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Fig 2

Description

TECHNICAL FIELD

[0001] The present technology relates to a balancing method and balancing system for balancing of a ventilation system.

BACKGROUND

[0002] When balancing ventilation systems, the permanent dampers of the systems have to be adjusted in the ventilation system. At least two operators work together to adjust the dampers to set airflow through supply diffusers to match predetermined specifications. One of the operators lifts up and holds a capture hood airflow probe against a diffuser, reads a meter attached to the capture hood and informs the second person, who has taken a position at the damper for adjusting its setting. The damper controlling the diffuser may be situated in the same space close to the diffuser or in another space of the building. A stand or jack can be employed to hold the capture hood against the diffuser. It that case, if the service person is alone, the person has to leave the damper, walk to the capture hood, read the result on the meter and return to the damper to make another adjustment. The described procedure may be iterated a couple of times until the airflow through the diffuser fulfills the specification or wanted air flow.

[0003] The procedure becomes more laborious if the procedure involves long distance between the diffuser and damper and climbing of ladders to be able to reach the damper and/or read the air flow meter of the capture hood.

[0004] A common example is the Proportional Balancing Method. Specifications often require that supply air diffusers be adjusted so that their airflows are all the same percentage of a specified airflow. For instance, if there are three diffusers, and the air available is 10% less than specified, then each air diffuser should be set to 90% of the specified flow.

[0005] Duct systems with dampers and supply diffusers and return grills have paths of resistance for airflow that are interrelated. That is, if one path is made more resistant to airflow by adjustment of a damper, the airflow adjusts and changes elsewhere in the system. This makes it difficult to set dampers so that they let the specified amount of air through. Usually the diffuser furthest from the fan is set by adjusting its damper. Then a second damper is adjusted. Then, the first diffuser must be measured again to determine if the second adjustment caused such a change in duct airflow distribution that the first airflow distribution that the first diffuser airflow became out of range. The two dampers are adjusted again until they are both in spec. Then a third damper is adjusted. This continues until all diffusers on the same branch of the duct system are within the specified range. This takes a long time, with many repeated measurements. Each

diffuser must be measured independently, one at a time, despite the fact that they are part of a connected and interdependent system. This method is repetitious and wastes time. It leads to compromise and non-ideal outcomes.

SUMMARY

[0006] One object of the following disclosure is to describe and provide a faster and less laborious solution for balancing a ventilation system than described above.

[0007] According to a first aspect, the object is provided by means of a balancing system for wireless adjustment of the operation settings of a ventilation system. The ventilation system comprises an air conductor system of ventilation conduits for conducting air flow in one or more branches and a plurality of conduit inlets or outlets and one or more permanent control components for manual setting and control of the air flow in the conduit inlets or outlets and/or in the air conduit of one or more branches. The balancing system comprises one or more portable, detachable adjustment components, which during the balancing of the ventilation system are attached on the conduit inlets or outlets and/or in the air conduits of the one or more branches thereby temporary replacing the permanent control components to allow adjustment of the manual damper settings controlling the air flow. The balancing system comprises a system controller for controlling said portable, detachable adjustment components, wherein said balancing system controller comprises a programmable processor. Said balancing system controller comprises a transceiver configured to receive measured operation data from the active adjustment components, wherein the programmable processor is configured to calculate by using the operation data a damper setting value of each of the active adjustment components that controls the air flow through the conduit inlets or outlets. Said balancing system controller adjusts by sending via the transceiver the calculated damper setting values to the active adjustment components and receives via the transceiver measured operation data based on the calculated damper setting values from the adjustment components. The balancing system controller is configured to indicate via display that the ventilation system is in balance and the permanent control components can be adjusted to the calculated damper setting values and reinstated.

[0008] According to a second aspect, the object is provided by means of a method for wirelessly balancing a ventilation system comprising an air conductor system of ventilation conduits for conducting an air flow, a plurality of conduit inlets or outlets and/or in an air conduit of one or more branches of the air conductor system and permanent control components for manual setting of the air flow in the conduit inlets or outlets. During the balancing of the ventilation system, the permanent control components are temporary replaced with portable, detachable adjustment components which are configured to be

attached on the conduit inlets or outlets and/or in the air conduits of the one or more branches of the air conductor system to allow adjustment of the manual damper settings controlling the air flow of the permanent control components in at least some of the inlets or outlets and/or one or more branches. A balancing system controller for controlling said portable, detachable adjustment components is further configured to perform the steps of receiving measured operation data from the active adjustment components, calculating by using the operation data a damper setting value of each of the active adjustment components that controls the air flow through the conduit inlets or outlets, adjusting by sending the calculated damper setting values to the active adjustment components, receiving measured operation data based on the calculated damper setting values from the adjustment components, and indicating that the ventilation system is in balance and the permanent control components can be adjusted to the calculated damper setting values and reinstated.

[0009] One advantage of the balancing system and method is that a lot of time is saved.

[0010] Another advantage of the balancing system and method is that the system and balancing process can be performed by only one person.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The foregoing, and other, objects, features and advantages of the present technique will be more readily understood upon reading the following detailed description in conjunction with the drawings in which:

Figure 1 is a block diagram illustrating a ventilation system;
 Figure 2 is a block diagram illustrating a balancing system 200 for balancing the ventilation system;
 Figure 3 is a block diagram schematically illustrating a ventilation system to be balanced according to the provided balancing method;
 Figure 4 is a flow chart of a method for wireless balancing a ventilation system.

