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(54) **METHODS AND APPARATUS FOR PROVIDING ALARM NOTIFICATION**

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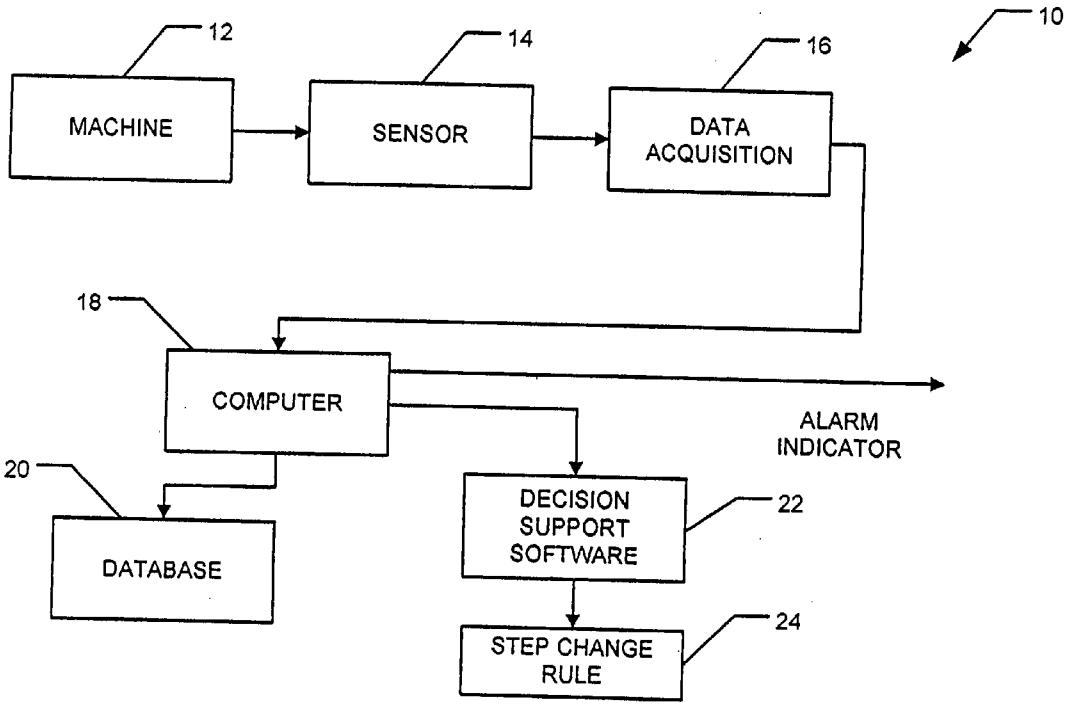
(57) **ABSTRACT**

A method for indicating an alarm condition in an industrial process includes measuring a parameter of the industrial process that varies over time and determining at least one parameter limit as a function of the parameter and also varying over time. The method further includes comparing the parameter to the parameter limit or limits and indicating an alarm condition when the parameter is outside of a bound set by the parameter limit or limits when the parameter is compared to the parameter limit or limits.



