



(51) International Patent Classification:
G06Q 10/00 (2012.01)

(21) International Application Number:
PCT/US2015/051673

(22) International Filing Date:
23 September 2015 (23.09.2015)

(25) Filing Language: English

(26) Publication Language: English

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(81) Designated States (unless otherwise indicated, for every
kind of national protection available): AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY,

BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM,
DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,
HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR,
KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG,
MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM,
PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC,
SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN,
TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every
kind of regional protection available): ARIPO (BW, GH,
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ,
TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU,
TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE,
DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU,
LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK,
SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ,
GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(54) Title: METHOD AND APPARATUS FOR COLLECTING LIKE-CASES

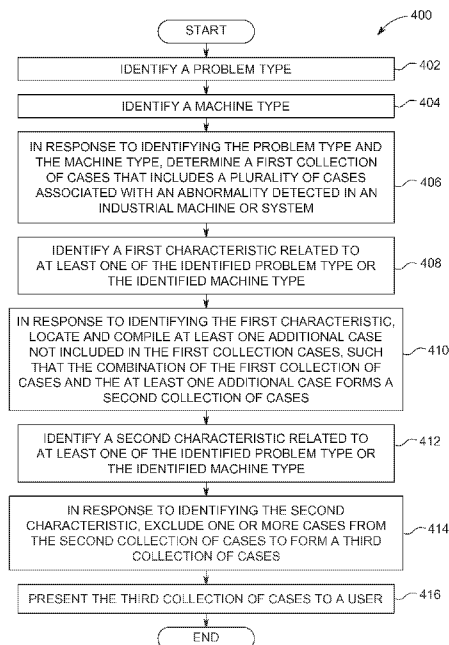


FIG. 4

(57) Abstract: Approaches are provided for an interface receiving at an input an identified problem type and an identified machine type. A processor determines a first collection of cases that includes a plurality of cases associated with an abnormality detected in the industrial machine or system in response to the input receiving the identify problem type and the identified machine type. The processor forms a second collection of cases in response to the input receiving a first characteristic related to at least one of the identified problem type or the identified machine type. The processor forms a third collection of cases in response to the input receiving the second characteristic related to at least one of the identified problem type or the identified machine type.

METHOD AND APPARATUS FOR COLLECTING LIKE-CASES

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The subject matter disclosed herein generally relates to collecting like-cases. More specifically, the subject matter relates to collecting prior like-cases having characteristics similar to a given case. More specifically, the subject matter relates to collecting prior like-cases having similar problem type characteristics and related machine type characteristics as compared to a given case.

Brief Description of the Related Art

[0002] In industrial operations, industrial machines and systems are monitored to ensure proper operation and/or detect anomalies which may arise. Remote Monitoring & Diagnostic (M&D) approaches often include personnel at one location communicating with personnel at an operating site located at a separate, geographically remote location. The M&D personnel view information related to industrial machines or systems located at the operating site.

[0003] During operation, problems oftentimes occur which may warrant an operator or maintenance engineer's involvement. Using known information related to the industrial machine or system, M&D personnel provide recommendations to personnel at the operating site.

[0004] When remotely assessing problems at operating sites, M&D personnel in some instances are unable to view and consider prior cases which could assist in solving the problem, involving the same or related machine, or the same or similar problem. Even in instances where M&D personnel are able to view and consider prior cases, the personnel are unable to efficiently locate relevant prior cases involving the same or related machine, or the same or similar problem.

[0005] The above-mentioned problems have resulted in some user dissatisfaction with previous approaches, inefficient case resolution, and sub-optimal application of remote monitoring and diagnostic approaches.

BRIEF DESCRIPTION OF THE INVENTION

[0006] The approaches described herein provide for collecting cases relating to problems associated with industrial machines or systems. These approaches permit a user to dynamically accumulate prior cases having characteristics common to, and to filter prior cases having characteristics distinct from, characteristics associated with a problematic industrial machine or system.

[0007] In many of these embodiments, an apparatus includes an interface having an input and an output. The input receives an identified problem type and an identified machine type. The input also receives a first characteristic related to at least one of the identified problem type or the identified machine type and a second characteristic related to at least one of the identified problem type or the identified machine type. In some approaches, the first characteristic comprises a related machine type. In other approaches, the first characteristic comprises a similar problem type.

[0008] The input also receives a second characteristic related to at least one of the identified problem type or the identified machine type and a second characteristic related to at least one of the identified problem type or the identified machine type. In some approaches, the second characteristic is a geographic location, or particular metadata describing the machine type.

[0009] The apparatus includes a processor coupled to the interface. In response to the input receiving the identified problem type and the identified machine type, the processor determines a first collection of cases that includes a plurality of cases associated with an abnormality detected in the industrial machine or system.

[0010] In response to the input receiving the first characteristic, the processor locates and compiles at least one additional case not included in the first collection cases, such that the combination of the first collection of cases and the at least one additional case forms a second collection of cases.

[0011] In response to the input receiving the second characteristic, the processor excludes one or more cases from the second collection of cases to form a third collection of cases. In some approaches, the cases comprising the third collection of cases include a case data structure that includes an evidence field with evidence, an interpretation field with an interpretation, and a recommendation field with a recommendation.

[0012] The processor is further configured to present via the output the third collection of cases to a user.

[0013] In some aspects, the processor is further configured to identify one or more outcomes provided in one or more of the cases of the third collection of cases. The one or more outcomes may be no action, operational change, scheduled maintenance, or outage.

[0014] In some approaches, the processor constructs a graphical representation of the one or more outcomes. The processor may further be configured to effect via the output a display of the graphical representation of the one or more outcomes.