DETAILED DESCRIPTION

[0012] In the following description, for purposes of explanation and not limitation, specific details are set forth, such as particular circuits, circuit components, techniques, etc. in order to provide a thorough understanding of the present technique. However, it will be apparent to one skilled in the art that the present technique may be practiced in other embodiments that depart from these specific details. In other instances, detailed descriptions of well-known methods, devices, and circuits are omitted so as not to obscure the description of the present technique with unnecessary detail.

[0013] In the following description, the term ventilation system includes any ventilation system that either is

working with an internal air pressure above ambient air pressure or an internal air pressure below the ambient air pressure.

[0014] Figure 1 is illustrating a ventilation system 10. The ventilation system comprises an air conductor system 100 (within a dot-dashed line in figure 1) with air conduits 110 such as air ducts and pipes for delivering air to different spaces, rooms or zones, $S_1, S_2, \dots, S_i$ (marked as dashed lined areas in figure 1) of a building for heating, ventilation, cooling and/or air conditioning (HVAC), wherein $i = 1, 2, 3, \dots$. In the figures, only 6 spaces are illustrated, but the number of spaces may be both more or less than 6. At least one electrical motorized fan 140 is arranged for moving the air in the air conductor system 100. Conduit inlets or outlets 120 are arranged on the air conduits 110 for conducting the air flow into or out, respectively, of a space. The flow of air into or out of each space is adjusted and regulated by a respective permanent control component 130, also identified as PD1, PD2, ..., PDk, arranged in the air conductor system 100, wherein $k = 1, 2, 3, \dots$. In the figures, a limited number of permanent control elements 130 are illustrated, but the number of permanent control elements 130 may be both more or less than 6. With a permanent control component is meant that the control component is used for and during the regular operation of the ventilation system, i.e. as a regular control component. Thus, a permanent control component could also be denoted as a regular control component. The permanent control component may be a permanent damper or diffuser or a combination of a diffuser and damper. The permanent control component 130 is placed in an outlet/inlet 120 of the air conduit 110 or in the air conduits for controlling one or more separate branches 160 of the air conductor system 100. At least one of the permanent control components 130, 150 is manually adjusted by an operator. PDkset is a damper setting value of an arbitrary permanent control component k. Each permanent control component PD1, PD2 is manually adjustable between a minimum damping setting PD1min, PD2min, ... to a maximum damping setting PD1max, PD2max,

[0015] The operation data involve different operation parameters or variables and operation conditions may be specified in a ventilation system specification. When the ventilation system is in balance, the measured operation data is equal to or within a range of the specified operation data and fulfills conditions defined by the ventilation system specification. As described in the background part of this document, it may be a very time consuming and laborious procedure to balance a ventilation system.

[0016] A balancing system and balancing method is therefore provided for speeding up the balancing procedure and minimize the time and number of persons needed for balancing a ventilation system in comparison to known balancing procedures. The method is enabled by means of the balancing system.

[0017] Figure 2 is illustrating an embodiment of a bal-

ancing system 200 for balancing a ventilation system. In general, a system 200 comprises one or more portable, detachable adjustment components 210 which are configured to be attached on the conduit inlets or outlets 120 and/or in the air conduit of one or more separate branches 160 of the air conductor system 100 to allow adjustment of the air flow during balancing of the ventilation system 10, see figure 1. The balancing system 200 further comprises a balancing system controller 220 for controlling said portable, detachable adjustment components 210, said controller 220 being configured to receive measured operation data from active adjustment components 210, calculating a damper setting value of each active adjustment component that controls the air flow through the conduit inlet or outlet 120, and thereafter, adjusting by means of the calculated damper setting values the adjustment components 210, receiving new measured operation data based on the sent calculated damper setting values from the adjustment components during the operation of the ventilation system, repeating said adjustment, measuring and calculation steps until the ventilation system is in balance. The permanent control components are thereafter adjusted according to respective calculated damper setting value resulting in the ventilation system to be in balance. The permanent control components could be considered to be balanced with the system. The adjustment component 210 are thereafter detached and replaced by the corresponding balanced permanent control components 130, 150 before the regular operation of the ventilation system is started.

[0018] The difference between the permanent control components 130, 150 and the portable, detachable adjustment components 210 is that, besides that the adjustment components 210 are portable and detachable, the adjustment components comprise a component control unit 240 which is connected to a measurement component 250 comprising one or more sensors for measuring operation data of the air in the ventilation system. The adjustment components have a more complicated construction than the permanent control components as the adjustment components comprise more technical devices than the permanent control components that each only comprises an adjustable damper device as active element. The permanent control components are therefore cheaper to manufacture than the adjustment components. A ventilation system only comprising adjustment components would be much more expensive than a ventilation system comprising only adjustment components that are not configured to measure and communicate operation data of the ventilation system. Therefore, when the ventilation system is in balance and the measured operation data fulfills specified ventilation system conditions set in a ventilation system specification after the balancing method is stopped, in that case, the permanent control components can be reinstated when adjusted according to the damper setting value indicated on the setting system controller displays.

[0019] Figure 2 is showing one adjustment component

210 attached to a part of an air conduit 110 replacing one permanent control component (150 in figure 1) and one adjustment component 210 to be attached (see the indicated arrow) to an inlet or outlet of the air conduit 110, from which outlet or inlet a permanent control component (130 in figure 1) has been temporary detached during the balancing process.

[0020] The component 210 comprises a hollow body 230 with opened ends, wherein one end of the hollow body 230 is adapted to be detachably and temporary attached to a conduit inlet or outlet 120 forming an airtight seal between the two. An adapter 212 may be used for achieving an airtight seal, especially if there is a difference regarding the dimensions of the inlet/outlet 120 and the end to be attached to the inlet/outlet 120. Said end of the hollow body 230 may preferably comprise a kind of locking device (not shown) which is easy to handle and which is enabling quick attachment before the balancing procedure is started and release when the balancing procedure is finished. Both ends are open for letting air to flow through the hollow body 230. The body construction is of stiff and light weight material, e.g. plastic, composite or light weight metal.