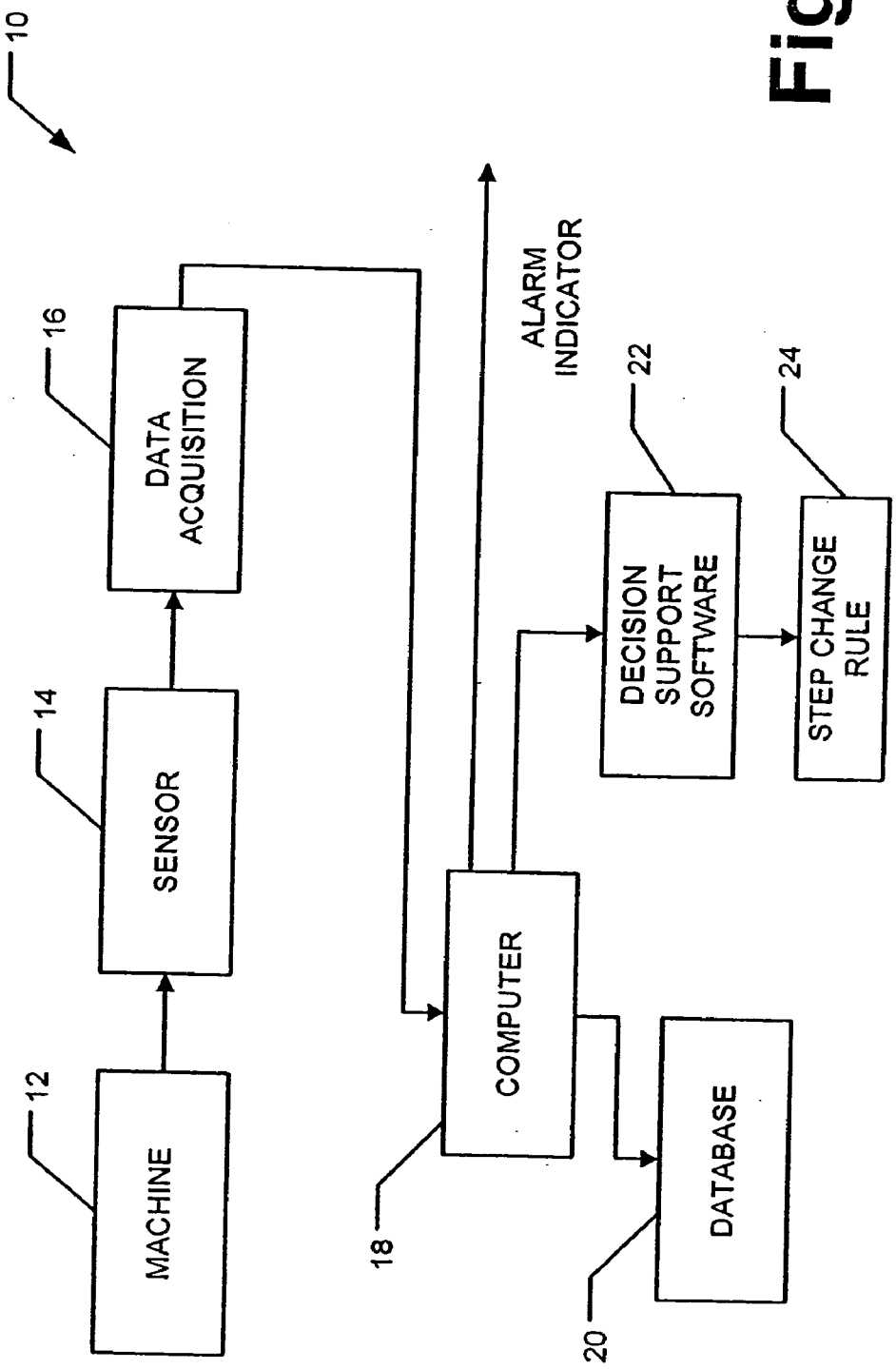


Fig. 1

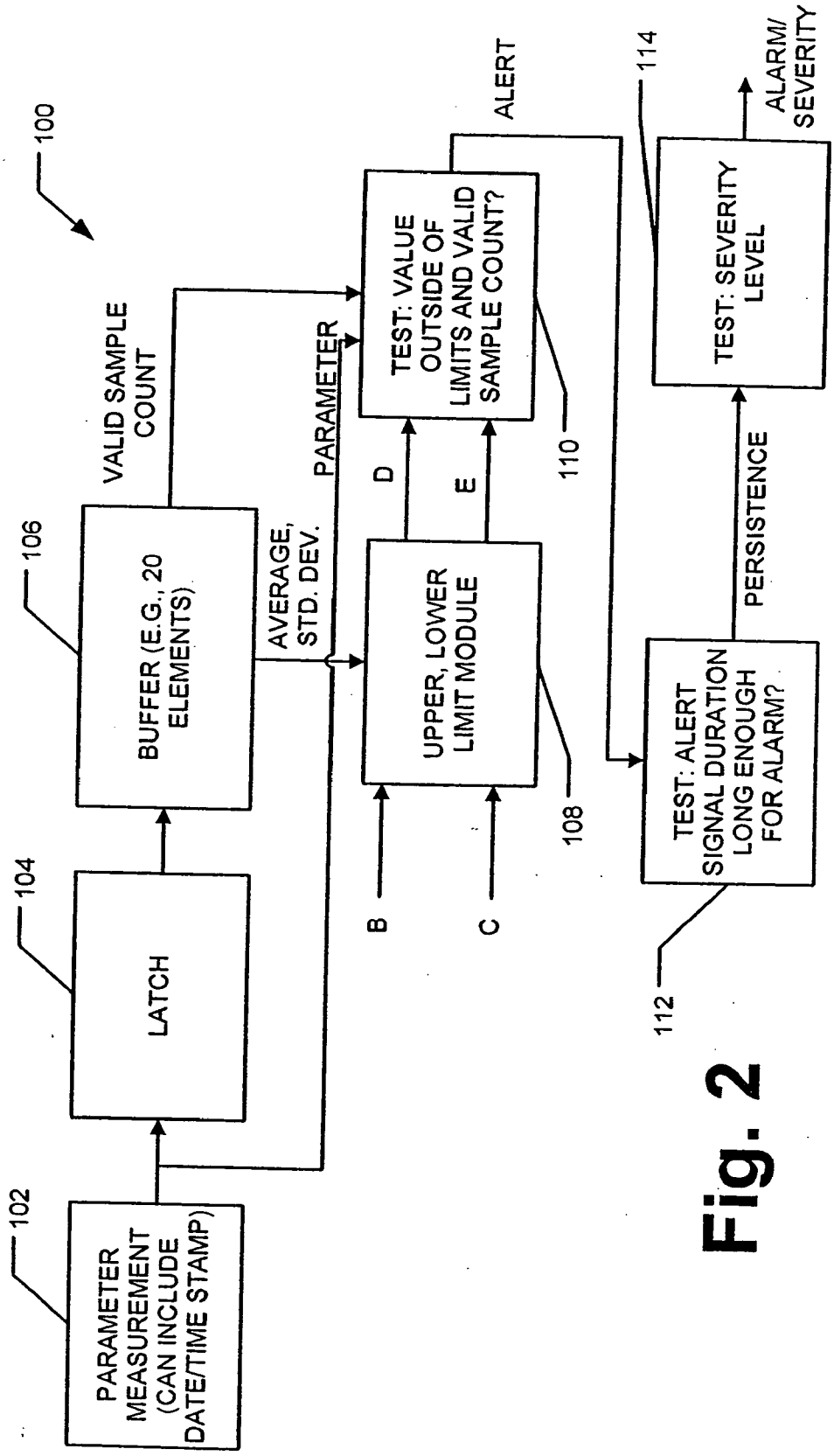


Fig. 2

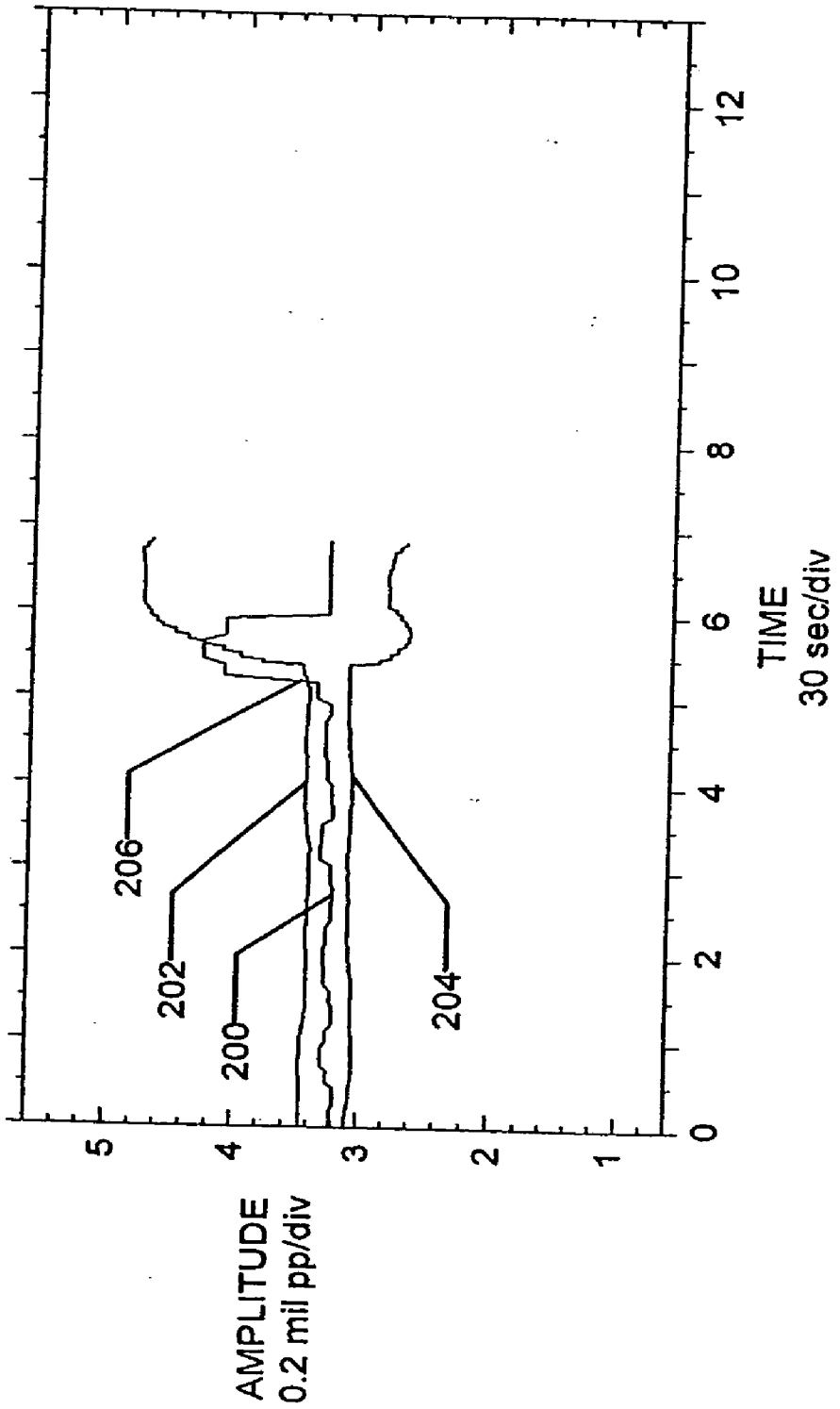


Fig. 3

METHODS AND APPARATUS FOR PROVIDING ALARM NOTIFICATION

BACKGROUND OF THE INVENTION

[0001] This invention relates generally to methods and apparatus that provide automatic notification of machine malfunctions.

[0002] Operators of significant equipment or processes need warning of equipment or process malfunction. Such equipment can include machinery in power plants, oil refineries, pipeline pumping stations, manufacturing facilities, and any other appropriate applications. Known threshold-based alarms can be used, and such alarms provide an operator to use remedial tools and procedures to correct malfunction conditions. However, alarms based on parameter thresholds may not be timely enough to allow an operator to use such tools and procedures optimally in all conditions.

