrangement is guaranteed.

Due to the fact that the end of the tube remote from the closed end is connected to a housing containing an electronic control arrangement, the housing containing the electronic control arrangement and the tube connected thereto as well as the sensors contained therein and the electronic control arrangement form a structural unit, which on the one hand can consequently be produced in a compact manner and on the other hand can be exchanged or serviced in a simple manner, without a great expenditure of labour being required.

If solely the part of the tube belonging to the structural unit, comprising the sensors, projects into the inside of the housing, then the latter can be designed to be relatively small or likewise compact, without special structural measures having to be provided for locating the structural unit within the housing.

If the inlet into the chamber of the control valve has a smaller cross-section than its outlet and if the chamber of the control valve is permanently connected to the rear side of the diaphragm of the diaphragm valve, then it is thus ensured that a preliminary control arrangement is provided, which makes it possible to be able to open the diaphragm when required, without in this case leading to a sudden pressure change and thus jerky movements of the diaphragm, so that a premature wear phenomenon is effectively opposed and on the other hand it is ensured that for controlling the diaphragm, the connection between the collecting chamber and the control valve chamber does not need to be broken separately.

If a collar or a baffle plate or a baffle wall is located in front of the connecting line between the collecting chamber and the outlet chamber, one effectively prevents impurities deposited on the base of the collecting chamber

from being welled up and discharged with the condensate, when the condensate is drained. Under certain circumstances, such impurities may block and clog the diaphragm valve or the outlet line in such a way that satisfactory cleaning is no longer possible or achieved even with pressure medium blown through subsequently.

Further features and advantages of the invention will become apparent from the following description and drawings.

Two embodiments of the apparatus according to the invention for draining condensate from pressure systems are illustrated in the drawings, in which:

Figure 1 is a vertical section through the apparatus according to a first embodiment, the diaphragm valve being located in the closed position, which it normally adopts,

Figure 2 is a partial section of the apparatus from Figure 1, the diaphragm valve being shown open and

Figure 3 is a vertical section through the apparatus according to a second embodiment, the diaphragm valve being located in the closed position.

The apparatus 1 shown in Figure 1 for draining condensate from pressure systems such as compressed air or compressed gas systems has a housing 2 with an upper part 3 and a lower part 4, which contains a collecting chamber 5 for condensate. The upper part 3 is provided with a connection socket 6 and the lower part is provided with a connection socket 7, which both open into the collecting chamber 5 and serve for connection to a pressure system (not shown). Normally the connection socket 6 is used as an inlet, so that the connection socket 7 is sealed in a pressure-tight and liquid-tight manner by means of

a plug (not shown) or a cap (likewise not shown), but it is also possible to use the connection socket 7 as an inlet. A line for supplying air and removing air is then connected to the connection socket 6. The line is then returned to the same pressure potential, at which the condensate is removed.

Fitted to the upper side of the upper part 3 is an electronic control arrangement 8, which comprises a measuring sensor tube closed at the lower end and projecting from above into the collecting chamber 5, which projects by a cylindrical shaft consisting of a material (for example synthetic material or ceramic) which is non-conducting in comparison with the collecting chamber 5, into a socket 11 of the upper part 3 of the housing 2 and is sealed with respect to the socket 11 by means of sealing rings 12.

Located one above the other in the measuring element tube 9 are two capacitive sensors 13, 14, which are electrically connected respectively by way of electrical leads 15 or 16 to the electronic control arrangement 8, i.e. monitor the condensate level in the container electronically, capacitively, completely free from wear. The upper sensor 13 serves for monitoring the maximum admissible state of the condensate level in the collecting chamber 5, whereas the lower sensor 14 supplies the minimum indication, in order that the electronic control arrangement 8 can issue the desired control signals for opening and closing the outlet valve.

The collecting chamber 5 is connected by an inclined channel 17 to an outlet chamber 18, which at the upper end contains an opening 19, which leads into the chamber 20 of a diaphragm valve 21.

