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(54) **Condition monitoring**

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Surveillance d'état

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Description

[0001] This invention relates to a condition monitoring system for a railway network, a railway network comprising such a condition monitoring system, and a method of condition monitoring of railway equipment.

[0002] More particularly, this invention relates to arranging for local compression or consolidation in condition monitoring systems, in order to reduce the communications bandwidth required to transmit condition monitoring or measuring data to a central system.

Background

[0003] There is an increasing desire to gather condition management data from across the various different systems deployed within railway systems, in order to construct condition management systems, with the ultimate aim of improving reliability and availability of the railway.

[0004] Typically, this is achieved using either extra measuring or monitoring equipment, or else building such measuring or monitoring equipment into the railway systems themselves. Whichever method is used, there are potentially large amounts of data generated. As examples which can generate large amounts of data may be mentioned:

i) Points condition monitoring equipment, which measure current drawn by points motors during movement of the points. Typically these will require some hundreds of current values each time a point moves.

ii) Track circuit condition monitoring equipment, which measures current and/or voltage within the track circuit, to enable the profile of shunting of track circuits by trains to be examined.

iii) Signal lamp condition monitoring equipment, which measures inrush current as a signal lamp is turned on.

iv) Points condition monitoring equipment, which measures air pressure used to drive pneumatically-operated points during points movement.

[0005] A typical architecture with separate condition monitoring is shown in the accompanying drawing, in which blocks 1, 1' are field locations, for example track-side locations, and block 2 is an "office" location, i.e. a centralised location, which may be remote from each field location 1, 1', and which houses complex or expensive equipment, and which may oversee operations at a number of different field locations. Although two field locations 1 and 1' are shown in Fig. 1, such systems may include any practical number of such field locations. In the field location 1, remote equipment 3, such as a points machine, track circuit equipment, signal lamp equipment

is controlled by a remote equipment controller 4, which in turn is coupled with an interlocking 5 at the office location 2. Also in the field location 1 there is a condition monitoring unit 6, for example a points machine current monitoring unit, coupled with the remote equipment 3 and which sends data to a condition management facility 7 at the office location 2. Each additional field location 1' may have similar equipment and connectivity to office location 2. The condition management facility 7 is operable to collate and process the condition monitoring data received from the condition monitoring unit 6, to assess functioning of the equipment 3 and to determine if there are any errors occurring or maintenance issues to be addressed. Depending on the type of error detected by condition management system 7, the system 7 may instigate maintenance activities on the equipment, in order to pre-empt failures.

[0006] A problem with this system is the need for a relatively large communications bandwidth, to transmit the condition monitoring data, which as noted above may be large, from the remote field location 1 to the office location 2.

[0007] In many instances, there may not be a readily available communications system from remote field locations to the office location, as the only current communications system is for the vital controlling of the railway equipment, and it would not be practicable or acceptable to superimpose non-vital condition monitoring data on this system.

[0008] As prior art may be mentioned US-A1-2006/020375, US-A-5743495 and US-A1-2008/296441, which show the pre-characterising features of claim 1.

Description of the invention

[0009] It is an aim of the present invention to overcome this problem. This aim is achieved by the system of claim 1 and the method of claim 8, thereby consolidating the condition monitoring or measuring data remotely, to a relatively small number of discrete values, and then transmitting these to the central office location.

[0010] This will have two effects:

- i) There will be a degradation of the condition monitoring or measuring data available in the central office location; and
- ii) There will be a reduction in the bandwidth requirements to transmit the condition monitoring or measuring data from the remote field locations to the central office location.

[0011] The ideal solution consolidates the data just enough so that it can be carried by the available bandwidth. As long as relatively minor consolidation is performed, then adequate monitoring may still be achieved.