[0015] In another aspect, a method includes identifying a problem type and identifying a machine type. In response to identifying the problem type and the machine type, the method includes determining a first collection of cases that includes a plurality of cases associated with an abnormality detected in an industrial machine or system.

[0016] The method further includes identifying a first characteristic related to at least one of the identified problem type or the identified machine type. In response to identifying the first characteristic, the method includes locating and compiling at least one additional case not included in the first collection cases, such that the combination of the first collection of cases and the at least one additional case forms a second collection of cases.

[0017] The method further includes identifying a second characteristic related to at least one of the identified problem type or the identified machine type. In response to identifying the second characteristic, the method includes excluding one or more cases from the second collection of cases to form a third collection of cases.

[0018] The method further includes presenting the third collection of cases to a user.

[0019] In some approaches, the method includes identifying one or more outcomes provided in one or more of the cases of the third collection of cases.

[0020] In some aspects, the method includes constructing a graphical representation of the one or more outcomes. The method may further include displaying the graphical representation of the one or more outcomes.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] For a more complete understanding of the disclosure, reference should be made to the following detailed description and accompanying drawings wherein:

[0022] FIG. 1 comprises an illustration of an informational flow chart for providing information relating to industrial machines or systems according to various embodiments of the present invention;

[0023] FIG. 2 comprises a block diagram illustrating an exemplary apparatus for managing information relating to industrial machines or systems according to various embodiments of the present invention;

[0024] FIG. 3 comprises a block diagram illustrating an exemplary case data structure for managing information relating to industrial machines or systems according to various embodiments of the present invention;

[0025] FIG. 4 comprises an operational flow chart illustrating an approach for case management according to various embodiments of the present invention; and

[0026] FIG. 5 comprises a schematic diagram illustrating an exemplary approach for case management according to various embodiments of the present invention.

[0027] Skilled artisans will appreciate that elements in the figures are illustrated for simplicity and clarity. It will further be appreciated that certain actions and/or steps may be described or depicted in a particular order of occurrence while those skilled in the art will understand that such specificity with respect to sequence is not actually required. It will also be understood that the terms and expressions used herein have the ordinary meaning as is accorded to such terms and expressions with respect to their corresponding respective areas of inquiry and study except where specific meanings have otherwise been set forth herein.

Detailed Description of the Invention

[0028] Referring now to FIG. 1, a system 100 for monitoring industrial machines includes an operating site 110, optionally, a data center 120, and a central monitoring center 130. The operating site 110 includes one or more industrial machines, equipment, or systems of industrial machines or equipment 112. Examples of industrial machines 112 monitored in system 100 include aircraft machinery (e.g., turbine engines), marine machinery, mining machinery, oil

machinery, gas machinery, health care machinery, telecom machinery, to mention a few examples. Other examples are possible.

[0029] Industrial machine 112 is operably connected to a local computing device 114 such that the computing device 114 receives or obtains information from the industrial machine 112. The computing device 114 may be continuously connected to the industrial machine 112, or may be removably connected to the industrial machine 112. In one approach, the computing device 114 is located at the operating site 110. In other approaches, the computing device 114 is instead located remotely from the industrial machine 112.

[0030] Information received at the computing device 114 from the industrial machine 112 includes operational characteristics of the industrial machine 112. Operational characteristics may include a measured temperature, a measured vibration, a measured pressured, a calculated efficiency, a structural defect, a lifespan of machine, a machine history, and/or a detected position shift. Other examples are possible.

[0031] The computing device 114 may be any type of hardware device such as a personal computer, a tablet, a cellular telephone, and/or a personal digital assistant. Other examples are possible. The computing device 114 may include a processor, an interface (e.g., a computer based program and/or hardware) having an input (which may also include a user input) and an output, a memory, and a display device (e.g., a screen or a graphical user interface which allows for a visualization to be made). In this way, a user of the computing device 114 is able to observe information at the computing device 114 (such as operational characteristics of the industrial machine 112), input information into the computing device 114, send information from the computing device 114 to a remote device (such as at the data center 120 or the central monitoring center 130), and receive information from a remote device. The computer device 114 may be configured to run specific software applications, such as a historian.

[0032] The computing device 114 is operably connected to a data storage module 116. The data storage module 116 includes a memory for short- and/or long-term storage of information received from the computing device 114. Examples of information received and stored at the data storage module 116 include historical information relating to the industrial machine 112, or information received at the computing device from a remote device (such as at the data center 120 or the central monitoring center 130).

[0033] The optional data center 120 is in communication with the operating site 110 (preferably, with the computing device 114 at the operating site) such that the data center 120

can send and/or receive information pertaining to one or more industrial machines 112 located at the operating site 110. The data center 120 may be located at the operating site 110, at the central monitoring center 130, or in a location geographically remote from the operating site 110 and the central monitoring center 130. In one approach, the data center 120 is disposed on a cloud based network.

[0034] The data center 120 includes one or more data storage modules 122 having corresponding memories. The data center 120 may also include one or more computing devices 124 that include a processor, an interface having an input (which may include a user input) and an output, a memory, and a display device (e.g., a screen or a graphical user interface which allows for a visualization to be made). Various applications may be performed at the data center 120, including analytic modeling, anomaly detection, and/or calculations of key performance indicators.

[0035] The central monitoring center 130 includes a computing device 132 that is in communication with the data center 120 such that the central monitoring center 130 can send and/or receive information pertaining to one or more industrial machines 112 located at the operating site 110. Alternatively, the central monitoring center 130 is in communication with the operating site 110 (preferably, with the computing device 114 at the operating site) such that the central monitoring center 130 can send and/or receive information pertaining to one or more industrial machines 112 located at the operating site 110.

