COMMISSIONER'S DECISION

Sec. 2, Obviousness Monitoring Nuclear Power Plants

The concept of monitoring vibration characteristics of a component is shown in the cited reference. This application establishes acceptable vibration characteristics at various locations of the plant along with a power spectral density analysis at selected locations to predict potential breakdown.

Final Action - Reversed Sec. 2; Amended claims submitted after the Hearing.

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Patent application 248,995 (Cl. 349/29), was filed on March 29, 1976 for an invention entitled Method And Apparatus For Automatic Abnormal Events Monitor in Operating Plants. The inventors are Paul J. Pekrul et al, assignors to Rockwell International Corporation. The Examiner in charge of the application took a Final Action refusing to allow it to proceed to patent. In reviewing the rejection, the Patent Appeal Board held a Hearing at which the Applicant was represented by Mr. Orleans.

The subject matter of this application is a method to monitor industrial plants such as nuclear power plants. Vibration and pressure signal sensors are located throughout the plant to continually monitor the various operating components. Signals from these sensors are processed by a computer, which compares them to signals that have been accepted as normal. If the difference between the signals and the predetermined normal signals exceeds an acceptable level, the computer actuates a warning light or an alarm to alert the operator, who then takes corrective action or shuts the plant down.

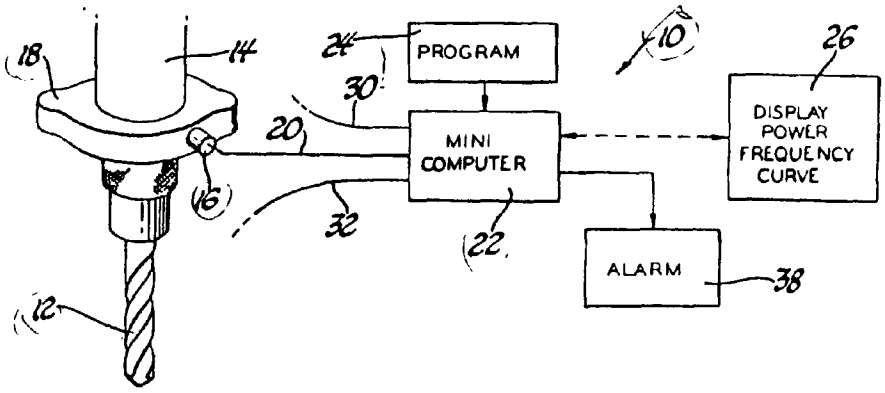
In the Final Action the Examiner refused all the claims as obvious in view of three United States patents and because they differ from the cited art merely by the nature of the algorithm which the Applicant uses. These patents are:

3,324,458	Jun. 6, 1967	MacArthur
3,694,637	Sep. 26, 1972	Edwin et al
3,778,347	Dec. 11, 1973	Giras et al

MacArthur relates to apparatus for monitoring computer controlled processes. A computer checks the condition of a great number of process variables (pressure, temperature etc.) and compares these with predetermined conditions; if the variable is not within acceptable limits an alarm condition will be established and presented on a visual display to the operator.

Giras shows a digital computer control system for operating a boiling water nuclear reactor and its associated steam turbine in an electric power producing plant.

Edwin relates to detecting tool wear by monitoring the vibrational characteristic of a tool in use and comparing that characteristic by computer to a preestablised standard. Figure 1 of that patent is shown here.



Apparatus 10 comprises a transducer 16 mounted on collar 18 in contact with drill 12, which is linked with computer 22.

In the Final Action the Examiner stated (inter alia):

Applicant argues that a plant has complex vibrational patterns and various components operate independently of other components thus presenting a different problem from Edwin et al and that applicant provides more than one comparison level.

The examiner agrees with applicant's statements that several components of a plant operate independently and that applicant provides more than one comparison level; however, the examiner does not agree with applicant's conclusion that this presents a different problem in kind from Edwin et al or that the extra comparison level makes the disclosed system patentable. Each of the components of the plant which interest applicant are monitored independently, therefore each information channel feeding the computer presents exactly the same type of problem as that facing Edwin et al. The choice of comparison level or levels is a mere design choice which does not confer patentability upon applicant's system.

With reference to claim 1 in particular:

(a) Monitoring a plant by computer is common knowledge as shown by McArthur and Giras et al.

(b) The step of computer scanning a plurality of input data channels is common knowledge in the art.

(c) Edwin et al show that it is known to process input vibrational signals to produce power spectral density data, and to compare the spectral data with test limits to determine the condition of a component.