In the collecting chamber 5, no particles can be sucked from the bottom, since the opening of the outlet channel 17 is higher. If the opening of the channel 17 is located lower and the outlet is not by way of a drainage chamber 18, but by way of an ascending tube 47 (as shown in Figure 3), then a chamber 22, baffle plate or baffle wall can be located before the opening or before the suction end of the ascending tube, in order to prevent impurities deposited on the bottom of the collecting chamber from being whirled-up when draining condensate from the collecting chamber and from being discharged with the condensate or subsequently flowing pressure medium, which impurities may block the outlet pipe and/or the diaphragm valve 21 or make it otherwise incapable of operating.

The diaphragm valve 21 comprises a flexible diaphragm 23, which is clamped by its outer edge 24 between the upper part 3 of the housing 2 and an attachment member 25, which is fastened to the upper part 3. The diaphragm is centered by a centrally located neck 26, this neck 26 being slideably guided in a blind hole 27 of the attachment member 25. Acting on the diaphragm 23 is a helical spring 28, which is located in the neck 26 and is supported on the bottom of the blind hole 27.

When air is supplied to the diaphragm 23 by the valve seat surface 29 in the position shown in Figure 2, the pressure of the helical spring 28 must be overcome.

Extending downwards from the valve seat surface 29 in the upper part 3 is a blind bore 30, from which a transverse bore 31 leads into an outlet socket 32. Normal pressure prevails in the outlet socket 32, whereas the over-atmospheric pressure of the pressure system is maintained in the collecting chamber 5 during operation.

Fitted to the attachment member 25 is a solenoid 33, which comprises an electrical coil 34 and a magnet core 35. Bearing against the upper end of the magnet core 35 is a compression spring 36, which pushes the magnet core 35 downwards against the attachment member 25. The solenoid 33 is actuated by the control arrangement 8. If electrical current flows through the coil 34, it attracts the magnet core 35, so that the latter is lifted into the position shown in Figure 2. When the coil 34 is de-energized, the magnet core 35 is located in the position shown in Figure 1, in which it rests on a projection 37 of the attachment member 25 and is pressed against the latter by the compression spring 36 as well as by excess pressure.

Together with the attachment member 25, the solenoid 33 forms a control valve 38, by means of which the diaphragm valve 21 is actuated.

Located between the solenoid 33 and the attachment member 25 is a chamber 39, into which a channel 40 starting from the upper end of the collecting chamber 5 opens, which has a straight shape, i.e. its surfaces forming the channel have neither corners nor edges on which dirt for example could lodge. The end 41 of the channel 40 opening into the chamber 39 is narrowed-down or tapered in the manner of a venturi nozzle. Also the transition between the end 41 constructed in the manner of a venturi nozzle and the channel 40 comprises no projections, corners or edges.

The chamber 39 is connected by way of a vertical channel 42 to the chamber 20 of the diaphragm valve 21, so that the pressure prevailing in the chamber 39 also acts on the upper side of the diaphragm 23. Located in the projection 37 of the attachment member 25 is a central

bore 43, which is connected to the outlet socket 32 by way of two transverse bores 44, 45 adjoining each other.

The attachment member 25 and in this case specifically the projection 37 with the bore 43 provided therein forms the control valve 38 together with the magnet core 35 of the solenoid 33.

The apparatus illustrated in Figures 1 and 2 for draining condensate from pressure systems operates as follows:

In the normal case, the individual parts of the apparatus 1 are located in the positions shown in Figure 1. Prevailing in the collecting chamber 5 is the over-atmospheric pressure of the pressure system, to which the apparatus is connected. This pressure also prevails in the outlet chamber 18, and indeed on account of the connection by way of the channel 17, and in the chamber 39, which is connected by the constantly open preliminary control channel 40 to the collecting chamber 5. Therefore, the over-atmospheric pressure also acts on the upper side of the diaphragm 23, because the channel 42 produces a continuously open connection from the chamber 39 to the chamber 20 of the diaphragm valve 21. Therefore, the diaphragm 23, assisted by the helical spring 28, is pushed firmly against the valve seat surface 29. The solenoid 33 is de-energized, so that its magnet core 35 rests on the projection 37 and is pressed against the latter likewise by the excess pressure, assisted by the compression spring 36. Both valves 21, 38 are closed, so that condensate flowing from the pressure system into the collecting chamber 5 remains there.

