

Method and device for indicating the position of hydraulically actuated armatures

The invention relates to a method and a device for indicating the position of hydraulically actuated armatures, especially in shipbuilding, which are acted on by a pressure medium via a hydraulic line from a central control unit.

The indication of the position of such hydraulically actuated armatures, such as rotary and linear drives, is performed via the displacement of the armature, which can be arranged on a ship at a distance of, for example, 200m from the central control unit. In the case of such line lengths, the compressibility of the pressure medium has an effect on the precision of the position indicator. For example, it is known from DE 44 29 019 to provide a costly hydraulic circuit to compensate for the lack of precision of the position indicator caused by the compressibility of the pressure medium.

It is the object of the invention to form the position indicator of hydraulically actuated armatures of the type mentioned above such that high precision of the position indicator is achieved at low cost.

This object is solved according to the invention by the features of claim 1. Because the throughflow through the hydraulic or pressure medium line is converted into electrical pulses which are used for indicating the position, in the case of a simply configured device it is possible reliably and precisely to determine the position of the armature arranged at a distance from the control unit, because a pulse corresponds only to a slight volume flow rate of pressure medium. The signal processing in a program makes it possible to compensate in a simple way for the compressibility of the pressure medium and even for temperature influences on the position indicator.

According to the invention, the influence of the compressibility of the pressure medium according to one embodiment is determined and compensated for, in the case of switching the pressure medium line to be the pressure-causing pressure line, the higher number of pulses occurring during the actuation of the armature is counted and the lower number of pulses is

subtracted therefrom, wherein the lower number of pulses is then counted when the pressure medium line is switched to be the unpressurised return line during the same adjustment travel of the armature. The difference between the numbers of pulses corresponds to the influence of compressibility. According to another embodiment, the pulses are counted in the case of predetermined adjustment travel when the pressure medium line is switched to be the pressure line, whereupon the pressure line is switched to unpressurised and the pulses occurring during decompression are counted. The number of pulses corresponding to compressibility is left out of consideration during the further actuations of the armature, to compensate for the influence of compressibility.

Exemplary embodiments of the invention are explained in more detail below with reference to the drawing, which schematically shows a device for indicating a position, in which the armature is acted on by two pressure medium lines

Reference numeral 1 denotes a unit comprising for example a pivoted flap 1.1 arranged in a pipe (not shown) and being adjusted by an adjust cylinder 1.2, for example, by means of a gear rack, the adjust cylinder 1.2 being connected on opposite sides to hydraulic or pressure medium lines 2 and 3. In unit 1, return valves 1.3 and pressure-limiting valves 1.4 are arranged in a circuit which is known per se.

Reference numeral 4 refers to a schematically represented central control unit, at which a large number of armatures is controlled which can be found at a great distance from the control unit. For simplification of the representation, only one armature 1.1 is represented. For each armature, a known adjustment valve 4.1 is arranged in the control unit 4; via this, the one or the other side of the adjust cylinder 1.2 is acted on by pressure, while the other pressure medium line 2 or 3 respectively is switched to be the return line. P denotes a hydraulic line connected to a pressure medium source (not shown), and T denotes the return line leading to a reservoir (not shown).

A flow rate sensor 5 is arranged in one of the two pressure medium lines 2 or 3, preferably in the area of the control unit 4. This flow rate sensor converts the flow of pressure medium passing through the line into a series of electrical pulses which are indicated at 5a. The flow rate sensor 5 can, for example, have a gear driven by the pressure medium flow and generating electrical pulses in a non-contacting manner by means of Hall sensors. Such flow rate sensors

or flow rate measuring devices are known per se. The signals emitted by the flow rate sensor 5 can, for example, be rectangular signals, as represented schematically at 5a, wherein one pulse corresponds to a predetermined unit of volume of the pressure medium. Here, a pulse can correspond to a unit of volume of, for example, 0.05 cm^3 of the pressure medium passing through the line.

Reference numeral 6 denotes a control and indicator unit which has a display 6.1 and control buttons 6.2 and is connected via first electric lines 6.3 at a and b to the opposite sides of the adjusting valve 4.1, which is switched to the one or other position by a solenoid in each case. Further, the indicator unit 6 is connected to the flow rate sensor 5 via second electric lines 6.41 and 6.42, through which different pulses corresponding to the throughflow direction of the pressure medium are supplied to the indicator unit 6 or to a program provided therein, in which the signals or numbers of pulses are processed. Reference numeral 6.5 denotes electric lines for the power supply of the indicator unit 6.

By using two pulse signals which are offset from each other by 90° , the flow direction of the pressure medium is revealed by means of the series of pulses. In the program of the indicator unit 6, by means of direction-determination logic the flow direction of the pressure medium is revealed as an open or close actuation. In other words, pulses are transmitted via the one electric line 6.41 when the pressure medium is flowing in the one direction, and pulses are transmitted via the electric line 6.42 when the flow is in the other direction. The difference between forwards and backwards flow in the pressure medium line 2 results essentially from the rotational direction of the gear in the flow rate sensor 5 or from identifying the rotational direction at the encoder, as to whether this rotates to the right or to the left.