[0036] In one example of the operation of the system of 100 of FIG. 1, a problem type or a machine type are identified, typically by personnel or computing devices 132 at the central monitoring center 130. In response to identifying the problem type and the machine type, personnel or computing devices 132 at the central monitoring center 130 determine a first collection of cases that includes a plurality of cases associated with an abnormality detected in an industrial machine or system 112. A first characteristic related to at least one of the identified problem type or the identified machine type is then identified. In response to identifying the first characteristic, at least one additional case not included in the first collection cases is located and compiled, for example, by computing device 132. The combination of the first collection of cases and the at least one additional case forms a second collection of cases.

[0037] A second characteristic related to at least one of the identified problem type or the identified machine type is identified by personnel or computing devices 132 at the central

monitoring center 130. In response to identifying the second characteristic, one or more cases from the second collection of cases are excluded to form a third collection of cases.

[0038] The third collection of cases may be presented to a user, such as a user at the operating site 110, at the data center 120, or at the central monitoring center 130.

[0039] With reference now to FIG. 2, an apparatus 200 (such as computing device 132 of FIG. 1) includes a memory device 202. The memory device 202 stores a case data structure 204 (discussed in greater detail elsewhere herein). The memory device 202 may also store one or more work data plans 206 and/or one or more prior case histories 208. A work data plan 206 includes prior maintenance performed on an industrial machine or system (such as industrial machine 112), as well as scheduled maintenance to be performed on an industrial machine or system in the future. A prior case history 208 includes previous case data structures 204 associated with an industrial machine or system, or with one or more classifications of industrial machines or systems.

[0040] The apparatus 200 further includes an interface 210 including an input 212 (which preferably includes a user input) and an output 214. The apparatus 200 may also include a display device 216. The apparatus 200 includes processor 218 coupled to the memory device 202, and the interface 210, and optionally, the display device 216.

[0041] When an anomaly, abnormality, or incident is detected in an industrial machine or system (such as machine 112 of FIG. 1), a case data structure 204 (or combination of case data structures 204) associated with the case is created and stored in the memory device 202. As used herein, a “case” is associated with an anomaly, an abnormality, or an incident detected in an industrial machine or system, and a “case data structure” 204 includes a data structure that represents a compilation of characteristics of the case. In one approach, the case data structure 204 is generated by personnel at the central monitoring center 130. In another approach, the case data structure 204 is generated at a local computing device (e.g., local computing device 114 at the operating site 110 shown in FIG. 1). In either approach, a user may link evidence, expert interpretation associated with the evidence, metadata describing the particular nature of the industrial machine at issue, and/or other relevant information such that a visual aid is created. When a case is resolved, the case data structure 204 is stored in a memory (e.g., in data storage modules 122 at data center 120, or in a memory device 202 of computing device 132 at the remote monitoring center 130).

[0042] Knowledge of prior cases often provides valuable insight into the resolution of subsequent cases involving the same or similar industrial machines or systems. The apparatus 200 of FIG. 2 may be used to search for and recall (also referred to as “mine”) aggregated case data structures 204.

[0043] In this regard, the input 212 of the interface 210 is configured to receive an identified machine type and an identified problem type. The machine type may be, for example, any type of industrial machine 112 monitored in system 100 as discussed with respect to FIG. 1. The problem type may be any type of anomaly, abnormality, or incident associated with such machines. Collectively, the identified machine type and identified problem type may be referred to as a “blueprint” for mining and forming collections of prior cases. “Blueprint,” as used herein, refers to the focal attributes in identifying like-cases.

[0044] In response to the input 212 receiving the identified problem type and the identified machine type, the processor 218 determines a first collection of cases. This first collection of cases includes a plurality of cases (e.g., case data structures 204) associated with an abnormality detected in the industrial machine or system.

[0045] The input 212 of the interface 210 is further configured to receive a first characteristic related to at least one of the identified problem type, the identified machine type, and information related to the industrial machine or system. In some approaches, the first characteristic comprises a related machine type. In other approaches, the first characteristic comprises a similar problem type. In some aspects, the first characteristic is a plurality of first characteristics.

[0046] In response to the input 212 receiving the first characteristic, the processor 218 locates and compiles at least one additional case not included in the first collection cases. In this way, that the combination of the first collection of cases and the at least one additional case forms a second collection of cases.

[0047] The input 212 of the interface 210 is further configured to receive a second characteristic related to at least one of the identified problem type, the identified machine type, and information relating to the industrial machine or system. For example, the second characteristic may include a geographic location. In some approaches, the second characteristic is a plurality of second characteristics.

[0048] In response to the input 212 receiving the second characteristic, the processor 218 excludes one or more cases from the second collection of cases to form a third collection of cases. The cases comprising the third collection of cases include a case data structure (e.g., case data structure 204) that includes at least an evidence field with evidence, an interpretation field with an interpretation, and a recommendation field with a recommendation.

[0049] The processor may also present, via the output 214, the third collection of cases to a user. In some approaches, the third collection of cases is presented at display device 216 of the apparatus 200. In other approaches, the third collection of cases is presented at a remote display device.

[0050] In some aspects, the processor 218 identifies one or more outcomes provided in one or more of the cases of the third collection of cases. The outcomes may be stored, for example, in a case history field of the case data structure 204 of the respective cases. The one or more outcomes may be, for example, “no action taken,” “operational action taken,” “scheduled action,” and/or “outage.”

[0051] In some approaches, the processor 218 constructs a graphical representation of the one or more outcomes. The processor 218 may effect, e.g., via the output 214, a display of the graphical representation of the one or more outcomes. In some approaches, the graphical representation is presented at display device 216 of the apparatus 200. In other approaches, the graphical representation is presented at a remote display device.