(d) Reading out the results of the comparison for use by an operator is common knowledge.

Applicant's method therefore consists of common knowledge steps combined with the Edwin et al method. The difference consists merely of different input data and different test limits. In other words the differences reside solely in the algorithm which is used to solve applicant's problem.

Algorithms are non patentable subject matter and cannot be relied upon to lend patentability to an otherwise unpatentable method. Applicant's apparatus also differs over the art only in the nature of the algorithm disclosed by applicant.

...

In response to the Final Action the Applicant stated (in part):

...

It is important to note that the invention does not reside in a mere aggregation, for a mere aggregation of, say, the system of Edwin et al would consist of a plurality of such simple systems each with its own monitor. Applicant has provided for a complex plant, a unitary monitoring system having an appropriate number of channels and a central scanning system with data processing unit.

Nor would it be obvious to provide such an aggregation with a central scanning system as well as a two-level control for each channel, since to do so would require an appreciation of the problem to which the invention is addressed and an appreciation of the advantages to be gained.

Applicant's teachings make the problem clear and indicate the advantages to be gained. However, there is nothing in the cited prior art to indicate that the problem was even recognized, and there is certainly nothing to point towards its recognition and solution.

Admittedly, referring to the Examiner's comments made in the "Final Action", monitoring a plant by computer is known.

Admittedly, computer scanning a plurality of input data channels is known.

Admittedly, Edwin et al shows that it is known to process input vibrational signals to produce power spectral density data, and to compare the spectral data with test limits to indicate the condition of a component.

Admittedly, reading out the results of a comparison for use by an operator is common knowledge.

However, these elements of prior art referred to by the Examiner are taken from quite different contexts and there can be no justification whatsoever for making a "mosaic" of them. It is quite impermissible to show by analysing an invention that each of its elements is separately known.

The Examiner refers to "common knowledge in the art", but does not indicate which particular art he is referring to. The references are taken from different arts. But in any case, it has to be noted that there is nothing in the cited prior art to indicate any reason for combining the references in the manner suggested, or that such combination would result in applicant's solution to the particular problem, or even that the particular problem had ever been recognized previously.

The Examiner makes a blanket rejection of all the claims, apparently without recognizing that the claims are not all of the same scope. It would therefore be difficult to discuss the Examiner's objections on a claim by claim basis. However, we wish to stress that the present submission urges allowance of all the claims, including the broad claims 1 and 11, but it is pointed out that the remaining subsidiary claims are directed to features which the Examiner has not discussed at all; we therefore submit that a Final Action in respect of those claims is inappropriate.

The Examiner's reference to an "algorithm" is not understood. There is no claim to an algorithm, and the invention is not based on an algorithm. A computer is used in implementing the invention, admittedly, and a computer program will involve an algorithm, but there is nothing in the claims or the specification to suggest that the invention resides in an algorithm as such. The invention resides in a new monitoring process and a new monitoring apparatus in the environment of a complex industrial plant and organization in a novel manner to provide a novel solution to a problem which had not previously been recognized.

The issue before the Board is whether or not the claims are patentable.

At the Hearing Mr. Orleans indicated that from his understanding of the Final Action the rejection of the claims is on the grounds of obviousness, but found this is somewhat obscured by other issues in which reference to algorithms and to two United States Court decisions was presented. Since the U.S. application issued over the same art, Mr. Orleans felt that reliance upon the two U.S. court decisions was an additional factor for advancing his case to allowance in this country.

On review of the application we note that "this invention relates to abnormal event monitors, and more particularly to dynamic signal monitors for parts of operating plants that are not readily accessible for inspection." It is concerned with nuclear power plants in which inspection of components is virtually impossible without shut down, so it would be desirable to continually "seek out potential problems, analyze them as to severity and indicate what action should be taken." Applicant describes the placing of vibration and pressure monitoring sensors at select locations throughout the plant.

MacArthur utilizes a computer for monitoring an industrial process. Alarm conditions are established when the actual condition does not match a predetermined condition, such as pressure, temperature, generator out of limits or switch position being open when it should be closed. Column 3 at line 45 ff reads as follows:

> Regardless of the complexity of any particular process, the general approach to monitoring that process will very likely be the same. That is, simply stated, all measurable process variables can be periodically interrogated and compared with predetermined values in accordance with some predetermined sequence. In response to the comparisons, process parameters can be adjusted or, in other instances, it may be preferable to merely notify some supervisory authority or in other words, establish an alarm condition.