When the pressure medium line 2 is switched to be the pressure line and the pressure medium is flowing in a direction towards the armature, due to the compressibility of the pressure medium in the pressure line, a higher number of pulses occurs than during the return flow when the pressure medium line 2, as the return line, is switched to pressureless. Hereby, the compressibility of the pressure medium can be calculated by the program located in the indicator unit 6 by means of the different number of pulses, when the piston in the adjust cylinder 1.2 has the same adjustment travel. For example, compressibility can be detected by counting the number of pulses when the piston has a full adjustment travel in the adjust cylinder 1.2, when the pressure medium line 2 is switched to be the pressure-causing pressure line, and in

the same way the number of pulses is counted when the pressure medium line 2 is switched to be the pressureless return line, wherein the difference in the two determined numbers of pulses having the same adjustment travel corresponds to the influence of compressibility.

In the one embodiment, only the number of pulses is stored which is detected when the pressure line is decompressed, while in the other embodiment the number of pulses during the closing and opening process is stored and calculated together. It is also possible to combine both embodiments in the program.

The program processing the pulses is expediently formed as a learning program wherein, after installing the position-indicating device, predetermined program steps take place by means of which the position indicator adjusts itself to the respective armature including the type of pipe. This therefore eliminates costly adaptation of the position indicator at the armatures, which often have very different displacement volumes, and at the different line lengths and line cross-sections.

According to one embodiment of the learning or checking program, the adjusting valve 4.1 is adjusted into the end position by the program in the control and indicator unit 6 via one of the electric lines 6.3, for moving towards an end position of the armature, for example, for moving towards the closed position, so that the flap connected to the adjust cylinder 1.2 is moved into the closed position via the pressure medium line 3, which is switched to be the pressure line. On reaching the closed or end position, the piston in the adjust cylinder 1.2 comes to abut at the front wall thereof, so no further throughflow takes place through the pressure medium lines 2 and 3. This end position can be predetermined as the initial position for counting the pulses that occur. Hereupon the armature is moved by the program into the other end position, in this embodiment into the open position, wherein the pressure medium line 2 is switched to be the pressure line, and the pulses occurring during actuation into the open position are counted. Hereupon the control valve 4.1 is offset by the program into the middle position and thus the pressure line 2 is switched to unpressurised, wherein the pressure medium in the line 2 decompresses. Hereby, backflow occurs in the pipe 2, which corresponds to the decompression of the pressure medium and is determined with regard to its volume by counting the occurring pulses. To compensate for the influence of compressibility, in the further actuations of the armature, the number of pulses measured during decompression of the pressure medium is left out of consideration when the pressure medium line 2 is again

switched to be the pressure line. In other words, the number of pulses corresponding to decompression is subtracted from the previously measured complete number of pulses, so that for the predetermined adjustment travel the number of pulses corresponding thereto is obtained.

The influence of compressibility can also be detected by counting and storing the numbers of pulses occurring during full adjustment travel of the piston in the adjust cylinder when the pressure medium line 2 is switched to be the pressure line and to be the return line. The difference between the measured numbers of pulses shows the influence of the compressibility of the pressure medium.

This learning or checking program is preferably carried out automatically before each start-up or after repairing the armature, to detect the corresponding numbers of pulses. By carrying out the checking program before each start-up, it may be possible to determine errors which have occurred in the meantime. When carrying out the checking program after repairing the armature, it is not necessary for the plant operator to carry out a readjustment of the position indicator to the existing system.

The checking program is preferably also carried out when the armature is moved into intermediate positions. Hereby, the pressure medium line 2 is switched to be, for example, the pressure line, to move the adjust cylinder 1.2 into a predetermined intermediate position, wherein the number of pulses occurring thereby is counted. Hereupon, the flap or the adjust cylinder is fixed in the attained intermediate position and the pressure medium line 2 is switched to unpressurised, wherein the number of pulses occurring during decompression of the pressure means is measured. When the armature is again to be moved into the same or another random intermediate position, compensation is made for the influence of compressibility thereby occurring by leaving out of consideration the number of pulses detected during decompression.

To compensate for the temperature influences on the position indicator, for example in the case of an armature assembled on the deck of a ship, in which differences of, for example, 20°C occur between daytime and nighttime temperatures, it is predetermined in the program of the indicator unit 6 that a number of pulses of, for example, "five" per time unit is left out of consideration for the position indicator, wherein it is assumed in this example that five

pulses correspond to a volume change of the pressure medium during a higher or lower temperature compared to the normal operating temperature.