[0052] With reference now to FIG. 3, a case data structure 300 (such as case data structure 204 stored in memory device 202) may include an evidence field 302 with evidence. The evidence includes information associated with the anomaly and/or the industrial machine 112. For example, the evidence associated with the industrial machine or system may include: a measured temperature, a measured vibration, a measured pressured, a calculated efficiency, a structural defect, a lifespan of machine, a machine history, and/or a detected position shift. The evidence may be in the form of advisories, alarms, charts, or reports.

[0053] The case data structure 300 also includes an interpretation field 304 with one or more interpretations. The interpretation includes a user determined condition based at least in part on the evidence. For example, the interpretation may be: a case diagnosis, a case prognosis, a case impact, and/or a case urgency. The interpretation field 304 may further include an impact field 306 for storing a case impact value, and an urgency field 308 for storing a case urgency value.

[0054] The case data structure 300 also includes a recommendation field 310 with one or more recommendations. The recommendation includes a user determined course of action to undertake with respect to the industrial machine or system based at least in part on the interpretation. For example, the recommendation may be: watch, wait, manual inspection, offline analysis, contact subject matter expert, contact original equipment manufacturer, change operation, invasive inspection, minor maintenance, schedule work, and/or shut down.

[0055] The case data structure 300 may also include a rating field 312 for storing one or more ratings. The rating field 312 may include an explanation field 314 for storing a rating explanation and/or a provider field 316 for storing a rating provider.

[0056] The case data structure 300 may also include a permission field 318, a case history field 320, and/or one or more widgets 322. The case history field 320 may include, for example, a case outcome.

[0057] The information contained in a case data structure 300 may not only be used to assist an analyst in ascertaining a solution to the present case, but it also may be used in subsequent cases to better aid analysts from exploring resolutions which have been historically shown to be ineffective. Additionally, the system may be configured to automatically access past cases which may be related to the present case to assist the analyst in determining the best solution. Any information that is used in the present case may also be linked to provide additional information within the apparatus.

[0058] The case data structure 300 is structured so as to allow a user to provide updates to the case, to evidence relating to the case, to their expert interpretation as to the meaning and implication of the evidence (that is, what the issue might be, and what to do about it at a particular time), and to their recommendation regarding actions to be taken. Additional abnormalities which may occur prior to or after the creation of the case data structure 300 may also be linked to the created case data structure 300. Ancillary capabilities such as collaboration, workflow with assignment/request timers, analytic escalation notifications, and other constructs can be input and stored in the case data structure 300. That is, whatever data structure is used, the case data structure 300 is easily modified.

[0059] Turning now to FIG. 4, a method 400 includes identifying 402 a problem type and identifying 404 a machine type. In response to identifying 402 the problem type and identifying 404 the machine type, the method 400 includes determining 406 a first collection of

cases that includes a plurality of cases associated with an abnormality detected in an industrial machine or system.

[0060] The method 400 further includes identifying 408 a first characteristic related to at least one of the identified problem type or the identified machine type. In response to identifying the first characteristic, the method 400 includes locating 410 and compiling at least one additional case that is not included in the first collection cases, such that the combination of the first collection of cases and the at least one additional case forms a second collection of cases.

[0061] The method 400 further includes identifying 412 a second characteristic related to at least one of the identified problem type or the identified machine type. In response to identifying the second characteristic, the method 400 includes excluding 414 one or more cases from the second collection of cases to form a third collection of cases.

[0062] The method 400 further includes presenting 416 the third collection of cases to a user.

[0063] In some approaches, the method 400 includes identifying one or more outcomes provided in one or more of the cases of the third collection of cases.

[0064] In some aspects, the method 400 includes constructing a graphical representation of the one or more outcomes. The method 400 may further include displaying the graphical representation of the one or more outcomes.

[0065] An example implementation will now be discussed with reference now to FIG. 5. In this example 500, an anomaly is detected with regard to a gas turbine located at an operating site. To help identify past “like-cases” that may provide insight into resolving the anomaly, the problem type 502, here, “axial position shift,” is identified. The machine type 504, “General Electric LM2500 turbine,” is also identified. The identified problem type 502 and machine type 504 (“axial position shift on a General Electric LM2500 turbine”) are collectively used as a blueprint for mining for past like-cases.

[0066] Using the identified blueprint, a first collection 506 of cases is accumulated. The accumulation of cases may be performed by a processor (e.g., processor 218). The first collection 506 of like-cases includes a plurality of prior cases (e.g., case data structures 300) matching at least one, and preferably both, of the identified problem type 502 and the identified machine type 504.

[0067] To expand the first collection 506 of returned like-cases, a user enters a first characteristic 508 related to at least one of the identified problem type or the identified machine type. In this example 500, the first characteristic 508 is one or more of: a related machine type (such as “General Electric LM1600” or “General Electric LM6000” turbines), a common alarming parameter associated with the LM2500 turbine (such as a SmartSignal alarm), evidence associated with the LM2500 turbine (such as an oil analysis report), an interpretation (such as a user diagnosis of the problem), and changes to the case data structure.

[0068] Using the first characteristic 508, a second collection 510 of cases is accumulated. The accumulation of cases may be performed by a processor (e.g., processor 218). As shown schematically in FIG. 5, the second collection 510 of like-cases includes a greater number of like-cases than the first collection 506 of like-cases.

[0069] To filter the second collection 510 of returned like-cases, a user enters a second characteristic 512 related to at least one of the identified problem type or the identified machine type. The second characteristic 512 could be a geographic location, for example. In this example 500, the problematic LM2500 turbine is located in a desert environment. By entering the second characteristic 512, the user is able to filter out matches on past like-cases that occurred in less relevant environments (e.g., arctic environments). Entering the second characteristic 512 allows a user to filter the first collection 506 of like-cases to refine the returned cases to hone in closer to a judged representation of the current case. The user may also wish to focus the second collection 510 of returned like-cases by the revising information pertaining to the previously-entered first characteristic 508.