[0012] In accordance with a first aspect of the present invention there is provided a condition monitoring system

according to claim 1. In accordance with a second aspect of the present invention there is provided a railway network according to claim 7. In accordance with a third aspect of the present invention there is provided a method of condition monitoring according to claim 8. Accordingly, the present invention enables:

a) A process or system for the consolidation of data representing a waveform to a series of discrete values which still permit the necessary condition management processing, thus permitting the gathering of data even when there is low bandwidth available, without providing an additional communications system.

b) Application of such a process or system to the railway domain, to enable wider condition management.

c) A system or process in which condition monitoring or measuring data from condition monitoring or measuring means at a remote location is consolidated to a number of discrete values and these are transmitted to a central location at a bandwidth less than necessary for transmitting all of said condition monitoring or measuring data.

[0013] The present invention is suitable for both for retrofitting to existing installations, or for implementation in new installations.

Detailed description

[0014] The invention will now be described with reference to the accompanying figures, of which:

Fig. 1 schematically shows a typical conditioning monitoring system;

Fig. 2 schematically shows a condition monitoring system in accordance with an embodiment of the present invention; and

Fig. 3 shows a typical waveform of a measured variable.

[0015] Fig. 2 schematically shows a condition monitoring system in accordance with an embodiment of the present invention. As far as possible, similar components to those of Fig. 1 are denoted with similar reference numerals.

[0016] As shown, as in Fig. 1, blocks 1, 1' are field locations, for example trackside locations, and block 2 is an "office" location, i.e. a centralised location, which may be remote from each field location 1, 1', and which houses complex or expensive equipment, and which may oversee operations at a number of different field locations. Although two field locations 1 and 1' are shown in Fig. 2, such systems may include any practical number of such field locations. In the field location 1, remote equipment

3, such as a points machine, track circuit or signal lamp is controlled by a remote equipment controller 4, which in turn is coupled with an interlocking 5 at the office location 2. Also in the field location 1 there is a condition monitoring unit 6, for example a points machine current monitoring unit, coupled with the remote equipment 3. Linked with condition monitoring unit 6, and adapted to receive condition monitoring data from condition monitoring unit 6, is a data consolidation unit 8 for consolidating said data, the functioning of which will be described in more detail below.

[0017] Data consolidation unit 8 sends consolidated condition monitoring data to a condition management facility 7 at the office location 2. Each additional field location 1' may have similar equipment and connectivity to office location 2. In Fig. 2, field locations are shown as having separate, individual connections to office location 2, however it is alternatively possible to use bus communications instead, such that each field location communicates with office location 2 via a common communications bus.

[0018] The condition management algorithms at the office location 2 are adapted to process the consolidated data, and raise any necessary alarms and warnings.

Data consolidation

[0019] As mentioned above, data consolidation unit 8 performs consolidation of the condition monitoring data received from condition monitoring unit 6, to produce a number of discrete values representative of the waveform, such that the original waveform could be at least partially reconstructed from those discrete values. Various different types of consolidation are possible. For example, Fig. 3 schematically shows a waveform representing the variation of a parameter ("A") over time ("t") during a discrete event. In practice, such parameters may comprise the current drawn by points motors during movement of the points, or the current / voltage measured within a particular track circuit during passage by a train. For simplicity, the waveform shown is exemplary only, and generally the waveform will be dependent upon the parameter in question.

[0020] The waveform can, for example, be characterised by the following values:

- i) Average value of the parameter over the duration of the discrete event - $\bar{A}$
- ii) Duration of event ($t_2 - t_1$)
- iii) Maximum value of the parameter during the event - " A_{peak} "
- iv) Parameter value after specific time interval(s) from the start of the event - A_t
- v) Average value of the parameter in specific time frame(s) (Δt) - $\bar{A}_{\Delta t}$

It will be recognised that there are other ways of describ-

ing the waveform of A, for example the time taken for A to reach its peak value A_{peak} or the time taken to return to its base level.

[0021] It will be noted that various of these values depend upon identifying the start and / or conclusion of a discrete event. There are various ways of doing this, dependent on the type of event in question. According to the invention as claimed, processing means, which may be located within condition monitoring unit 6, is set to identify the start and conclusion of the event by analysing the sensor data directly, e.g. by detecting a statistically significant change in the sensed value of the parameter, and correlating this to either the start or conclusion of an event. Additionally, the event may be detected by other means, for example point movement may be correlated with sensors mounted on the points to directly determine movement, or by synchronising the event duration with the application of current to the points motors.

