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WO98/10248

PCT/EP97/04602

Method and device for measuring the volumetric flow of a fluid

The invention concerns a method and a device for the measurement of the volumetric flow of a fluid, according to the generic part of claim 1.

A methods of this kind, respectively such a device is known from WO 93/12 405, which describes a refuelling system for motor vehicles where the volumetric measuring device consists of a screw spindle counter. The screw spindle counter consists of two intermeshing wormdrive screw spindles, one of which carries a magnet. Rotation of this magnet as a result of rotation of the screw spindle causes the generation of pulse-shaped measurement signals from a sensor element, which co-operates with the magnet, and which are fed to a measuring transducer which converts such measurement signals into counting signals for use by a counter stage. The pulse generator, integrated into the measuring transducer, contains a pulse alignment and pulse shaper stage which allows electronic adjustment of the pulses generated by the rotation of the screw spindles for calibration purposes before these are fed to the electronic counter with its arithmetic unit. In this way pulses can be modified in amplitude and repetition frequency by external check and control pulses, which are derived from the arithmetic stage of the counter unit, so that they may, for example, be matched to an arithmetic relationship with the volume flow of the fuel uplifted., Within the arithmetic unit of the electronic counter these check and control pulses may be adjusted by suitably authorised personnel to cater for certain operational or climatic conditions or, when required, for calibration purposes.

In case of a screw spindle counter or a counter in which the displacer consists of paddle wheels or in case of counters having an oscillating piston as the movable element, then their construction often results in non-linearity between the test signal and the actual volume flow. For example, in case of a low flow rate, the

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fluid quantity associated with one pulse may be greater or smaller than the flow rate associated with one pulse when the flow rate is higher.

The invention is based on the task to improve a generic device, respectively a generic process in respect of measurement accuracy.

The task is solved by the invention cited in the claims.

According to the invention, signal correction takes place in the transducer whereby the correction factor used depends on the flow rate of the medium to be measured. For this purpose the cycle frequency is determined, as a measure for the flow rate, of the movable element, respectively of the screw spindle.. Relating to a plurality of cycle frequency values, corresponding correction factors are stored in a table or similar within the transducer. Using the appropriate correction factor for the corresponding cycle frequency, the transducer derives counter signals and feeds these to the counter. For preference, transducer signals are pulse-shaped, but they could also follow a sinusoidal law. For preference, the cycle frequency is derived from the pulse duration or pulse chopping rate. In a preferred version of the invention, each pulse measured is weighted by the correction factor with a volume level. Volume levels are then dependent on the flow rate. For example, at a flow rate of 10 l / min. the volume level may be 8 ml, whilst, for constructional reasons, at a flow rate of 1 l / min this increases to 11 ml. Such volume levels are summed up by the transducer which then generates a counter signal as soon as the sum total of all volume levels has reached a multiple of a standard volume level. If, in case of the example mentioned, 10 ml were chosen as the standard volume level and if refuelling takes place at a flow rate of 1 l / min, then the transducer will generate a counter signal with the first measurement signal. If, on the other hand, refuelling takes place at a flow rate of 10 l / min, then the transducer will not issue a counter

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signal after receiving the first measurement signal, since its memory store only holds a value of 8. Only after receipt of the second measurement pulse and when the memory contains a value which reaches or exceeds the standard volume level of 10 ml, a counter signal is generated. It is also conceivable that the value of the memory store is reduced by the amount of the standard volume level after generating a counter signal so that counter signals are always issued when the memory store exceeds the level of the set standard. The memory store then only contains the remaining balance. For preference, correction factors are stored in a table within the transducer for a multitude of cycle frequencies. In addition to the correction factors, a calibration factor may also be stored which, after signal linearisation to generate counter signals, is multiplied with the latter as in the state of the art by means of a proportionality factor so that the actual volume flow, dependent on operational and climatic conditions, may be shown on the display, respectively may be added up by a counter. Correction factors between two levels contained in the table may be interpolated. For preference, the transducer contains a microprocessor. Conversion of test signals into counter signals may then be micro-program controlled. A counter may add up the counter signals and display may be either the sum total or the current flow rate.

An example of a version of the invention is explained by means of the appended schematic representation.