[0070] Using the second characteristic 512, a third collection 514 of cases is accumulated. The accumulation of cases may be performed by a processor (e.g., processor 218). As shown schematically in FIG. 5, the third collection 514 of like-cases includes fewer like-cases than the second collection 510 of like-cases.

[0071] Presented with the third collection 514 of like-cases, a user may review details of the refined collection of cases such as the evidence attached to the case data structures of the matched past cases, the actions taken in the cases, and the outcomes of the cases. As discussed, knowledge of such information may provide greater insight into resolving current or future cases.

[0072] Additional approaches provide for automated identification of at least one of a problem type, a machine type, a first characteristics, and a second characteristic. Automated

identification may be performed by a processor (e.g., processor 218). The automated identification may be performed using information contained in a case data structure (e.g., case data structure 300). For example, using the evidence (e.g., evidence field 302 of case data structure 300), a processor can determine the type of machine, one or more abnormalities associated with the machine, and the location of the machine. Additional approaches include a combination of automated identification and manual identification.

[0073] Preferred embodiments of this invention are described herein, including the best mode known to the inventors for carrying out the invention. It should be understood that the illustrated embodiments are exemplary only, and should not be taken as limiting the scope of the invention.

WHAT IS CLAIMED IS:

1. A method comprising:

identifying a problem type;

identifying a machine type;

in response to identifying the problem type and the machine type, determining a first collection of cases that includes a plurality of cases associated with an abnormality detected in an industrial machine or system;

identifying a first characteristic related to at least one of the identified problem type or the identified machine type;

in response to identifying the first characteristic, locating and compiling at least one additional case not included in the first collection cases, such that the combination of the first collection of cases and the at least one additional case forms a second collection of cases;

identifying a second characteristic related to at least one of the identified problem type or the identified machine type;

in response to identifying the second characteristic, excluding one or more cases from the second collection of cases to form a third collection of cases;

presenting the third collection of cases to a user.

2. The method of claim 1, further comprising:

identifying one or more outcomes provided in one or more of the cases of the third collection of cases.

3. The method of claim 2, wherein the one or more outcomes are selected from the group consisting of no action, operational change, scheduled maintenance, or outage.

4. The method of claim 2, further comprising:

constructing a graphical representation of the one or more outcomes.

5. The method of claim 4, further comprising:

displaying the graphical representation of the one or more outcomes.
6. The method of claim 1, wherein the first characteristic comprises a related machine type.
7. The method of claim 1, wherein the first characteristic comprises a similar problem type.
8. The method of claim 1, wherein the second characteristic comprises a geographical location characteristic.
9. The method of claim 1, wherein cases comprising the third collection of cases include a case data structure comprising:
 - an evidence field with evidence;
 - an interpretation field with an interpretation; and
 - a recommendation field with a recommendation.
10. An apparatus, the apparatus comprising:

an interface comprising an input and an output, the input configured to receive:
 - an identified problem type;
 - an identified machine type;
 - a first characteristic related to at least one of the identified problem type or the identified machine type;
 - a second characteristic related to at least one of the identified problem type or the identified machine type;
a processor coupled to the interface, the processor configured to:
 - in response to the input receiving the identified problem type and the identified machine type, determine a first collection of cases that includes a plurality of cases associated with an abnormality detected in the industrial machine or system;
 - in response to the input receiving the first characteristic, locate and compile at least one additional case not included in the first collection cases, such that the combination of the

first collection of cases and the at least one additional case forms a second collection of cases;

- in response to the input receiving the second characteristic, exclude one or more cases from the second collection of cases to form a third collection of cases; and
- present via the output the third collection of cases to a user.

11. The apparatus of claim 10, wherein the processor is further configured to identify one or more outcomes provided in one or more of the cases of the third collection of cases.
12. The apparatus of claim 11, wherein the one or more outcomes are selected from the group consisting of no action, operational change, scheduled maintenance, or outage.
13. The apparatus of claim 11, wherein the processor is further configured to construct a graphical representation of the one or more outcomes.
14. The apparatus of claim 13, wherein the processor is further configured to effect via the output a display of the graphical representation of the one or more outcomes.
15. The apparatus of claim 10, wherein the first characteristic comprises a related machine type.
16. The apparatus of claim 10, wherein the first characteristic comprises a similar problem type.
17. The apparatus of claim 10, wherein the second characteristic comprises a geographical location characteristic.
18. The apparatus of claim 10, wherein cases comprising the third collection of cases include a case data structure comprising:
 - an evidence field with evidence;
 - an interpretation field with an interpretation; and
 - a recommendation field with a recommendation.