[0021] In figure 2, the hollow body construction of the adjustment component is further configured for allowing and enabling temporary attachment of the adjustment component 210 into an air conduit 110. A permanent control component 150 (see figure 1) is during regular operation of the ventilation system placed in the air conduits for controlling the air flow, e.g. to or in a separate branch 160 (see figure 1). During the balancing procedure the permanent control component 150 is replaced with an adjustment component 210. Both ends of the hollow body 230 comprise therefore a kind of locking device (not shown) which is easy to handle and which is enabling quick attachment and detachment to the free and open ends of the conduit. Adapters 212 in one end or both ends of the hollow body 230 may be used for achieving airtight seals, especially if there is a difference regarding the dimensions of the hollow body construction 230. Said adapters 212 may also be flexible in the longitude direction of the hollow body for adaptation to the distance between the open air conduit ends and the open ends of the hollow body 230.

[0022] The adjustment component 210 further comprises a component control unit 240 that may be attached outside the hollow body 230 for not disturbing the air flow inside the hollow body. The component control unit 240 of the adjustment component 210 is connected to a measurement component 250 comprising one or more sensors for measuring operation data of the air flow and a damper 260 for regulating the air flow through the hollow body. The damper 260 is connected to an electric actuator or electric motor 246, which controls the damper setting by means of a component controller 242 to which it is electrically connected. The component controller 242 is also connected to a display 248. The component control unit 240 comprises an electric power source 252, e.g.

one or more batteries. The battery may be chargeable, but ordinary replaceable batteries may as well be used. The electric power source is via a switch connected to and powers the electric circuits of the adjustment component, i.e. the component controller 242, a transceiver 244, the electric actuator or electric motor 246, the display 248 and the measurement component 250. The operator may switch the adjustment component on or off by means of the manually actuated switch. The component controller 242 is configured to be set in different operation modes, e.g. off or on, and different display modes by means of a key pad (not shown). In the operation mode "off" the adjustment component is not active, and in operation mode "on", the adjustment component is active. In the display modes, different parameters and their values are selectable to be shown on the display 248. Parameter values of the measured operation data may be selected and displayed. Further, the calculated damper setting value of the damper 260 of the adjustment component which damper setting value will be used as the damper setting value PDKset of the permanent control component k could be provided by the component controller 242.

[0023] The component controller 242 is connected to the measurement component 250 which provides measured operation data, e.g. the variable parameters air flow velocity, pressure, temperature, humidity. The component controller 242 may therefore be configured to control the measurement process of the component controller, wherein the operation data is measured continuously or within discrete time periods or at discrete time points. The operation data is handled and/or processed by the component controller 242 and inserted in a suitable protocol, e.g. Internet Protocol, etc.

[0024] The protocol may comprise besides the operation data also identity information of the adjustment component 210, location of the adjustment component 210 in the ventilation system, identity of the permanent control component that controls the air flow through the conduit inlet or outlet 120 where the adjustment component 210 is situated.

[0025] The protocol is provided to a transceiver 244 of the component control unit 240, which is adapted to wirelessly communicate with the balancing system controller 220 for controlling said portable, detachable adjustment components 210.

[0026] The balancing system controller 220 can be handled and operated by one single person, an operator. The balancing system controller 220 is therefore provided with a display 228 and a keyboard 225. Said controller 220 is configured to receive the sent protocol comprising measured operation data from active adjustment components 210 by means of a controller transceiver 222. An active adjustment component 210 is herein a component 210 that is attached to the ventilation system and activated for measurement and control of the air flow. The balancing system controller 220 comprises the controller transceiver 222 and a programmable processor

224 connected to the controller transceiver 222, the display 228 and the keyboard 225. The programmable processor 224 comprises computer program software which enables the processor 224 to process the received operation data from all active adjustment components 210 and to calculate a damper setting value of each active adjustment component 210 that controls the air flow through the conduit inlet or outlet 120 where the adjustment component 210 is situated. The balancing system controller 220 may be portable. In that case, the system controller is powered by means of an electric battery 226, chargeable and/or exchangeable. When the programmable processor 224 has received all operation data from all active adjustment components 210 in real time, continuously, or during a discrete time period or at discrete time point, the processor 224 calculates a separate damper setting value for each active adjustment component 210. Said damper setting values of the active adjustment components 210 are inserted in protocols, which are addressed and sent to the respective adjustment component 210 to which the setting value belongs.

[0027] The transceiver 222 of the balancing system controller 220 is configured to establish contact and send each protocol to the control unit 240 of the adjustment component 210 to which the protocol is addressed.

[0028] When the transceiver 244 of the adjustment component 210 receives a protocol, it is configured to deliver the protocol to the component controller 242. The component controller 242 reads the damper setting value.

[0029] Alternatively, all damper setting values are inserted in a list in one protocol that is broadcasted to all adjustment components 210 in the system. In this case, the list indicates which damper setting value that belongs to which adjustment component 210. The component controller 242 is configured to read the list and locate the damper setting value belonging to its active adjustment component 210 and neglect or reject damper setting values belonging to other active said adjustment component 210.

[0030] When the component controller 242 has read the damper setting value, the component controller 242 adjusts its damper 260 by means of the calculated setting value. The calculated damper setting value is transformed to a corresponding control signal by the component controller 242, which control signal is used for actuating the electric actuator or electric motor 246 to set the damper controlling the airflow in correct position, PDKset.