Reference number 5 identifies a fuel supply line within a fuel pump which originates from a fuel delivery pump and which leads to a fuel delivery nozzle. A volume measuring device is contained in supply line 5, consisting of a screw spindle counter, as described in WO 93/12 405. As explained therein, the screw spindle counter delivers measurement signals, in the form of pulses, identified by the letter M. Measurement signals M are fed by a connecting cable 7 to a

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transducer 3, containing a summation store 9 and a table memory 9. Correction factors are stored in table memory 4, which contains a multitude of correction factors relating to different pulse durations, respectively pulse repetition frequencies, of measurement signals M.

The microprocessor 3 analyses pulses M, coming from the measuring device 1 and fed by cable 7, in respect of their duration or repetition frequency and in this way determines the rotational frequency of the screw spindle. Based on such a rotational frequency, processor 3 calls a correction factor from table 4 and applies a weighted volume level to each pulse received, depending on its duration or repetition frequency, which corresponds to the actual volume level which has flown during the corresponding spindle rotation through the volumetric meter or which corresponds to a proportional value. For example, at a pulse duration of 10 ms, the corresponding measurement pulse is weighted with a volume level of 12 ml whilst a pulse of only 1 ms duration is weighted, for example, with a volume level of 8 ml. This would apply if at lower flow rates relatively more fuel passes through the measuring device 1 than at higher flow rates.

Volume levels determined for the individual pulses are added by a summation store 9. If the sum total reaches a multiple of the standard volume level, for example 10 ml, then transducer 2 will supply a counter pulse Z by cable 6 to the display-/arithmetic unit 8. Store 9 may either continue to total-up or its contents may be reduced by the amount of the standard volume level whenever a counter signal Z has been received. That way only the balance remaining from the last measurement value remains stored.

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The device described, respectively the described process, is suitable for liquid as well as for gaseous media. Preferred applications are in fuel pumps for motor vehicles. The invention originates from the idea, that in case of measuring units of equal construction and depending on flow rate of the medium to be measured, identical errors occurs. It is the aim of the invention to compensate errors caused through constructional effects by integrated electronics. For preference the transducer is contained in the housing of the volume measuring device.

All features disclosed are material to the invention. Into the disclosure of the application, the full disclosure contents of the corresponding / enclosed priority documents (copy of earlier application) are deemed to be included, including for the purposes to adopt features contained in such documents into the present application.

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**Claims**

1. Device for measuring the volumetric flow of a fluid, whereby the cyclic movement of a movable element in a volume measuring device, such as two or more screw spindles, generates measurement signals which are fed to a transducer which converts these into counter signals, characterised in that the cycle frequency of the movable element is determined from the measurement signals, which are modified by means of stored correction factors corresponding to the appropriate cycle frequency to represent the actual volume flow rate and which are then passed on.
2. Device for measuring the volumetric flow of a fluid, whereby the cyclic movement of a movable element in a volume measuring device, such as two or more screw spindles, generates measurement signals which are fed to a transducer and which converts these into counter signals, characterised in that the transducer (2) derives the cycle frequency of the movable element from the measurement signals (M) and modifies these into actual volume-flow proportional counter signals (Z) by means of correction factors stored for the appropriate cycle frequency.
3. Process or device according to one of the previous claims or in particular thereafter, characterised in that the measurement signals are pulse shaped and that the cycle frequency is established by determining the pulse duration or pulse repetition frequency of the measurement signals.
4. Process or device according to one or more of the previous claims or in particular thereafter, characterised in that each pulse measured is weighted with a volume value by the correction factor and where such volume values are

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totalled up by the transducer which generates a counter signal when the sum total has reached the level of a standard volume level or a multiple thereof.

5. Process or device according to one or more of the previous claims or in particular thereafter, characterised in that correction factors have been stored in the transducer and in the form of a table for a multitude of cycle frequencies.

6. Process or device according to one or more of the previous claims or in particular thereafter, characterised in that correction factors between two table values may be obtained by interpolation.

7. Process or device according to one or more of the previous claims or in particular thereafter, characterised in that the transducer contains a microprocessor.

8. Process or device according to one or more of the previous claims or in particular thereafter, characterised in that the volume measuring device (1) is a screw spindle counter or a gearwheel counter or another volume displacing counter in a fuel pump.

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