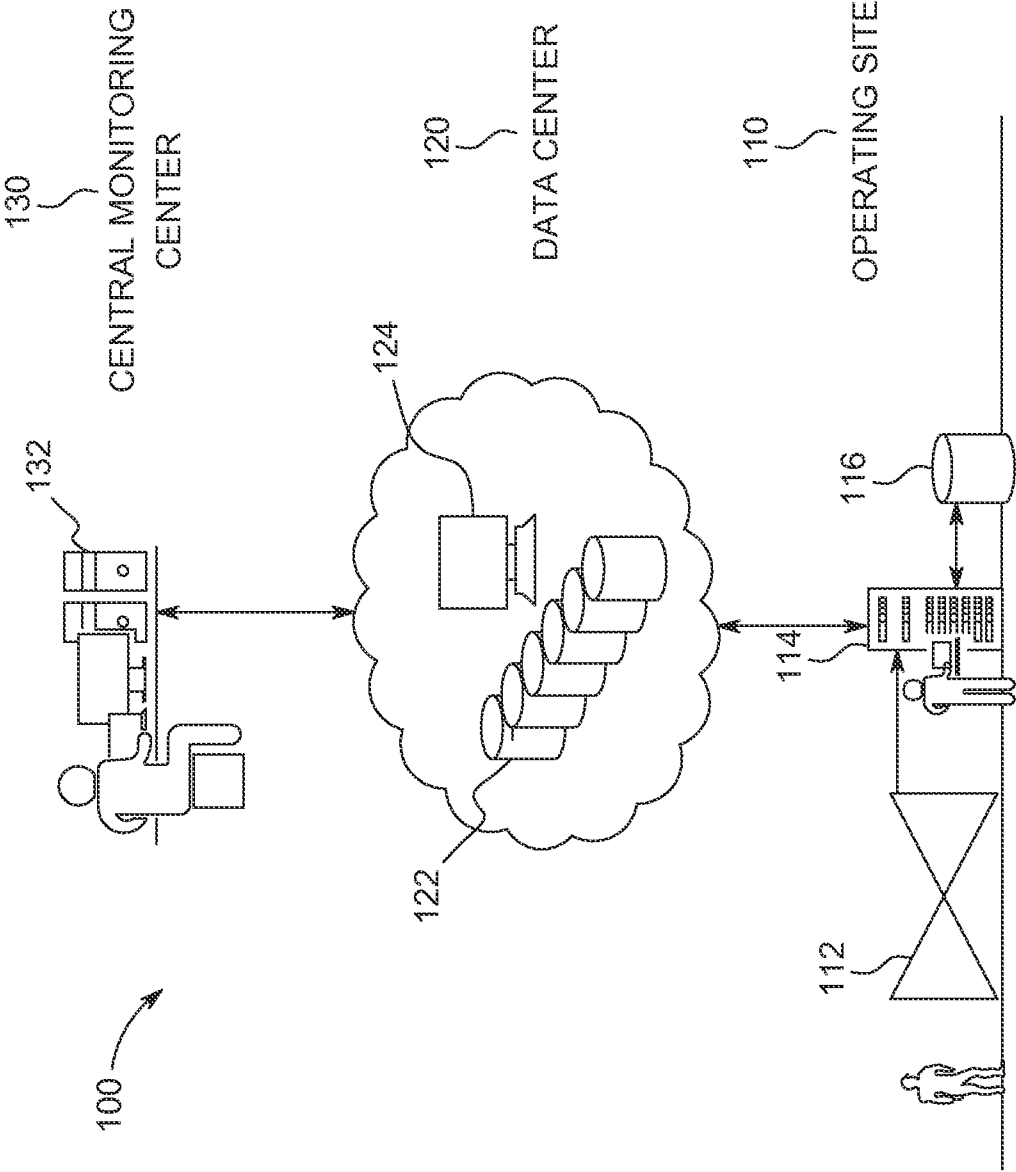


FIG. 1

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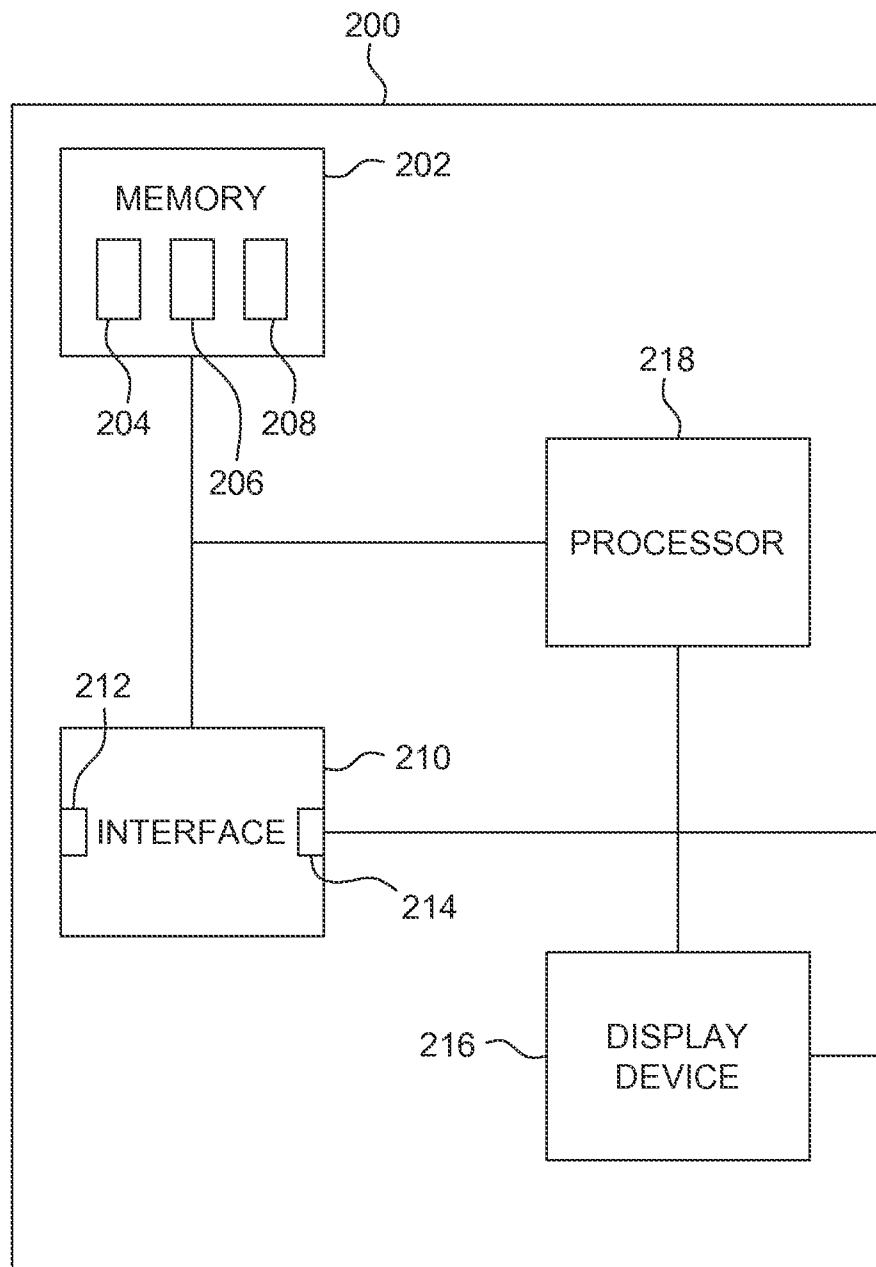