[0031] When all the dampers 260 are set and the ventilation system is in balance, the calculated damper setting value of the damper 260 of the adjustment component may be the same as the damping setting value PDKset of the permanent control component to be used as the balanced setting value. But the permanent control components used in a system may vary in the system as well from system to system. When transferring the computed damper setting value of an adjustment component

to a permanent control component of the same position in the ventilation system, the damper setting value of an adjustment component may have to be adapted to the technical and operation data of the permanent control component. The technical and operation data of the permanent control component may vary from manufacturer to manufacturer of such components as well as different types of permanent control components. The computed damper setting value is therefore multiplied with a correction factor to achieve a corrected damper setting value for adjusting the setting of the permanent control component. Said correction factor is therefore specific and selected in dependency to the type and manufacturer of the permanent control component. The specific correction factor to the type and manufacturer of the permanent control component could be stored in a memory of the balancing system controller 220. Further, the operator can use the keyboard and display to prepare the balancing system controller 220 by identifying the type and manufacturer of the permanent control component located on each position in the ventilation system. The balancing system controller 220 is therefore configured to select and use a correction factor in dependence of the position of the permanent control component in the ventilation system when transferring the computed damper setting value of an adjustment component to a permanent control component.

[0032] The damper setting value to be used when adjusting the permanent control component is provided by the component controller 242 to the display 248, which is read by an operator that manually adjusts the permanent control components according to the indicated, calculated value, which is the balanced value in the balanced ventilation system. The adjustment component 210 is thereafter detached and replaced by the adjusted permanent control component.

[0033] When all the damping settings of the permanent control components have been adjusted, all the adjustment components 210 have been detached and removed and replaced with the permanent control components. The ventilation system as illustrated in figure 1 now runs with the settings of the permanent control components 130, 150 adjusted to their balanced values by the operator by indication of the measurement and control system.

[0034] According to one embodiment of the balancing system, the balancing system controller 220 is connected to and configured to communicate wirelessly via the transceiver 222 with each active adjustment component 210 comprising a transceiver 242. Said transceivers 222, 242 are configured to receive and transmit messages according to any wireless RF (Radio Frequency) technology, e.g. used such as Wi-Fi or any available telecommunication radio standard, e.g. 3G, 4G or 5G.

[0035] According to further one embodiment of the balancing system, the balancing system controller 220 is portable or locally situated.

[0036] According to further one embodiment of the balancing system, the balancing system controller 220 is

implemented as one or more virtual machines assigned to computer resources in a cloud service.

[0037] According to yet one embodiment of the balancing system, the computed damper setting value is multiplied with a correction factor to achieve a corrected damper setting value for adjusting the setting of the permanent control component. The correction of the damper setting value may be performed in either the balancing system controller 220 or the component controller 242.

[0038] According to another embodiment of the balancing system, the measurement component 250 measures the air flow according to one or more of the following measurement methods; supersonic measurement via Doppler effect, temperature measurement for measurement of the cooling of a heated wire and/or pressure measurement of changes of pressure over a known distance in a pipe.

[0039] According to yet another embodiment of the balancing system 200, the ventilation system operation parameter is maximal air flow for lowest electric power [Watt] of a fan of the ventilation system.

[0040] According to further one embodiment of the balancing system 200, the controller 220 of the balancing system is configured to communicate with a central control unit of the ventilation system.

[0041] According to additional embodiments of the balancing system 200, the balancing system controller 220 is configured to communicate wirelessly with a central control unit, which is configured to communicate and adjust the permanent control components of the ventilation system according to the calculated damper setting values for each permanent control component. The communication may use Wi-Fi or any available telecommunication radio standard, e.g. 3G, 4G or 5G.

[0042] The controllers 224 and 242 may be implemented in digital electronically circuitry, or in computer hardware, firmware, software, or in combinations of them. Apparatus of the technique may be implemented in a computer program product tangibly embodied in a machine readable storage device for execution by a programmable processor; and method steps of the balancing process may be performed by a programmable processor executing a program of instructions to perform functions of the technique by operating on input data and generating output.

[0043] Figure 3 is a block diagram schematically illustrating a ventilation system to be balanced according to the provided balancing method. The ventilation system 10 comprises an air conductor system 100 (within a dot-dashed line in figure 3) of ventilation conduits 110 for conducting an air flow to a plurality of conduit inlets or outlets 120 via three conduit branches 160 for delivering air to different spaces, rooms or zones, S1, S2,..., Si (marked as dashed lined areas in figure 3) of a building for heating, ventilation, cooling and/or air conditioning (HVAC), wherein $i = 1, 2, 3, \dots$. In the figures, only 6 spaces are illustrated, but the number of spaces may be both more or less than 6. Some or all of the permanent control

components (130, 150 in figure 1) for manually setting of the air flow in the conduit branches 160 and/or conduit inlets or outlets 120 have been temporary replaced with portable, detachable adjustment components 210 for enabling balancing with the herein suggested balancing method. Adapters 212 in one end or both ends of the hollow body 230 are used for achieving airtight seals. The portable, detachable adjustment components 210 are configured to be temporary attached on the conduit inlets or outlets or in the air conduit of a separate branch 160 of the air conductor system 100 to allow adjustment of the damper setting values of the portable, detachable adjustment components 210 temporary controlling the air flow, and which adjustment of the damper setting values is transferred to the manual damper settings of the corresponding permanent control components replaced and attached again to the inlets or outlets. A balancing system controller 220 is therefore configured to perform the method by executing the steps of the following balancing method.