Through the inlet opening of the collecting chamber 5, condensate collects in the housing 2. If the liquid

level of the condensate, which has run into the collecting chamber 5, has risen up to the maximum height, so that the capacitive level sensor 13 of the measuring element tube 9 triggers a corresponding electrical signal and sends it to the electronic control arrangement 8, the latter emits a control signal, which sets the solenoid 33 in operation. The coil 34 now carrying current attracts the magnet core 35, so that the latter is lifted from the projection 37 and remains in the position shown in Figure 2. Due to this the bore 43 is exposed, so that a connection from the chamber 39 into the outlet socket 32 is produced. Since over-atmospheric pressure prevails in the chamber 39, but atmospheric pressure prevails in the outlet socket 32, pressure medium, namely air or gas, flows from the chamber 39 into the outlet socket 32, due to which the pressure in the chamber 39 and thus the pressure acting on the upper side of the diaphragm 23 is reduced. Pressure medium indeed flows through the channel 40 from the collecting chamber 5, but consequently the pressure reduction in the chamber 39 cannot be compensated for, because the discharge cross-section of the bore 43 is chosen to be greater than the inlet cross-section of the narrowed end 41 of the channel 40. However, as before, the over-atmospheric pressure of the collecting chamber 5 acts on the under side of the diaphragm 23, which now has the result that the diaphragm 23 is pushed upwards and is thus lifted from the valve seat surface 29. Condensate flows through the opening 19 from the outlet chamber 18 into the chamber 20 and from the latter through the bore 30, 31 into the outlet socket 32.

The arrangement is chosen so that the pressure in the chamber 39 is less than the pressure acting on the under side of the diaphragm 23, as long as the control valve 38 is open and accordingly the magnet core 35 is lifted from the projection 37 forming a valve seat surface

and is cleared. Accordingly, the diaphragm valve 21 remains open, as long as the control valve 38 is open, so that compressed air or compressed gas flows through the solenoid valve and thus scavenges it.

After the expiration of the predetermined opening time of the diaphragm valve 21, the control arrangement 8 supplies a signal, which leads to the switching-off of the solenoid 33. Due to this the magnet core 35 drops from the raised position onto the projection 37 and is pushed against this projection 37 by the compression spring 36, which leads to the closing of the control valve 38, so that the bore 43 is closed and pressure medium can no longer flow through the latter. Pressure builds up in the chamber 39 due to the pressure medium flowing through the channel 40 from the collecting chamber 5, until the over-atmospheric pressure prevailing in the collecting chamber 5 is reached. By way of the connection through the channel 42, this pressure now acts once more on the upper side of the diaphragm 23, so that on account of this pressure and of the additional pressure of the helical spring 28, the diaphragm 23 is pushed into the closing position according to Figure 1 and thus the diaphragm valve 21 is closed. Then, no further pressure medium or condensate is able to flow from the collecting chamber 5, until the control valve 38 is once again opened.

In this embodiment, the time elapsed after producing the maximum signal by the first sensor 13 until the production of the minimum signal produced by the second sensor 14, located below the first sensor, is ascertained and monitored by the electronic control arrangement connected to the two sensors by way of electrical leads 15, 16. If the minimum is reached, no control signal once again closing the outlet valve 21 is delivered. On the contrary, the time between the maximum and minimum, ascertained

by the measuring sensor, is multiplied in the measuring electronic arrangement 8 by a factor, which results from the ratio of the height between the minimum and maximum and between the minimum and the desired lowest level in the collecting chamber 5. Due to this, the entire opening time of the diaphragm valve 21 is ascertained. After the expiration of this time, the measuring electronic arrangement 8 supplies the closing signal.