Here, empirical values are predetermined for the program. However, it is also possible to store, for example, viscosity curves of the respective pressure medium in the program, wherein it is possible in association with temperature sensors to detect more precisely the volume changes in the pressure medium as a function of temperature. To compensate for the temperature influences, a temperature sensor can be provided at the flow rate sensor 5 and/or at the adjust cylinder 12, to transmit the corresponding measurement values to the program in the indicator unit 6.

By means of the device described, leaks in the hydraulic arrangement can also be determined and shown at the indicator unit 6, for example when pulses continue to occur in the closed position of the armature, or the measured number of pulses no longer agrees with that defined by the checking program before start-up as the number of pulses corresponding to a complete adjustment travel. Hereby, operating safety is increased by error recognition.

The program in the indicator unit 6 can also be formed to control the armature in such a way that an intermediate position of the armature of for example 40% can be preset at the display 6.1, whereupon the control is then triggered by one of the control buttons. Thereafter, the armature is automatically moved into the intermediate position of 40% and on reaching the intermediate position it is held in this position. Hereby, the adjustment valve 4.1 is triggered by means of the electric lines 6.3 until the predetermined intermediate position is reached, whereupon the voltage supply of the adjustment valve 4.1 is interrupted by the program. In this way, the indicator unit 6 also serves as a control unit, wherein for controlling the armature by means of the adjustment valve 4.1, the previously determined pulse data from the flow rate sensor 5 are also processed by the program.

The indicator device described is of great advantage not only in shipbuilding, because a precise position indicator can be achieved using simple means. The indicator device can also be used in industrial plants, for example in refineries. It can also be used in relatively short lines of, for example, 20m between control unit and armature, in which the compressibility becomes noticeable by different number of pulses between pressure-causing forward flow and unpressurised backward flow.

The indicator device can also be provided in a hydraulically actuated armature which is supplied with pressure medium via only one pressure medium line, wherein the piston in the adjust cylinder 1.2, acted on by pressure medium, works against a spring which effects resetting of the piston when the pressure medium line is switched to backflow.

In this embodiment, the piston in the adjust cylinder can be fixed in the position with a stressed spring, so that when switching the pressure medium line to unpressurised, it is possible to measure the number of pulses which occurs due to decompression of the pressure medium and which corresponds to the influence of compressibility on the position indicator.

Claims

1. Method of indicating the position of a hydraulically actuated armature, comprising:
an adjust cylinder (1.2) for actuating the armature (1.1), connected by at least one pressure medium line (2, 3) to an adjustment valve (4.1) through which the pressure medium line can be switched between pressure-conducting feed flow and pressureless return flow,
characterised in that
the flow through the pressure medium line is converted into a number of electric pulses, wherein a pulse corresponds to a predetermined unit of volume of the pressure medium, and the number of pulses reflecting the flow is processed in a program of an indicator unit (6) such that, when the pressure medium line is switched to be a return line, the number of pulses occurring in a predetermined adjustment travel is calculated as being the same adjustment travel when the pressure medium line is switched to be a feed line
2. Method according to claim 1, wherein the program automatically performs adaptation of the position indicator to the displacement of the respective armature.
3. Method according to claim 2, wherein the program performs a check or adaptation of the position indicator on every start-up of the armature.
4. Method according to one of the preceding claims, wherein the armature is moved into a first end position, which is assessed as being the initial position,
the armature is moved from this first end position into the second end position and the number of pulses thereby occurring is measured and stored,
the armature is moved from the second end position back into the first end position
and the number of pulses thereby occurring is measured and stored,

the two measured numbers of pulses are compared and the number of pulses corresponding to the smaller number of pulses is set for the further operation of the armature as corresponding to the full adjustment travel.

5. Method according to one of claims 1 to 3, wherein the armature is moved from a first position into a second position and the pulses thereby occurring in the pressure medium line switched to be the **feed line** are counted and stored, whereupon the pressure medium line is switched to be the **return line** and the pulses occurring on decompression of the pressure medium are counted and stored, and then subtracted from the previously detected number of pulses to obtain the number of pulses required for adjustment travel of the armature from the first position into the second position.
6. Device for indicating the position of a hydraulically actuated armature, comprising: an adjust cylinder (1.2) for actuating the armature, connected by at least one pressure medium line (2, 3) to an adjustment valve (4.1), through which the pressure medium line can be switched between feed flow and return flow, characterised in that a throughflow sensor (5) is arranged in the pressure medium line (2) to convert the flow of the pressure medium in the pressure medium line into electric pulses, **such that a pulse corresponds to a predetermined unit of volume of the pressure medium**, wherein the throughflow sensor (5) is connected to an electronic indicator unit (6) in which a program is provided for processing the pulses
7. Device according to claim 6, wherein the program counts the occurring pulses and compares the numbers of pulses occurring in a flow in the pressure medium line in the one direction and in the opposite direction.
8. Device according to claim 6, wherein the throughflow sensor (5) is arranged only in one pressure medium line when the armature is acted on by pressure medium through two pressure medium lines (2, 3).