[0044] The advantage of the balancing method and the balancing system is that said system and method can be handled and operated by one single person, an operator. The balancing system controller 220 is therefore provided with a display 228 and a keyboard 225. The operator starts an adjustment procedure by temporary replacing the permanent control components by detaching them and attaching adjustment components to one or more conduit branches and/or conduit inlet or outlet of the air conductor system 100 of which the damper settings are to be adjusted. This means that all or some of the permanent control components have to be temporary detached and replaced with the portable, detachable adjustment components. An operator may preferably replace the permanent control components which damper settings have to be adjusted with the adjustment components. The damper setting of a permanent control component is transferred as a starting damper setting for the corresponding adjustment component replacing the permanent control component.

[0045] When the adjustment components are attached to the air conduit system 110, the operator actuates the switches of the adjustment components for powering the electric elements of the adjustment components. The adjustment components are also set in "on"-mode, i.e. they are activated for measurement and control. The ventilation system is also started by powering the electric fan 140. The adjustment components start measuring the operation data, such as air flow, speed, temperature by means of the measurement block (250 in figure 2).

[0046] Figure 4 is a flow chart of a method for wireless balancing a ventilation system. The object of the balancing method S100 is to wirelessly balance the damper settings of a ventilation system. The balancing method S100 is hereafter described with reference to figures, 2, 3 and 4. The balancing system controller 220 is configured to control the balancing method S100 by means of the programmable processor and computer program

software.

[0047] The balancing method S100 comprises an establishing phase or step:

S110: - Establishing connection with the activated adjustment components.

[0048] The balancing system controller 220 establishes connection links for up and down transmission of messages, e.g. by using a handshaking process with each of the adjustment component controllers wherein each of the adjustment components are identified with its predefined ID or is given an ID by the balancing system controller. Said ID may be an IP-address or an ID-number. Any known wireless RF (Radio Frequency) technology such as Wi-Fi or any available telecommunication radio standard, e.g. 3G, 4G or 5G may be used for establishing up and down links connection and message transfer,.

[0049] The balancing system is then organized for measurement and the balancing system controller 220 is wirelessly connected to each active adjustment component 210 via the transceiver 222 of the balancing system controller 220 and the transceivers 244 of the adjustment components 210. The active adjustment components 210 measures operation data when in "on"-mode and may either send the measured operation data on demand from the balancing system controller 220 or synchronized on an established sending schedule established during the establishing phase S110.

[0050] The balancing method S100 continues with following steps:

S120: - Receiving measured operation data from the active adjustment components.

[0051] The operation data is received via a suitable protocol that is addressed to and read by the programmable processor 224 of the balancing system controller 220, which processor extracts the received operation data from each active adjustment component and stores them in a data storage connected to the processor 224. The operation data is used by the programmable processor 224 for calculating new damper setting values, in the next step S120.

[0052] S130: - Calculating by using the operation data a damper setting value of each of the active adjustment components that controls the air flow through the conduit inlets or outlets.

[0053] The programmable processor 224 comprises computer program software which enables the processor 224 to process the received operation data from all active adjustment components 210 and to calculate damper setting values, each value dedicated to each one of the active adjustment component 210 that controls the air flow through the conduit inlet or outlet 120 or the air conduit of a separate branch 160 instead of the permanent control components. The different damper setting values of the active adjustment components are calculated for achieving a ventilation system in balance. The programmable processor 224 is configured to address and distribute the new calculated damper setting values to the

correct adjustment components, in accordance with the next step, S140.

[0054] S140: - Adjusting by sending the calculated damper setting values to the active adjustment components.

When an adjustment component 210 receives its calculated damper setting value, the adjustment controller 242 uses the calculated damper setting value for controlling the electric motor or electric actuator 246 to set the damper 260 in the damper position corresponding to the calculated and received damper setting value. The new damper position will probably change the operation condition and operation data of the adjustment component. The adjustment controller 210 measures continuously the operation data of the adjustment component and sends the momentary operation data by means of the measuring component 250.

[0055] S150: - Receiving measured operation data based on the calculated damper setting values from the adjustment components.

[0056] The programmable processor 224 now uses the received measured operation data for testing and indicating on the display whether the ventilation system is in balance and the measured operation data fulfills specified conditions, or not, according to step S160.

[0057] S160: - Is the ventilation system in balance?

[0058] If the ventilation system is in balance, the condition "Balanced?" is fulfilled, "yes", and the balancing method could be finished, S180. However, if the ventilation system is not in balance, and the condition "Balanced?" is not fulfilled, "no", a new iteration of the balancing method is needed, wherein new damper setting values are calculated. The condition "Balanced?" is also considered as not fulfilled, "no", if the operation data do not fulfill specified conditions, and a new iteration of the balancing method is needed, wherein new damper setting values are calculated.

[0059] Situation may occur wherein the balancing system has a problem to be balanced and the iterations of calculating new damper setting values. To limit the number of iterations, an iteration counter and a maximum iteration sum check may be used, which counter is automatically set to null at the start of the balancing method. If a new iteration is started, the iteration sum is increased by adding "1". A maximum iteration sum check is performed before a new iteration is started.

[0060] S170: - Maximum iteration sum is reached?

[0061] If the condition "Max iteration" is not fulfilled, No, a new iteration is started by calculating new damper setting values in S130 and the iteration sum is increased by adding "1". If the condition "Max iteration" is not fulfilled, yes, the balancing method and the balancing system controller 220 is configured to request the operator for new damper settings, as follows:

S172: Requesting operator for new damper settings if the ventilation system is not in balance and/or the operation data do not fulfill specified conditions. The

programmable processor 224 is configured to display a request for at least one new damper setting if the ventilation system is not in balance and the operation data according to specification.

S174: Receiving at least one new damper setting value;

S176: Sending said at least one new damper setting value to one or more of the adjustment components.