[0022] The exact consolidation methods applied will be determined by the condition management processing required in the office location, noting that there will always be a compromise between high detail (i.e. a closer representation of the waveform) leading to a correspondingly high volume of data to be sent to office location 2, and low detail (i.e. a "sparser" representation of the waveform) leading to a correspondingly low volume of data to be sent to the office location 2.

[0023] Whichever consolidation technique is used however, the basic functioning is similar - the full condition monitoring data is passed from condition monitoring unit 6 to data consolidation unit 8, which analyses the incoming data, and consolidates it to produce as many representative values as required, such as those values set out above.

[0024] The consolidated data are then transmitted to the condition management facility 7 at the office location 2. This requires less bandwidth than transmission of original, unconsolidated data. Since the data is consolidated rather than compressed, no additional equipment / functionality is required at office location 2, although the algorithms employed by office location 2 must be adapted to process the consolidated data.

[0025] Although the consolidated data does not contain all the information of the original data obtained from the sensors provided at remote equipment 3, by suitable selection of the consolidation technique employed, sufficient information may be received by condition management facility 7 to enable adequate monitoring, fault detection / diagnosis and control of the remote equipment 3. Furthermore, in the case where the inventive methodology is retrofitted to an existing installation, the transmission may still be enabled over the existing communications system.

[0026] The above-described embodiment is exemplary only, and various alternatives within the scope of the claims will be apparent to those skilled in the art. For example, Fig. 2 shows data consolidation unit 8 being a separate component to condition monitoring unit 6. Rath-

er than having a separate unit 8, it is possible to include consolidation means, e.g. circuitry, within condition monitoring unit 6 itself. In this case, each data consolidation means may be retro-fitted to existing condition monitoring units 6 / 6'. In other embodiments, the controlling software for condition monitoring unit 6 may be adapted to include data consolidation capabilities.

10 Claims

1. A condition monitoring system suitable for a railway network comprising:

a sensor (6) for producing condition monitoring data relating to the operation of railway equipment, wherein the data describes a waveform of a parameter;

consolidation means (8) for processing the data produced by the sensor to produce a consolidated data set which comprises a plurality of discrete values representative of the waveform of the parameter; and

output means for outputting the consolidated data set, wherein the sensor (6), the consolidation means (8) and the output means are located at a trackside location (1), **characterized by** further comprising processing means set to identify the start and conclusion of the waveform by analyzing the condition monitoring data.

2. A condition monitoring system according to claim 1, further comprising a condition management facility (7) for processing the consolidated data set, and transmission means for transmitting the output consolidated data set to the condition management facility (7).

3. A condition monitoring system according to claim 2, wherein the condition management facility (7) is located at a location remote from the trackside location (1).

4. A condition monitoring system according to any preceding claim, wherein the discrete values are selected from the group comprising: the average value of the parameter over the duration of a discrete event, the duration of said discrete event, the maximum value of the parameter during said discrete event, the parameter value after a specific time interval from the start of said discrete event, and the average value of the parameter during a specific time frame.

5. A condition monitoring system according to any preceding claim, for monitoring the condition of railway points.

6. A condition monitoring system according to any of

claims 1 to 5, for monitoring railway track circuits.

7. A railway network comprising the condition monitoring system of any preceding claim.

8. A method of condition monitoring of railway equipment, comprising the steps of:

a) producing, by a sensor (6), condition monitoring data relating to the operation of the equipment, wherein the data describes a waveform of a parameter;
b) processing, by consolidation means (8), the produced condition monitoring data to produce a consolidated data set which comprises a plurality of discrete values representative of the waveform of the parameter; and
c) outputting, by output means, the consolidated data set; wherein the sensor (6), the consolidation means (8) and the output means are located at a trackside location (1),
the method being **characterized by** further identifying the start and conclusion of the waveform by analyzing the condition monitoring data with processing means.

9. A method according to claim 8, wherein the discrete values are selected from the group comprising: the average value of the parameter over the duration of a discrete event, the duration of said discrete event, the maximum value of the parameter during said discrete event, the parameter value after a specific time interval from the start of said discrete event, and the average value of the parameter during a specific time frame.

