

Specification

The present invention relates to a maintenance monitoring device for a system on which maintenance work is to be carried out after maintenance intervals have elapsed, with a signal transmitter which is activated during maintenance-related system operating time, and at the outlet side of which is connected an integration arrangement and with an indicating arrangement which is connected to the integration arrangement at the outlet side, which indicating arrangement indicates when the operating time accumulated at the integration arrangement corresponds to a predetermined maintenance interval.

It is usual in industry, for example, to lubricate machines according to predetermined lubricating plans. The monitoring of such lubricating plans takes place by means of graphics, which necessitate a high degree of reliability of the monitoring point.

It is also known to monitor such procedures by means of programmed cards and computers. However this monitoring is, amongst other factors, too costly, particularly for small-scale manufacturing operations. Therefore, there is a call in industry for a foolproof monitoring device, which circumvents human monitoring and applies itself directly to the appropriate executing elements with corresponding signals.

An electronic counter with a programmable time delay belongs to the prior art. This operates on the analog principle. The counter has little accuracy and is complex in its structure: A condenser is charged. Its voltage increases with the charging time. After its charging, the voltage remains constant until, after a predetermined time, it is discharged again under voltage drop relative to time. The comparators determining the time lapses are switched via ohmic resistances such that on reaching an intended increasing voltage they connect in and with a decreasing voltage they connect out again at another threshold value. The time delays (ON/OFF) can only be changed by replacing the condenser and the resistances: For practice as a monitoring device in the machine-building industry, this apparatus is totally unsuitable, amongst other factors because it is not able to be used for lengthy periods (running times of machines in days). (Disclosure Bulletin, Vol. 20, No. 12, 1978, P.5323/24, The Electronic Engineer, August 69, P.80).

In a similar embodiment (US-PS 3 558 924) a main time emitter circuit operates on the same principle, but not with a condenser to produce the voltage ramps, but rather with a ramp generator.

It is also known (US-PS 3 290 669) to carry out the time interval measurement by means of electrolysis on the basis of a material quantity separated through a predetermined current : The method is not repeatable, because the capsule has to be replaced after each time interval. This is complicated and is not suitable for the solution of the present problem.

Likewise, an arrangement has become known from the US-PS 3 938 128, which on an occasionally operated installation allows its operating times to be integrated on, by means of a coulometer. During the operating times of the installation, a predetermined current flows through the coulometer and here the impedance of the coulometer is picked up as an indication criterion for the lapse of a time span which is to be monitored. Systems based on the use of coulometers are also known from the US-PS 3 290 669, the US-PS 3 546 693 and the US-PS 3 603 880, being suggested up to more recent times.

Basically, maintenance/monitoring devices which operate on coulometer- or respectively electrochemical processes have the disadvantages that they are not suitable when used on an installation which is to be monitored, to indicate in the course of time sequentially occurring maintenance times, as is necessary for maintenance on various units of the installation, after differing operating times. In addition, a simple resetting of such a monitoring device is not possible, because new initial conditions have to be set either through the provision of a new coulometer or respectively of a new electrochemical cell or through returning the same into the state defining the start of the measurement period. Furthermore, in such arrangements a flexible adaptation of one and the same device to the maintenance requirements of various installations which are to be monitored does not exist, due to a dynamic range on such coulometers which is only able to be changed taking into account complex procedures.

All these known devices are analog in operation.

Also, a maintenance computer, which can be programmed for the various maintenance posts of a machine and which operates day and night irrespective of whether the machine which is to be monitored is running or is at a standstill, is not capable of accommodating the requirements of practice. The resetting in such an apparatus takes place only with a key and through pressing the correct button. This harbours within it the danger of pressing the wrong button and cancelling

stored values which are still required. The apparatus would have to be supplied fully programmed from the factory; therefore, no self-adjustment would be possible in the manufacturing plant!

Furthermore, it is fundamental, as is known from the Handbook for electrical measurement of mechanical quantities by C.H.Rohrbach, published by VDI-Verlag, Düsseldorf, pages 431 to 437, that basically for the time measurement together with the measurement of the transport of electrical charge, as in coulometers, also the use of digital counter circuits is known. It is also known from general digital engineering, as can be seen from "Elektrotechnik" ("Electrical Engineering") 1976, pages 20 to 22 for example, to provide adjustable connecting means on counter circuits of a digital type, in order to monitor thereon the reaching of various predeterminable count states. Consequently, a large number of maintenance monitoring devices are known, which basically operate on an analog basis, whether this is through the use of elements corresponding to a ramp generator with monitoring of the reaching of particular ramp values, or whether through the use of coulometers. On the other hand, the procedure is known from general digital engineering for the determining of time intervals, used for complex maintenance computers, controls etc.