[0062] The iteration counter is automatically set to null before step S172 is performed as a sequence of iterations of the balancing method may be started.

[0063] When a damper setting value is changed such an amendment triggers changing of the operation data, which is measured by the adjustment components and sent to the system controller that performs step S120. Step S130 is repeated and a new iteration of the balancing method S100 is performed until the controller (220 in figure 2) of the balancing system (200 in figure 2) indicates that the system is in balance for the operator by means of the display.

[0064] S180: - Indicating that the ventilation system is in balance and the permanent control components can be adjusted to the calculated damper setting values and reinstated.

[0065] Thus, if the ventilation system is in balance and the measured operation data fulfills specified ventilation system conditions set in a ventilation system specification, in that case, the permanent control components can be reinstated when adjusted according to the damper setting value indicated on the setting system controller displays. The operator then uses the damper setting values of the adjustment components and set the damper values of the permanent control components (130,150 in figure 1) and said portable, detachable adjustment components (210 in figure 2 and 3) are replaced with the permanent control components.

[0066] According to one embodiment of the balancing process, all permanent control components (130,150 in figure 1) of the ventilation system are replaced by portable, detachable adjustment components (210 in figure 2 and 3) from start. The portable, detachable adjustment components are replaced with the permanent control components one at the time, wherein the steps of the balancing method are performed until the ventilation system is in balance between each replacement of an adjustment component, which damper setting value is transferred to the corresponding, replacing permanent control component, until all detachable adjustment components have been replaced with the adjusted permanent control components of the ventilation system.

[0067] The method may advantageously be implemented in one or more computer programs that are executable on a programmable system including at least one programmable processor coupled to receive data and instructions from, and to transmit data and instructions to, a data storage system, at least one input device, and at least one output device. Each computer program

may be implemented in a high-level procedural or object-oriented programming language, or in assembly or machine language if desired; and in any case, the language may be a compiled or interpreted language.

[0068] Generally, a processor such as the programmable processor 224 of the balancing system controller 220 will receive instructions and data from a read-only memory and/or a random access memory. Storage devices suitable for tangibly embodying computer program instructions and data include all forms of non-volatile memory, including by way of example semiconductor memory devices, such as EPROM (erasable programmable read only memory), EEPROM (electrically erasable programmable read only memory), and flash memory devices; magnetic disks such internal hard disks and removable disks; magneto-optical disks; and CD-ROM (Compact Disc Read-Only Memory) disks. Any of the foregoing may be supplemented by, or incorporated in, specially-designed ASICs (Application Specific Integrated Circuits).

[0069] A number of embodiments of the present technique have been described. It will be understood that various modifications may be made without departing from the scope of the technique. Therefore, other implementations are within the scope of the following claims defining the technique.

Claims

1. Balancing system (200) for wireless adjustment of the operation settings of a ventilation system (10) comprising an air conductor system (100) of ventilation conduits (110) for conducting air flow in one or more branches and a plurality of conduit inlets or outlets (120) and one or more permanent control components (130,150) for manual setting and control of the airflow in the conduit inlets or outlets and/or in the air conduit of one or more branches (160) of the air conductor system (110), the balancing system (200) comprising one or more portable, detachable adjustment components (210), which during the balancing of the ventilation system are attached on the conduit inlets or outlets and/or in the air conduits of the one or more branches (160) thereby temporary replacing the permanent control components (130,150) to allow adjustment of the manual damper settings controlling the air flow, and a system controller (220) for controlling said portable, detachable adjustment components, said balancing system controller (220) comprising a programmable processor (224), said balancing system controller (220) comprising a transceiver (222) configured to receive measured operation data from the active adjustment components, wherein the programmable processor (224) is configured to calculate by using the operation data a damper setting value of each of the active adjustment components that controls the air flow

through the conduit inlets or outlets, and adjusting by sending via the transceiver the calculated damper setting values to the active adjustment components, receive via the transceiver (222) measured operation data based on the calculated damper setting values from the adjustment components, and to indicate via display (228) that the ventilation system is in balance and the permanent control components can be adjusted to the calculated damper setting values and reinstated.

2. The balancing system according to claim 1, wherein the balancing system controller (220) may be configured to request the operator via the display for new damper settings if the ventilation system is not in balance and/or the operation data do not fulfill specified conditions, receive at least one new damper setting value, and to send said at least one new damper setting value to one or more of the adjustment components.
3. The balancing system according to claims 1 or 2, wherein the balancing system controller (220) is configured to communicating wirelessly with each adjustment component attached to the ventilation system.
4. The balancing system according to any of the previous claims, wherein the balancing system controller (220) is portable or locally fixed situated.
5. The balancing system according to any of the preceding claims, wherein the balancing system controller (220) is implemented as one or more virtual machines assigned to computer resources in a cloud service.
6. The balancing system according to any of the preceding claims, wherein the controller (220) is configured to multiply the computed damper setting value with a correction factor to achieve a corrected damper setting value for adjusting the setting of the permanent control component.
7. The balancing system according to any of the preceding claims, wherein a measurement component (250) measures the air flow according to one or more of the following measurement methods; sonic measurement via Doppler effect, temperature measurement for measurement of the cooling of a heated wire and/or pressure measurement of changes of pressure over a known distance in a pipe.
8. The balancing system according to any of the preceding claims, wherein a ventilation system operation parameter is maximal air flow for lowest electric power [Watt] of a fan of the ventilation system