FIG. 2

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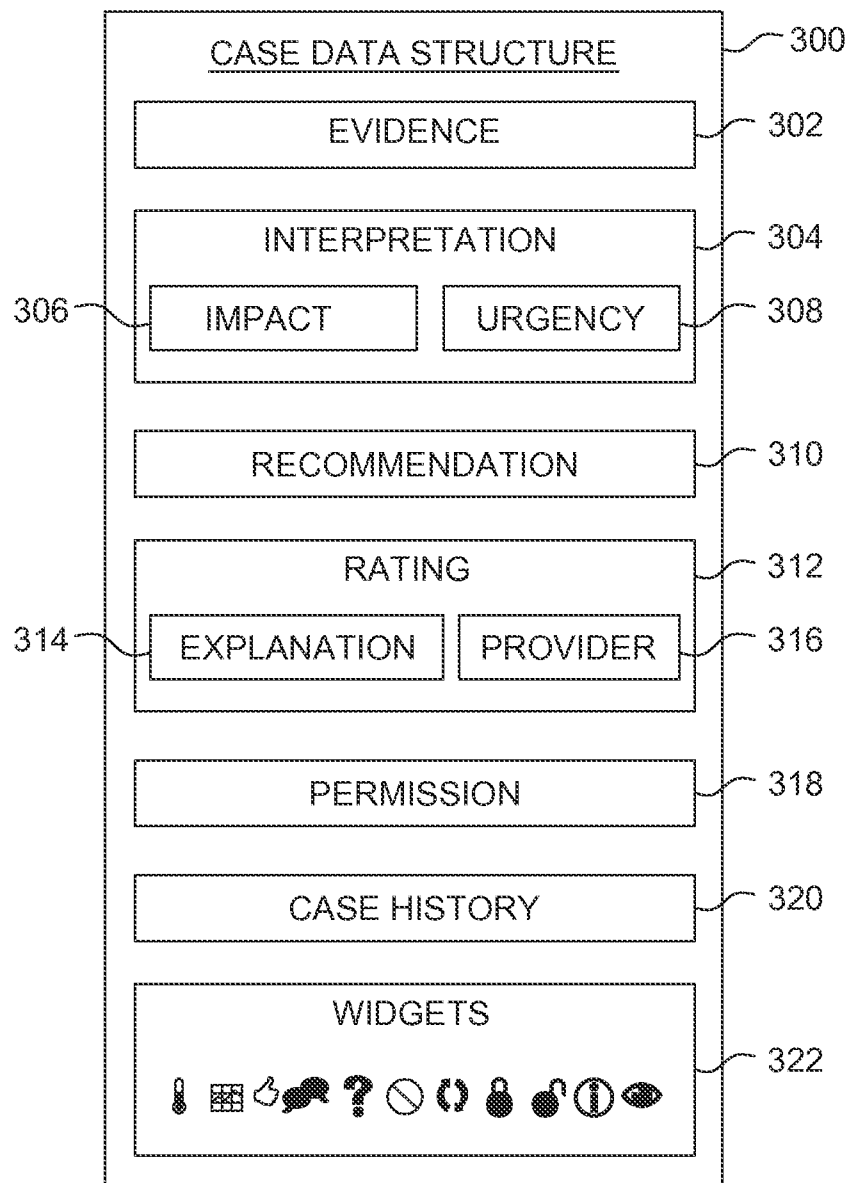