The present invention now proceeds from a known maintenance/monitoring device of the above-mentioned type, and aims to bring about the advantages of : being simple in construction, requiring few standard parts, being simple to operate, reliable in operation and cheap to acquire, and being able to allow the user to carry out an adaptation flexibly to the maintenance intervals arising on his installation which is to be monitored.

For this, the invention distinguishes itself according to the wording of Claim 1.

To accomplish the task which is set, technical precautions are taken up, which have been known for a long time from substantially more complex systems, but were unable to break through the trend of constructing such devices chiefly on a coulometer basis, in the advantageous manner mentioned, although there was a notable need for this.

The invention will be explained below by way of example with the aid of drawings.

Fig. 1 shows a combined signal flow/function block diagram of a signal transmitter,

- Fig. 2 shows a form of embodiment of a signal transmitter,
Fig. 3 shows a resetting switching section on the arrangement according to Fig. 2,
Fig. 4 shows a textual lubricating plan in the use of the arrangements according to Fig. 1 and Fig. 2 for lubrication control on a machine tool,
Fig. 5 shows a pictorial lubricating plan for use in an analogous manner to Fig. 4,
Fig. 6 shows a perspective view of a warning device which is built into a small box.

According to Fig. 1, an arrangement which is to be monitored by the signal transmitter, for example a machine 1 is switched on and off with an operating switch 3. Generally the position of the switch 3, arranged on the machine 1 which is to be monitored, determines the times which are to be monitored. If it is the on/off switch of the machine 1, its operating time is thus monitored. In function of the switching state of the switch 3, a signal generator 5 is started or respectively switched off. In its switched on state - ie. when the machine 1 is in operation - it emits a time-dependent signal $S(t)$, as generally shown by way of example, a constant signal level. This output signal is passed to an integration unit 7, and is integrated on there, so that at the output of the integration unit 7 a signal $S_2(t)$ appears. This corresponds to the overall time span, during which the generator 5 has been activated, which in other words corresponds to the time span during which the machine 1 was in operation and was therefore to be monitored. The output of the integration unit 7 is carried on to the inputs of one or more threshold value sensitive or time unit sensitive units 9. Thereby, a first unit emits a signal for example when the signal $S_2(t)$ exceeds a threshold value or a critical overall time value A_0 , a second unit when the said signal value exceeds a threshold value A_1 etc. The outputs of the threshold value sensitive units are carried in each case on to an indication 11.

These indications 11 may be acoustic or visual, or else, as shown with the outputs S_3 , they may be used for an automatic tripping of control processes.

According to Fig. 2, the signal generator 5 of Fig. 1 is constructed as a pulse generator 25. When activated through closing of the switch 3, it emits at its output an impulse sequence with the frequency f_1 . This depends on the clock frequency of the generator 25, the intervals which are to be monitored and the design of the integration unit described below. Connected at the outlet

side of the generator 25 is a frequency divider 26, at the output of which a pulse train with the frequency f_2 appears. The integration element 7 according to Fig. 1 is realised in the digital construction shown in Fig. 2 by one or more counter stages 27, which, according to requirements, are connected in series. The timing signal with the frequency f_2 is passed to the timing input CL, so that in a known manner at the individual counter stages of the counters 27 successive binary signals appear. The individual stages of the counters 27 are preferably carried on to connections 28, which may be switched by means of bridging pieces 28a selectively on to set inputs s of flip-flop 29. In this embodiment, the threshold value units or units for the critical overall time values 9 according to Fig. 1 are realised through the individual counter stages of the counters 27 and flip-flop 29 connected therewith, by which according to a predetermined number of pulses of the pulse train which occurs with the frequency f_2 and corresponding to the respective threshold value $A_0, A_1, A_2, \dots$, a corresponding counter output 28 is activated and consequently also the flip-flop 29 which is connected thereto is set. Via a driver 30 the flip-flop 29 control the indications, for example LED diodes 31, corresponding to the indications 11 of Fig. 1. The flip-flop 29 are able to be reset with individually actuated reset switches R_{FF} or R.

This enables the corresponding luminous diode 31 to be extinguished after the carrying out of an action performed after elapse of a time span which is to be monitored, practically as a voucher that the required action has been carried out. To prevent the integration element 7 corresponding to the counters 27 and perhaps also the flip-flop 29 and possibly even the luminous diodes 31 from being cancelled out in the case of a power failure, the counters 27 especially are supplied in a conventional manner via an AC-DC transformer 33, which for example converts mains voltage to the conventional direct voltage of eg. 8-12 V for integrated switching networks, whereby this takes place via a buffer battery or respectively an accumulator 35. It is thereby ensured that in the case of power failure on the counter side the counter states remain set which have occurred until then and which correspond to the monitored time which has elapsed. For the resetting of the counters 27, for example in the case of an inspection, their reset inputs are able to be activated by means of reset switches R_z .