Giras describes the use of a digital computer system for operating a boiling water nuclear reactor and steam turbine in an electric power plant. In this patent the computer provides a system for controlling or operating a turbine follow type of boiling water reactor plant with improved coordination among the various modes of plant operation.

Edwin describes a "method and apparatus for detecting tool wear by monitoring a vibrational characteristic of the tool while in use and comparing that characteristic to a pre-established standard." This patent has been acknowledged in the disclosure of this application as we find on page 4 at line 9 ff which reads:

> Monitoring the vibration energy of a cutting tool and comparing it with a reference has been recognized as an effective way of determining wear for the purpose of determining the optimum time to change the tool. See for' Example U.S. patents Nos. 3,694,637 [Edwin et al] and 3,841,149. But monitoring a single tool is not the same problem as monitoring an operating plant. Plants usually have complex vibrational patterns due to various components operating independently. To complicate things even more, some components operate independently and unsynchronized, and some even operate intermittently.

As we understand the Edwin citation, obtaining the predetermined data of tool wear analysis is easily achieved because of the limited number of variables involved.

It is the Applicant's position that when a complex plant is first built from components supplied by one or more manufacturers, and in a physical environment which has no exact precedent, then the exact behavioral characteristics of the various components are not known. He argues that since "one does not know exactly what the critical levels are" his system enables adjustment of the reference data according to operational experience.

While agreeing with the applicant's statements that several components of the plant operate independently and that the applicant provides more than one comparing level, the Final Action disagrees with the "applicant's conclusion that this presents a different problem of the kind Edwin et al faced or that the extra comparison level makes the disclosed system patentable". There is no doubt that the concept of monitoring vibration characteristics is taught by Edwin. However, this patent is concerned with tool wear vibration characteristics in which tool change time is indicated by analyzing the change in power frequency distribution which occurs in the "vibration acceleration signal produced by a test tool over the life thereof." Computer monitoring of a process by comparing with pre-established limits such as temperature, pressure and switch position is found in MacArthur and Giras, but they are not concerned with any vibration characteristics. We believe that the progress the applicant has made resides in determining the acceptable vibration (pre-established) levels for a plant, along with the power spectral density analysis at selected points for predicting potential breakdown. Consequently we find the subject matter of the application is not obvious in view of the cited patents.

After looking at the independent claims on file in the application we found that their terminology lacked certain necessary characteristics to distinguish them over the cited art. We informed Mr. Orleans by telephone and on July 6, 1983 and August 3, 1983 he submitted proposed amendments to the claims of which amended claim 1 now reads as follows:

> In an operating plant having significant background noise in time dependent fluctuating signals derived from sensors placed at selected points for continually monitoring the operating vibration conditions of system components, a method for scanning in real-time separate signal conditioning channels, one for each of said signals, to find potential malfunctions, draw conclusions as to their severity and indicating to an operator what action to take comprising the steps of:
>
> establishing predetermined sets of vibration frequency dependent limits on the basis of a stored table based upon prior experience as to malfunctions and known characteristic spectra of operating components;
>
> selecting each channel in sequence for spectral analysis;
>
> processing the signal of each channel selected to produce power spectral density data at predetermined frequencies over a predetermined frequency range as a simple Fourier transform;
>
> comparing said power spectral density data of each channel with said established predetermined sets of vibration frequency dependent limits, each set consisting of at least two limits, one for a condition requiring caution and another for an alarm condition requiring more direct action by the operator; and
>
> indicating to the operator the condition of plant components associated with each channel and the action to be taken as a function of which set of limits and which limit of the set is exceeded by said power spectral data.

It appears to the Board that this claim overcomes our objections to the claims on file and also differentiates this subject matter from the cited art.

Another objection made in the Final Action was the "applicant's method differs from the cited art merely by the nature of the algorithm which the applicant uses." This objection relies on the examiner's assessment that the subject matter of the application is obvious in view of the cited references. As we

have indicated, the applicant's advance in the art is in determining acceptable vibration levels for a plant, along with power spectral density analysis at selected points and we are guided by the view expressed in Schlumberger that the use of a "computer to implement discovery does not change the nature of that discovery."

In summary, on the art of record before us, we recommend withdrawal of the objections made in the Final Action and acceptance of proposed amendments to claims 1 and 11.

M.G. Brown
Acting Chairman
Patent Appeal Board

S.D. Kot
Member

I concur with the reasoning of the Patent Appeal Board. Accordingly I am remanding the application for prosecution in accordance with the decision.

J.H.A. Gariépy
Commissioner of Patents

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Dated at Hull, Quebec

this 25th. day of November, 1983