10. A method according to any of claims 8 to 9, for monitoring the condition of railway points.

11. A method according to any of claims 8 to 9, for monitoring railway track circuits.

Patentansprüche

1. Für ein Eisenbahnnetz geeignetes Zustandsüberwachungssystem, umfassend:

einen Sensor (6) zur Erzeugung von den Betrieb von Eisenbahnanlagen betreffenden Zustandsüberwachungsdaten, wobei die Daten den Signalverlauf eines Parameters beschreiben, Konsolidierungseinrichtungen (8) zur Verarbeitung der von dem Sensor erzeugten Daten, um einen konsolidierten Datensatz zu erzeugen, welcher eine Mehrzahl für den Signalverlauf des Parameters repräsentativer diskreter Werte umfasst, und

Ausgabeeinrichtungen zur Ausgabe des konsolidierten Datensatzes, wobei der Sensor (6), die Konsolidierungseinrichtungen (8) und die Ausgabeeinrichtungen sich an einem gleisseitigen Ort (1) befinden, **gekennzeichnet durch** weiteres Umfassen von zum Identifizieren des Beginns und Endes des Signalverlaufs durch Analysieren der Zustandsüberwachungsdaten eingestellten Verarbeitungseinrichtungen.

2. Zustandsüberwachungssystem nach Anspruch 1, ferner umfassend eine Zustandsmanagementeinrichtung (7) zur Verarbeitung des konsolidierten Datensatzes und Sendeeinrichtungen zum Senden des ausgegebenen konsolidierten Datensatzes an die Zustandsmanagementeinrichtung (7).

3. Zustandsüberwachungssystem nach Anspruch 2, wobei sich die Zustandsmanagementeinrichtung (7) an einem von dem gleisseitigen Ort (1) entfernten Ort befindet.

4. Zustandsüberwachungssystem nach einem der vorhergehenden Ansprüche, wobei die diskreten Werte aus der Gruppe ausgewählt werden, welche Folgendes umfasst: den Mittelwert des Parameters über die Dauer eines diskreten Ereignisses, die Dauer dieses diskreten Ereignisses, den Maximalwert des Parameters während dieses diskreten Ereignisses, den Parameterwert nach einem bestimmten Zeitintervall vom Beginn dieses diskreten Ereignisses und den Mittelwert des Parameters während eines spezifischen Zeitrahmens.

5. Zustandsüberwachungssystem nach einem der vorhergehenden Ansprüche zur Überwachung des Zustands von Schienenweichen.

6. Zustandsüberwachungssystem nach einem der Ansprüche 1 bis 5 zur Überwachung von Eisenbahn-Gleisstromkreisschaltungen.

7. Eisenbahnnetz, welches das Zustandsüberwachungssystem nach einem der vorhergehenden Ansprüche umfasst.

8. Verfahren zur Zustandsüberwachung von Eisenbahnanlagen, welches die folgenden Schritte umfasst:

a) Erzeugung, durch einen Sensor (6), von den Betrieb der Anlagen betreffenden Zustandsüberwachungsdaten, wobei die Daten einen Signalverlauf eines Parameters beschreiben,
b) Verarbeitung, durch Konsolidierungseinrichtungen (8), der erzeugten Zustandsüberwachungsdaten, um einen konsolidierten Datensatz zu erzeugen, welcher eine Mehrzahl für den

Signalverlauf des Parameters repräsentativer diskreter Werte umfasst, und

c) Ausgabe, durch Ausgabeeinrichtungen, des konsolidierten Datensatzes, wobei der Sensor (6), die Konsolidierungseinrichtungen (8) und die Ausgabeeinrichtungen sich an einem gleisseitigen Ort (1) befinden, wobei das Verfahren **gekennzeichnet ist durch** weiteres Identifizieren des Beginns und Endes des Signalverlaufs durch Analysieren der Zustandsüberwachungsdaten mit Verarbeitungseinrichtungen.