In order to be able to carry out the resetting of the individual indications 11 respectively 29 with the least possible effort, it is given to carry the reset inputs of the flip-flop 29 on to a first metal contact 37 (Fig. 3). In the immediate region thereof a second metal contact 39 is arranged, which now in turn is switched to reset potential, for example to earth.

The reset switch R_{FF} is formed through the two contacts 37 and 39 and also through a metallic object, for example a special pincers 41. For resetting, the two contacts 37 and 39 of the flip-flop 29 are connected with the pincers from the outside.

Fig.4 shows the possibility of a lubricating plan 45, which supplies the necessary information textually. A column 46 specifies the lubrication points of the machine 1, a column 47 specifies the lubricants to be used for the individual lubrication points, a column 48 specifies the number of basic time units, for example one week, after which lubrication is to be carried out. A column 49 represents the LED diodes 31 which are provided for illumination after elapses of time. Corresponding to the number of lubrication points a corresponding number of luminous diodes 31 is arranged. A luminous diode 40, eg. green, at the top of the monitoring table, is the frequency control for the pulse generator 25.

It is also possible, instead of a textual lubricating plan 45 to provide a pictorial lubricating plan 50, as shown in Fig. 5 on a reduced scale. Therein, the outline of a machine is shown with four lubrication points, which point to the associated LED 31.

Corresponding to the provided lubricating plan 45 or respectively 50 of the machine tool 1, as is shown for example in Fig. 4 and 5, the programming takes place by means of the bridging piece 28a which is constructed for example as prints, which determine the machine running times after which the individual lubrication points are due for lubrication according to the lubricating plan. According to the lubricating plan, consequently as the first position which is to be lubricated, on the fifth line the luminous diode to "Guideways vertical" lights up, which are to be lubricated for example weekly or respectively after a running time of the machine of 40 hours. Accordingly, the luminous diode for lubrication of the horizontal guideways lights up after 3×40 , ie. 120 hours.

The main transmission gear and the hydraulics have the longest running time without lubrication, namely 7×40 hours, whereby the two associated luminous diodes 31 are connected in parallel, and therefore light up simultaneously.

The switching from the pulse generator 25 up to the LED diodes 31 is situated together in a closed housing 70 (Fig. 6). On the top of the latter, the corresponding lubricating plan, eg. according to Fig. 4, can be inserted, whereby at the end of each line the associated LED diode 31 follows. In Fig. 6

only five lubrication points are provided. For the resetting of the flip-flop 29 the housing 70 has corresponding slits or openings 73 on the side, through which the person responsible for the lubrication can introduce his resetting instrument, eg. a pincers 41, and can return the corresponding flip-flop 29 into its zero position and can cancel out the associated LED diode 31.

As pulse generator and first frequency divider, a CMOS 4 521 can be used, as second divider for picking up a CMOS 40 24 and as inverter for ensuring the correct flank position a CMOS 40 49. These parts are manufactured for example by National, Motorola or RCA. The FF 40 43 of RCA can be used as flip-flops.

The power supply for the signal transmitter has a voltage of for example 8 to 12 volt direct current. It supplies the installation off from the counter 27 uninterrupted and independently of the state of the machine 1 as regards its being connected in. In order, in the case of power failure and failure of the machine 1, in which state this supply voltage would also fail, to ensure and hence achieve that the values of the running time of the machine which were stored up to the power failure are not cancelled out, the accumulator 35 is built in to the supply. The pulse generator 25 is coupled with the switching state of the main switch 10 of the machine 1. Only when the machine 1 is running does the pulse generator 25 also run. This state can be seen in the illumination of a frequency control lamp 40, for example green, which is likewise a luminous diode (LED). It indicates the fundamental frequency of the pulse generator 25 through periodic fluctuation of its luminous power.

With a pulse length of for example 1.125 sec., on the pulse generator 25 (frequency f_1) in this way frequencies of hours can be produced at the outputs of the counter 27, namely corresponding to the division of the frequency f_1 in the relationship 1.125^n sec.

For the present case of a machine lubrication which has ten lubrication points, or, as in the present case, eight lubrication points, the last ten or respectively the last eight stages of the frequency divider or respectively counter 27 are tapped.

The programmable times, which correspond to the last eight stages of the frequency divider, are provided as follows : 40, 80, 160, 320, 640, 1280, 2560 and 5120 hours with a pulse generator oscillation time of 1.125 sec. The adjustment range which is provided lies between 50%-200%.

Through exchanging the corresponding bridging pieces 28a (prints), another lubricating plan can be programmed.

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In this sense, the illumination of each LED diode 31 indicates that the machine 1 has run for a predetermined time, and the corresponding lubrication point of which the LED diode is illuminated, has to be lubricated.