9. The balancing system according to any of the preceding claims, wherein the controller (220) of the balancing system is configured to communicating with a central control unit of the ventilation system.
10. The balancing system according claim 9, wherein the controller (220) is configured to communicating wirelessly with a central control unit, which is configured to communicate and adjust the permanent control components of the ventilation system according to the calculated adjustment values for each permanent control component.
11. Method (S100) for wirelessly balancing a ventilation system comprising an air conductor system (100) of ventilation conduits for conducting an air flow and a plurality of conduit inlets or outlets and/or in an air conduit of one or more branches of the air conductor system and permanent control components for manual setting of the air flow in the conduit inlets or outlets, wherein during the balancing of the ventilation system, the permanent control components are temporary replaced with portable, detachable adjustment components which are configured to be attached on the conduit inlets or outlets and/or in the air conduits of the one or more branches of the air conductor system to allow adjustment of the manual damper settings controlling the airflow of the permanent control components in at least some of the inlets or outlets and/or one or more branches, and a balancing system controller (220) for controlling said portable, detachable adjustment components, said balancing system controller (220) being configured for performing the steps of:
- Receiving (S120) measured operation data from the active adjustment components;
 - Calculating (S130) by using the operation data a damper setting value of each of the active adjustment components that controls the air flow through the conduit inlets or outlets;
 - Adjusting (S140) by sending the calculated damper setting values to the active adjustment components;
 - Receiving (S150) measured operation data based on the calculated damper setting values from the adjustment components;
 - Indicating (S160) that the ventilation system is in balance and the permanent control components can be adjusted to the calculated damper setting values and reinstated.
12. The method (S100) according to claim 11, wherein if the ventilation system is tested to be not in balance and/or the operation data differs from a ventilation system specification, test result "No", the balancing system controller (220) may be configured to make a modification of step, the method comprises:
- Requesting (S172) operator for new damper settings if the ventilation system is not in balance and/or the operation data do not fulfill specified conditions.
 - Receiving (S174) at least one new damper setting value;
 - Sending (S176) said at least one new damper setting value to one or more of the adjustment components.
13. The method according to claims 11 or 12, wherein the receiving and sending is performed wirelessly with each adjustment component attached to the ventilation system.
14. The method according to any of the previous claims 11 - 13, wherein the balancing system controller (220) is portable or locally situated.
15. The method according to any of the preceding claims 11 - 14, wherein the balancing system controller (220) is implemented as one or more virtual machines assigned to computer resources in a cloud service.
16. The method according to any of the preceding claims 11 - 15, wherein the calculating step involves multiplying the computed damper setting value with a correction factor to achieve a corrected damper setting value for adjusting the setting of the permanent control element.
17. The method according to any of the preceding claims 11 - 16, wherein a measurement component (250) measures the air low according to one or more of the following measurement methods; sonic measurement via Doppler effect, temperature measurement for measurement of the cooling of a heated wire and/or pressure measurement of changes of pressure over a known distance in a pipe.
18. The method according to any of the preceding claims 11 - 17, wherein a ventilation system operation parameter is maximal air flow for lowest electric power [Watt] of a fan of the ventilation system.
19. The method according to any of the preceding claims 11 - 18, wherein the controller (220) of the balancing system is configured to communicating with a central control unit of the ventilation system.