FIG. 3

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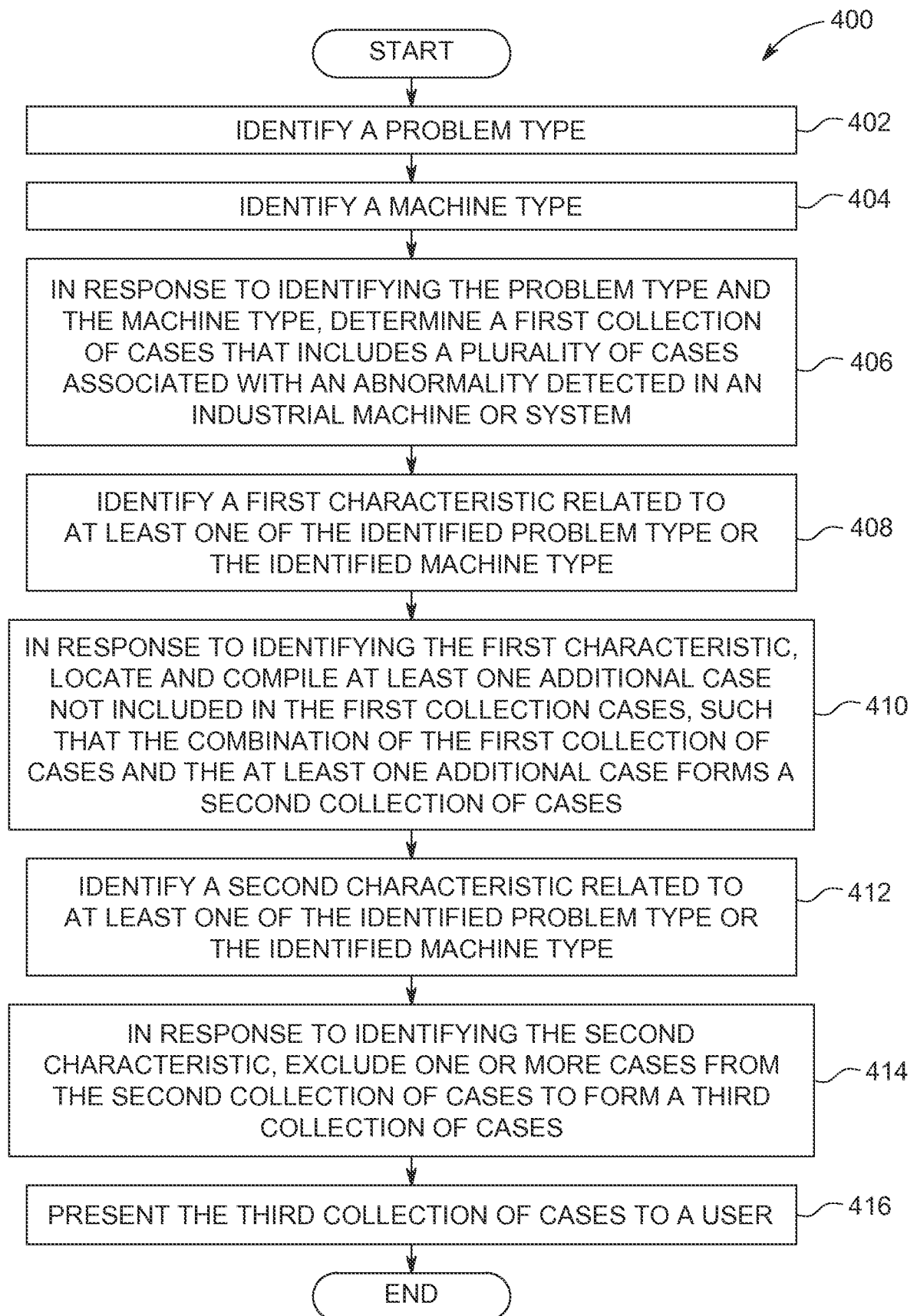


FIG. 4

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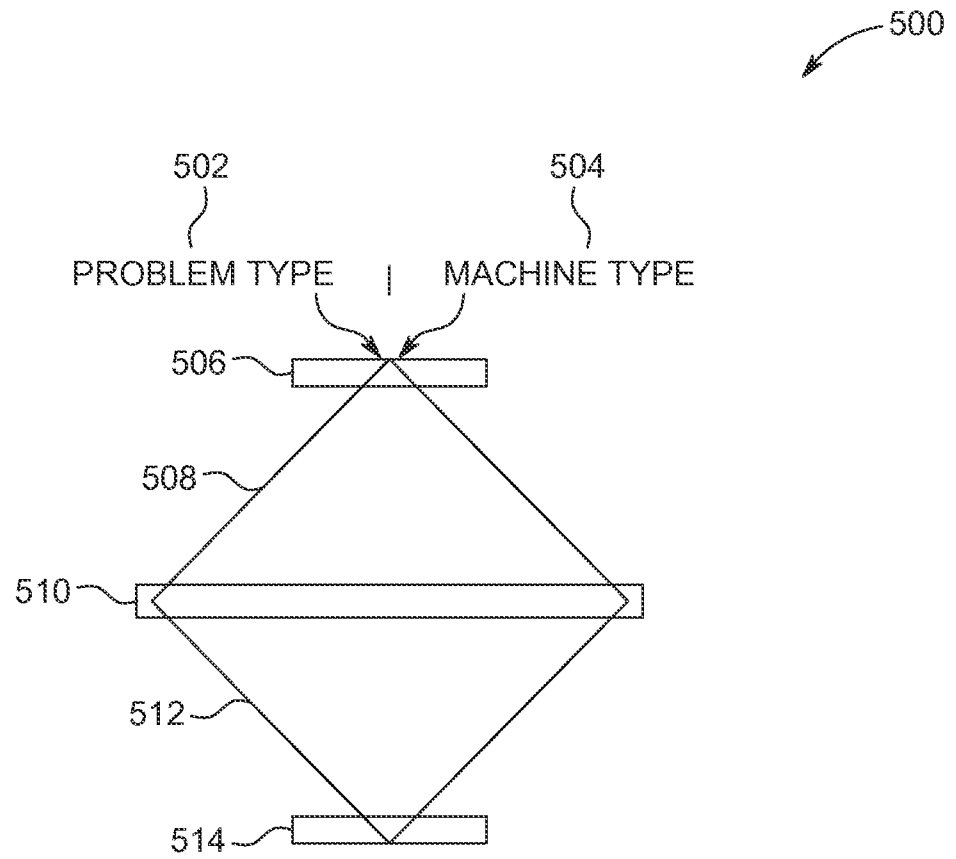


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2015/051673A. CLASSIFICATION OF SUBJECT MATTER
INV. G06Q10/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G06Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2015/161573 A1 (UCHIDA TAKAYUKI [JP] ET AL) 11 June 2015 (2015-06-11) the whole document -----	1-18



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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"&" document member of the same patent family

Date of the actual completion of the international search

4 May 2016

Date of mailing of the international search report

18/05/2016

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2015/051673

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2015161573 A1	11-06-2015	CN 104487998 A	01-04-2015
		EP 2874115 A1	20-05-2015
		JP 5820072 B2	24-11-2015
		US 2015161573 A1	11-06-2015
		WO 2014010039 A1	16-01-2014