BRIEF DESCRIPTION OF THE INVENTION

[0003] Some configurations of the present invention therefore provide a method for indicating an alarm condition in an industrial process. The method includes measuring a parameter of the industrial process that varies over time and determining at least one parameter limit as a function of the parameter and also varying over time. The method further includes comparing the parameter to the parameter limit or limits and indicating an alarm condition when the parameter is outside of a bound set by the parameter limit or limits when the parameter is compared to the parameter limit or limits.

[0004] Also, some configurations of the present invention provide an apparatus for indicating an alarm condition in an industrial process. The apparatus includes a sensor configured to measure a parameter of the industrial process, a data acquisition system, and a computer. The apparatus is configured to measure a time-varying parameter of the industrial process and determine at least one parameter limit that is a function of the parameter and also varies over time. The apparatus is further configured to compare the parameter to the parameter limit or limits and indicate an alarm condition when the parameter is outside a bound set by the parameter limit or limits when the parameter is compared to the parameter limit or limits.

[0005] In addition, some configurations of the present invention provide a medium having machine-readable instructions recorded thereon that are configured to instruct a computer to input a sensed, time-varying parameter of an industrial process, determine at least one parameter limit as a function of the parameter and also varying over time. The instructions also are configured to instruct a computer to compare the parameter to the parameter limit or limits, and indicate an alarm condition when the parameter is outside of a bound set by the parameter limit or limits when the parameter is compared to the parameter limit or limits.

[0006] In yet another aspect of the present invention, there is provided a method for indicating an alarm condition in an industrial process. The method includes measuring a time-varying parameter of the industrial process, latching the tions of values of the buffered parameter stored in the FIFO buffer. The method further includes utilizing the determined statistical functions to determine one or more alert limits, comparing value of the parameter to the one or more alert limits; and indicating an alarm dependent upon the parameter being outside a bound set by the one or more alert limits.

[0007] Furthermore, some configurations of the present invention provide an apparatus for indicating an alarm condition in an industrial process. The apparatus is configured to latch a varying parameter value of the industrial process and buffer successive latched parameter values in a FIFO (first-in, first-out) buffer, determine statistical functions of values of the buffered parameter stored in the FIFO buffer, and utilize the determined statistical functions to determine one or more alert limits. The apparatus is further configured to compare value of the parameter to the one or more alert limits, and indicate an alarm dependent upon the parameter being outside a bound set by the one or more alert limits.

[0008] Some configurations of the present invention provide a medium having recorded thereon machine-readable instructions configured to instruct a computer to latch a varying parameter value of an industrial process and buffer successive latched parameter values in a FIFO (first-in, first-out) buffer and determine statistical functions of values of the buffered parameter stored in said FIFO buffer. The instructions are also configured to instruct a computer to utilize the determined statistical functions to determine one or more alert limits, compare value of the parameter to the one or more alert limits, and indicate an alarm dependent upon the parameter being outside a bound set by the one or more alert limits.

[0009] Configurations of the present invention allow early notification in accordance with behavior that might not trip a conventional threshold based alarm system. Additionally, configurations of the present invention avoid inappropriate alarms that may occur with conventional alarm systems that are not cognizant of machine state (e.g., whether the machine is running or not).

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] **FIG. 1** is a block diagram of an industrial process in which a configuration of the present invention is provided to indicate an alarm when a step change in a parameter is encountered.

[0011] **FIG. 2** is a block diagram representative of another configuration of the present invention.

[0012] **FIG. 3** is a drawing showing a step change in a measured parameter.

DETAILED DESCRIPTION OF THE INVENTION

[0013] Some configurations of the present invention track a measurand (e.g., vibration magnitude or phase) and, using the measurand, generate a result or raise an alarm when one or more configurable criteria are met (e.g., a statistically defined step change of the measurand). The invention also provides one or more time based criteria to qualify the data

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