9. Verfahren nach Anspruch 8, wobei die diskreten Werte aus der Gruppe ausgewählt werden, welche Folgendes umfasst: den Mittelwert des Parameters über die Dauer eines diskreten Ereignisses, die Dauer dieses diskreten Ereignisses, den Maximalwert des Parameters während dieses diskreten Ereignisses, den Parameterwert nach einem bestimmten Zeitintervall vom Beginn dieses diskreten Ereignisses und den Mittelwert des Parameters während eines spezifischen Zeitrahmens.

10. Verfahren nach einem der Ansprüche 8 bis 9 zur Überwachung des Zustands von Schienenweichen.

11. Verfahren nach einem der Ansprüche 8 bis 9 zur Überwachung von Eisenbahn-Gleisstromkreisschaltungen.

Revendications

1. Système de surveillance d'état adapté à un réseau ferroviaire comprenant :

un capteur (6) servant à produire des données de surveillance d'état relatives au fonctionnement d'un équipement ferroviaire, étant entendu que les données décrivent une forme d'onde d'un paramètre ;

un moyen d'agrégation (8) servant à traiter les données produites par le capteur en vue de produire un jeu de données agrégées qui consiste en une pluralité de valeurs discrètes représentatives de la forme d'onde du paramètre, et un moyen de sortie servant à sortir le jeu de données agrégées, étant entendu que le capteur (6), le moyen d'agrégation (8) et le moyen de sortie sont situés sur un emplacement en bord de voie (1),

caractérisé en ce qu'il comprend par ailleurs un moyen de traitement réglé en vue d'identifier le début et la conclusion de la forme d'onde en analysant les données de surveillance d'état.

2. Système de surveillance d'état selon la revendication 1, comprenant par ailleurs une installation de

gestion d'état (7) servant à traiter le jeu de données agrégées, et un moyen de transmission servant à transmettre à l'installation de gestion d'état (7) le jeu de données agrégées sorti.

3. Système de surveillance d'état selon la revendication 2, dans lequel l'installation de gestion d'état (7) est située sur un emplacement distant de l'emplacement en bord de voie (1).

4. Système de surveillance d'état selon l'une quelconque des revendications précédentes, dans lequel les valeurs discrètes sont sélectionnées dans le groupe comprenant : la valeur moyenne du paramètre sur la durée d'un événement discret, la durée dudit événement discret, la valeur maximale du paramètre pendant ledit événement discret, la valeur du paramètre après un intervalle de temps spécifique à partir du début dudit événement discret et la valeur moyenne du paramètre pendant un laps de temps spécifique.

5. Système de surveillance d'état selon l'une quelconque des revendications précédentes, servant à surveiller l'état des aiguilles de voies ferrées.

6. Système de surveillance d'état selon l'une quelconque des revendications 1 à 5, servant à surveiller des circuits de voies ferrées.

7. Réseau ferroviaire comprenant le système de surveillance d'état selon l'une quelconque des revendications précédentes.

8. Procédé de surveillance de l'état d'un équipement ferroviaire, comprenant les étapes consistant :

a) à faire produire, par un capteur (6), des données de surveillance d'état relatives au fonctionnement de l'équipement, étant entendu que les données décrivent une forme d'onde d'un paramètre ;

b) à faire traiter, par un moyen d'agrégation (8), les données produites sur la surveillance d'état en vue de produire un jeu de données agrégées qui comprend une pluralité de valeurs discrètes représentatives de la forme d'onde du paramètre, et

c) à faire sortir, par le moyen de sortie, le jeu de données agrégées,

étant entendu que le capteur (6), le moyen d'agrégation (8) et le moyen de sortie sont situés sur un emplacement en bord de voie (1),

le procédé étant **caractérisé en ce qu'il** identifie par ailleurs le début et la conclusion de la forme d'onde en analysant les données de surveillance d'état avec le moyen de traitement.