The apparatus 46 illustrated in Figure 3, for draining condensate from pressure systems corresponds in construction and method of operation extensively to the apparatus illustrated in Figures 1 and 2. Therefore, identical parts are designated by the same reference numerals and not described in detail hereafter, in order to avoid repetition.

The essential difference consists in that for the drainage of condensate from the collecting chamber 5, an ascending tube 47 is located on the upper part 3 of the housing 2, which pipe is inserted in the blind hole 48. The blind hole 48 opens by way of an opening 49 into the chamber 20 of the diaphragm valve 21.

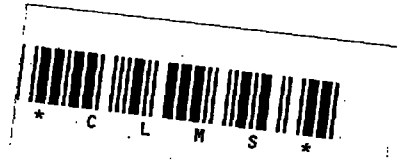
Integrally formed on the bottom 50 of the lower part 4 is an upstanding collar 51 projecting into the inside of the collecting chamber 5, into which the lower end 52 of the ascending tube 47 projects.

Outside the collar 51 forming a type of trough or basin, dirt 53 may collect on the bottom 50 of the lower part 4, which from time to time can be blown away through a socket 54 by means of a shut-off valve 55 actuated manually for example, before it has risen to the height of the connection socket 7.

Figure 3 also shows that the upper part 3 and lower

part 4 of the housing 2 are detachably fastened to each other by way of screw bolts 56 and nuts 57, which are inserted through flanges 58, 59 bearing one against the other.

If a fixed time interval between the first maximum signal and the second minimum signal, initiated by the lower sensor, is exceeded, for example 60 seconds, then a so called alarm control is actuated by the electronic control arrangement 8. The solenoid valve is switched off. In this state, the solenoid valve is opened for 5 seconds every 4 minutes.



Claims

1. Apparatus for draining condensate from a compressed air system or the like, with a collecting chamber (5) for condensate permanently connected to the compressed air system and with a diaphragm valve (21) closing off the outlet of the collecting chamber, in the collecting chamber solely two capacitive sensors (13, 14) being provided which monitor different filling levels and control the diaphragm valve by way of electronics and the control valve, characterised in that the sensors (13, 14) are located at a vertical distance apart in a tube (9) projecting perpendicularly into the collecting chamber (5) and closed at the outer end, which sensors are connected electrically to a control valve (38) controlling a preliminary control outlet (40, 41, 39, 43, 44, 45) from the collecting chamber (5) and that the inlet (40, 41) into the chamber (39) of the control valve (38) has a smaller cross-section than its outlet (43).
2. Apparatus according to Claim 1, characterised in that solely the part comprising the sensors of the component consisting of the tube (9) receiving the sensors and the electronic control (8) projects into the inside of the housing (5).
3. Apparatus according to Claim 1, characterised in that the chamber (39) of the control valve (38) is permanently connected to the rear side of the diaphragm (23) of the diaphragm valve (21).
4. Apparatus according to Claim 1, characterised in that the diaphragm (23) of the diaphragm valve (21) is acted upon by a spring (28) pushing it into its closed position.



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5. Apparatus according to one of Claims 1 to 4, characterised in that an outlet chamber (18) leading to the diaphragm valve (21) is connected to the collecting chamber (5).

6. Apparatus according to Claim 5, characterised in that a collar (22) is located in front of the connection (17) between the collecting chamber (5) and outlet chamber (18).

7. Apparatus according to one of Claims 1 to 6, characterised in that the lower end (52) of the ascending tube (47) leading from the collecting chamber (5) to the diaphragm valve (21), projects into an upright collar (51) projecting into the inside of the collecting chamber (5) on the base (50) of the lower part (4).