9. Procédé selon la revendication 8, dans lequel les valeurs discrètes sont sélectionnées dans le groupe comprenant : la valeur moyenne du paramètre sur la durée d'un événement discret, la durée dudit événement discret, la valeur maximale du paramètre pendant ledit événement discret, la valeur du paramètre après un intervalle de temps spécifique à partir du début dudit événement discret et la valeur moyenne du paramètre pendant un laps de temps spécifique. 5 10
10. Procédé selon l'une quelconque des revendications 8 à 9, servant à surveiller l'état des aiguilles de voies ferrées. 15
11. Procédé selon l'une quelconque des revendications 8 à 9, servant à surveiller des circuits de voies ferrées. 20
- 25
- 30
- 35
- 40
- 45
- 50
- 55

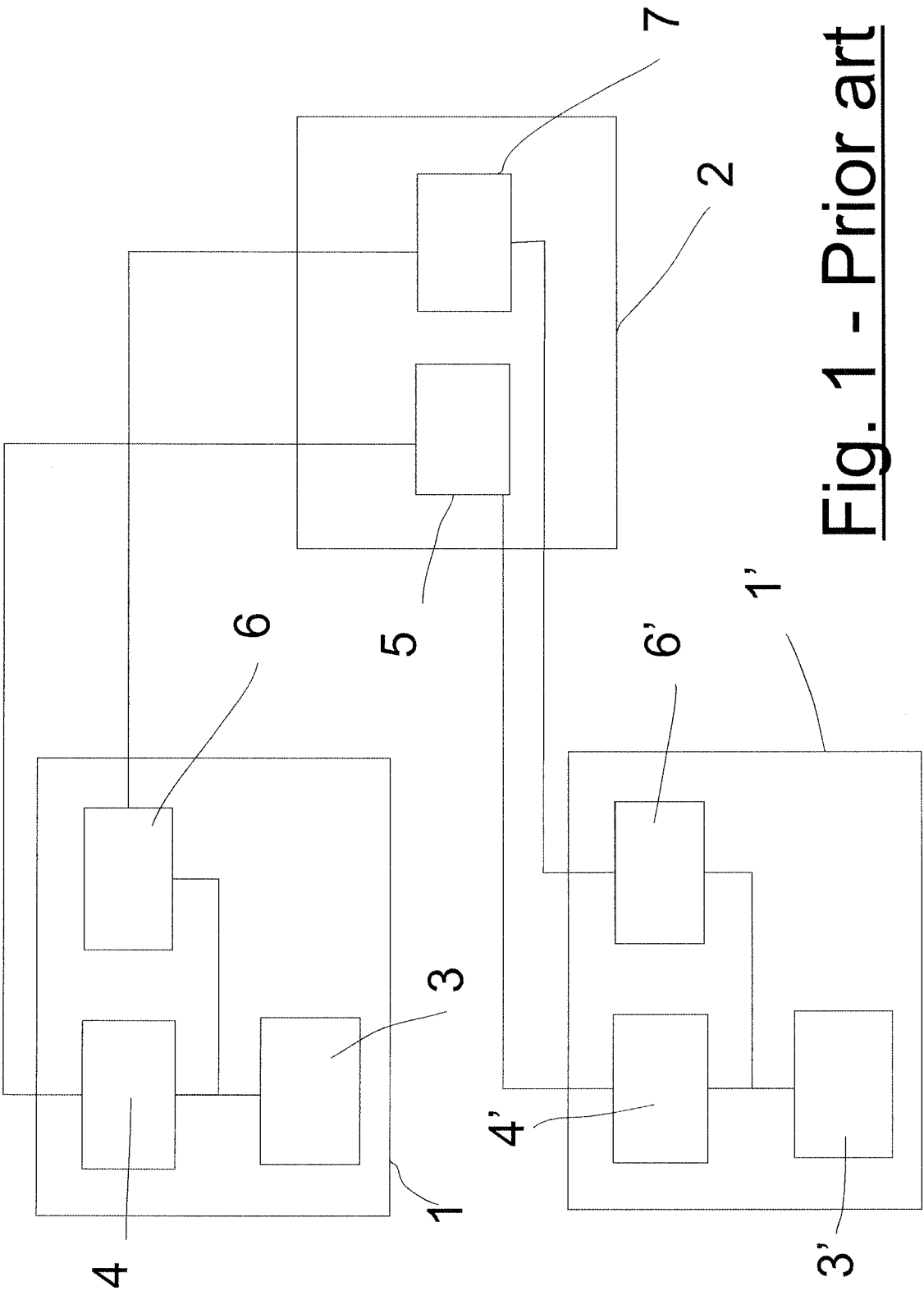


Fig. 1 - Prior art

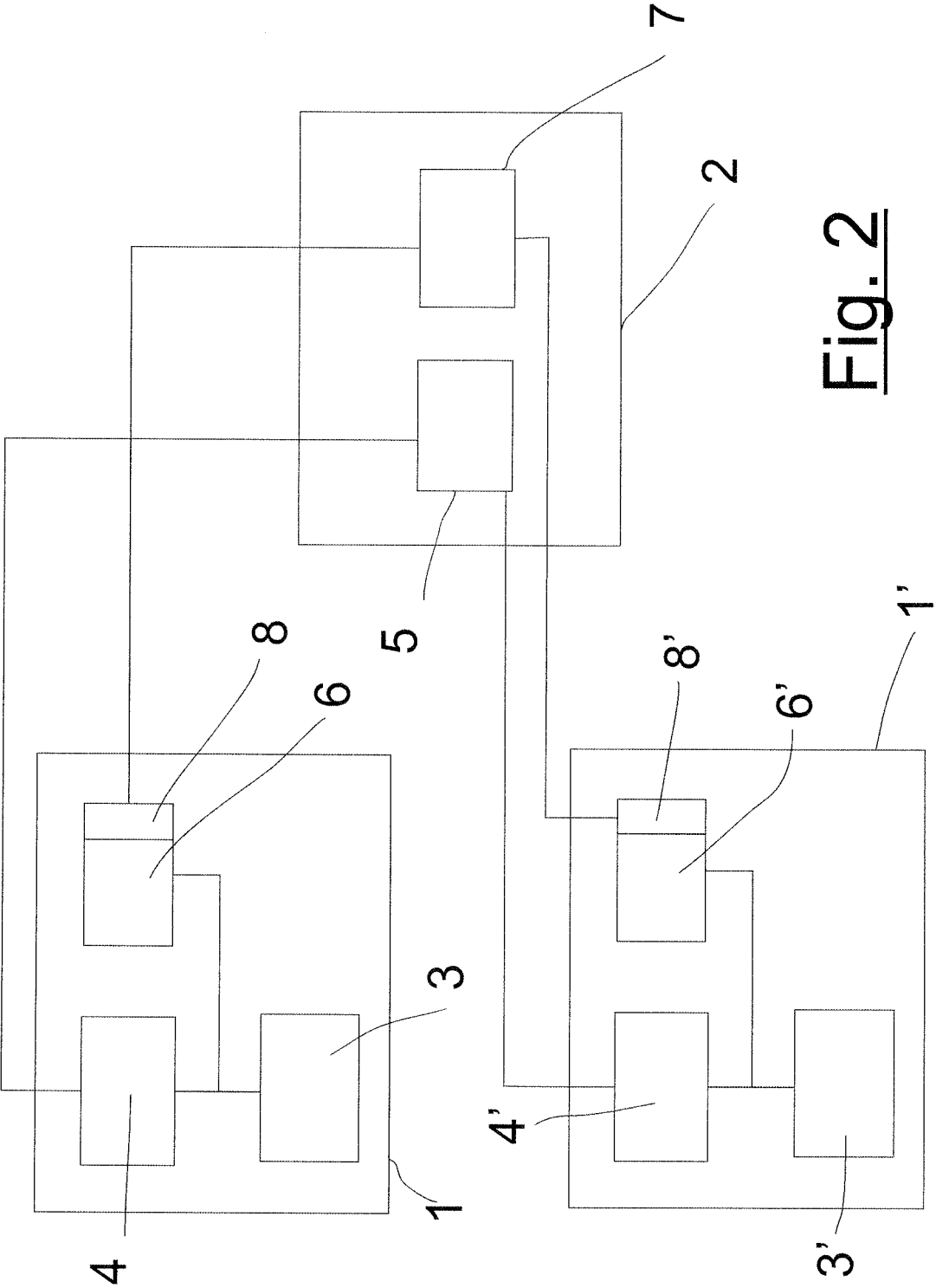
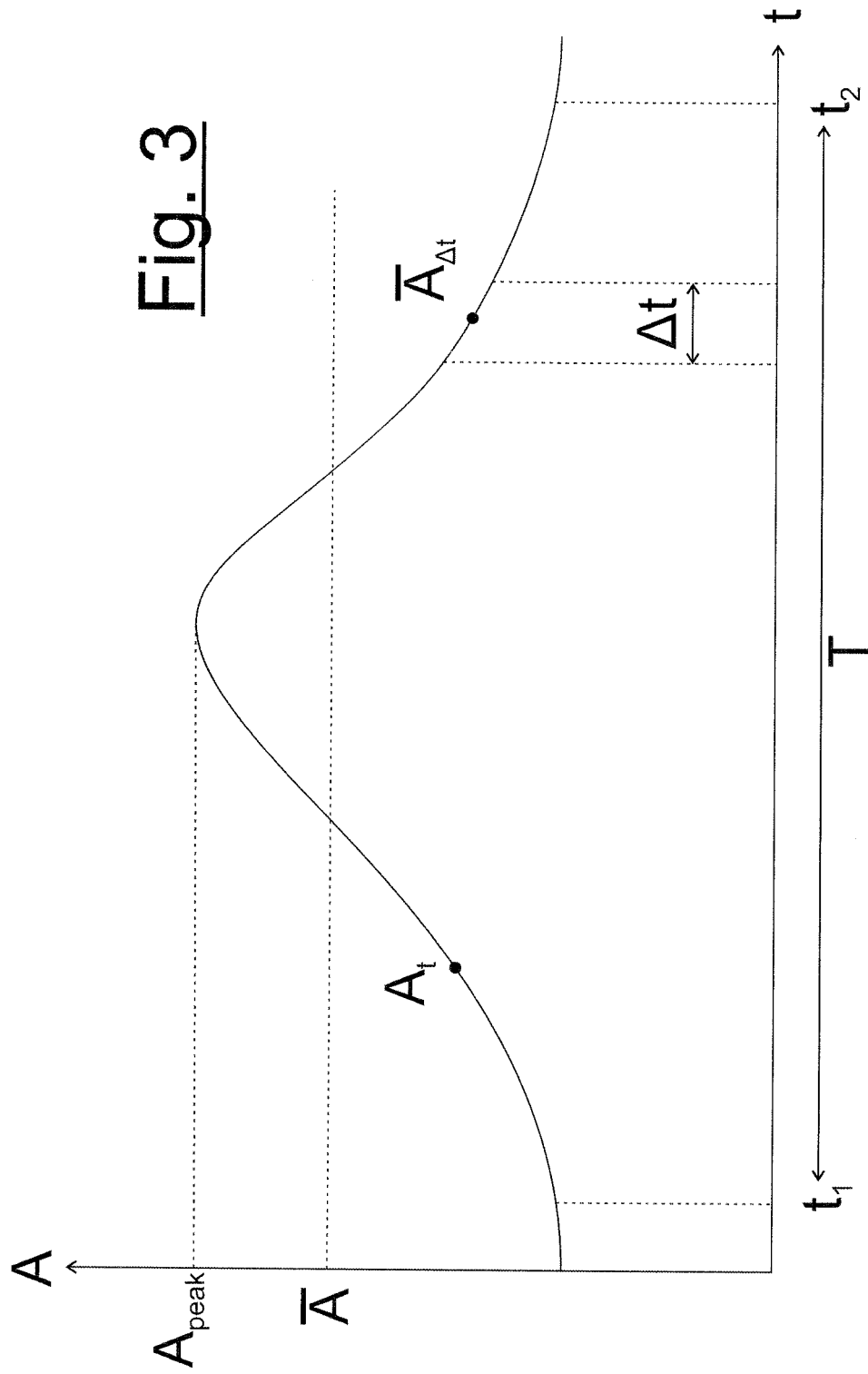


Fig. 2



REFERENCES CITED IN THE DESCRIPTION

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