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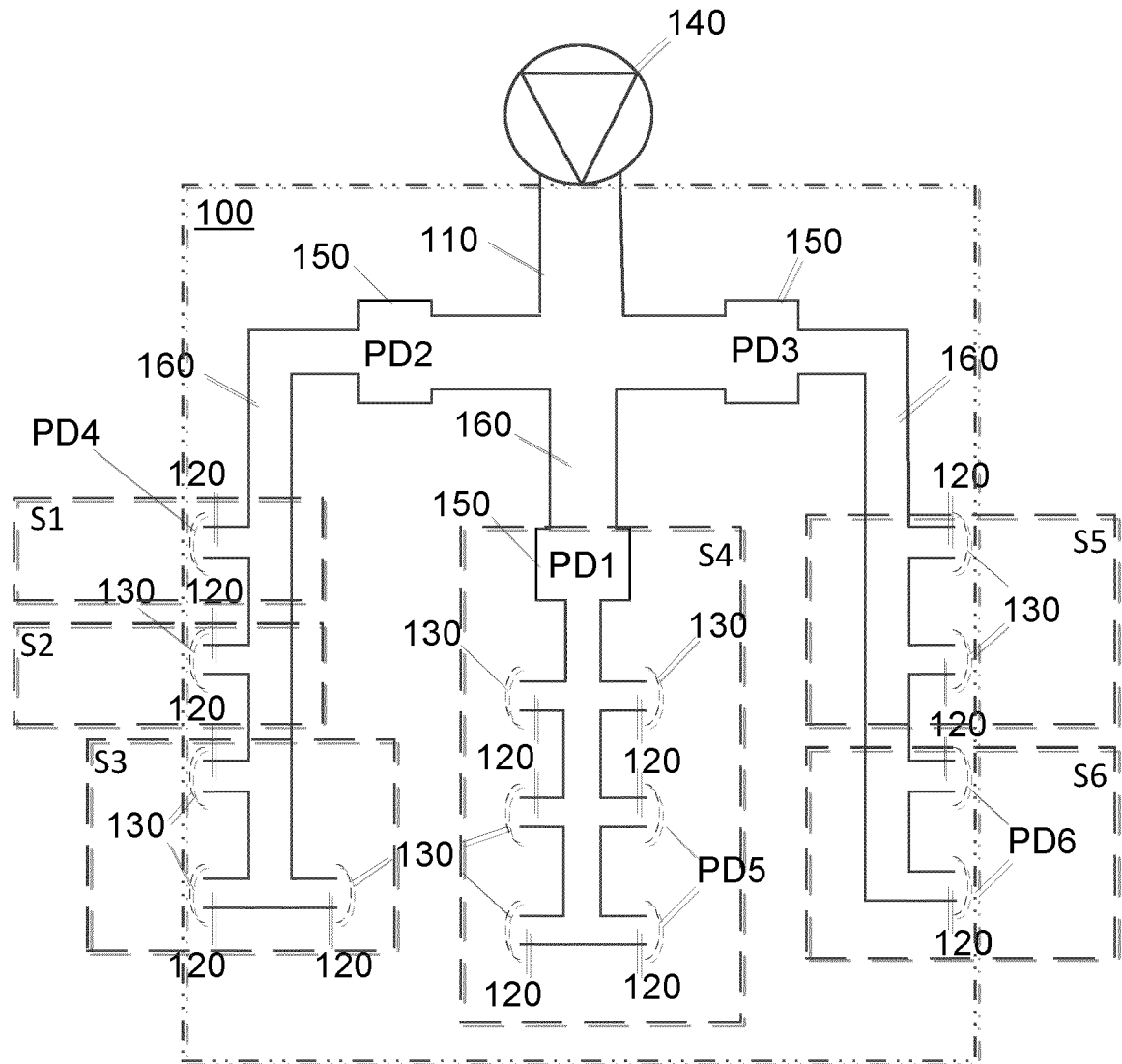
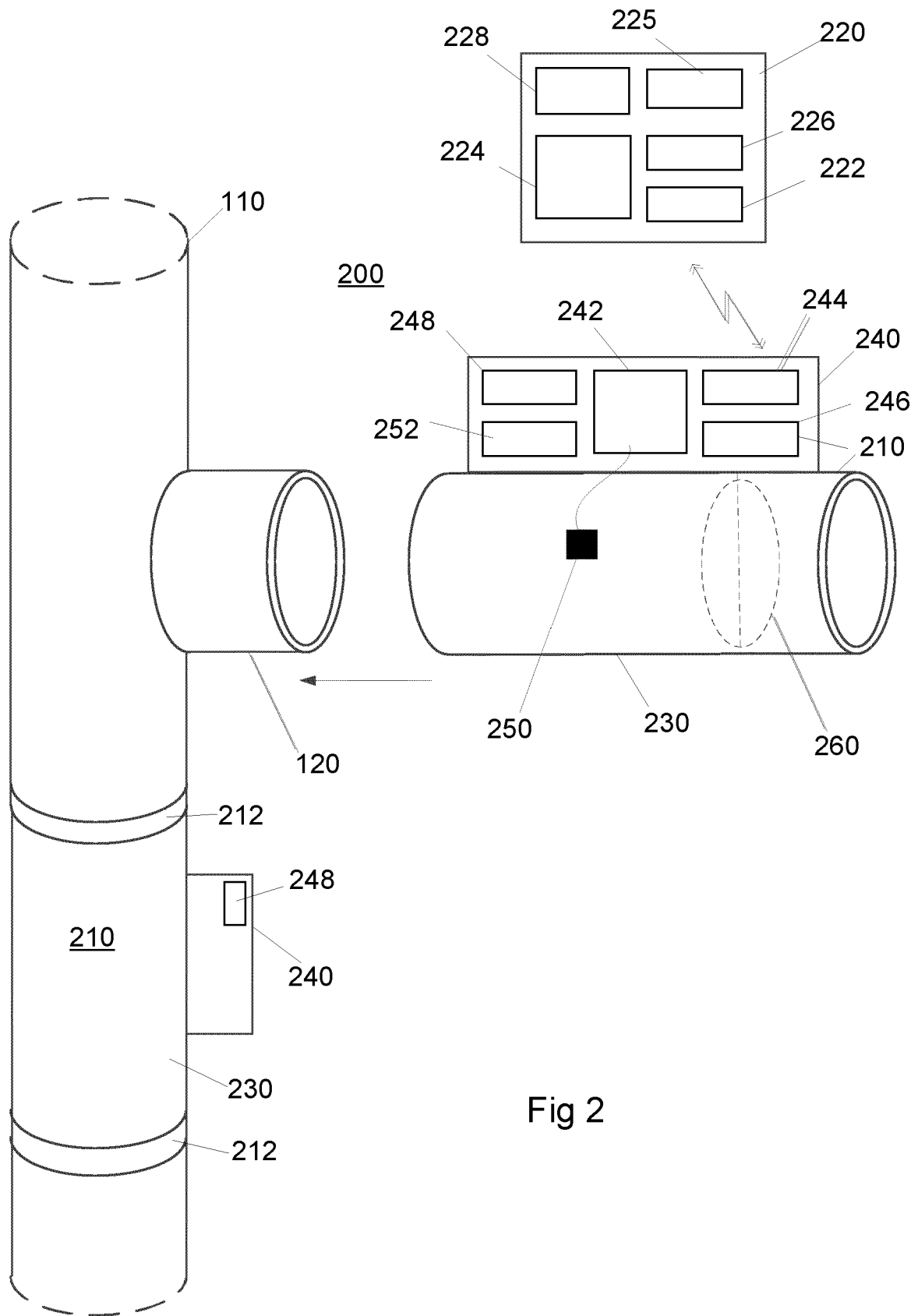


Fig. 1



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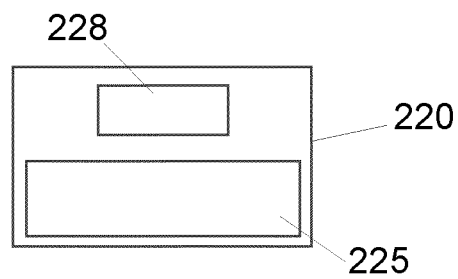
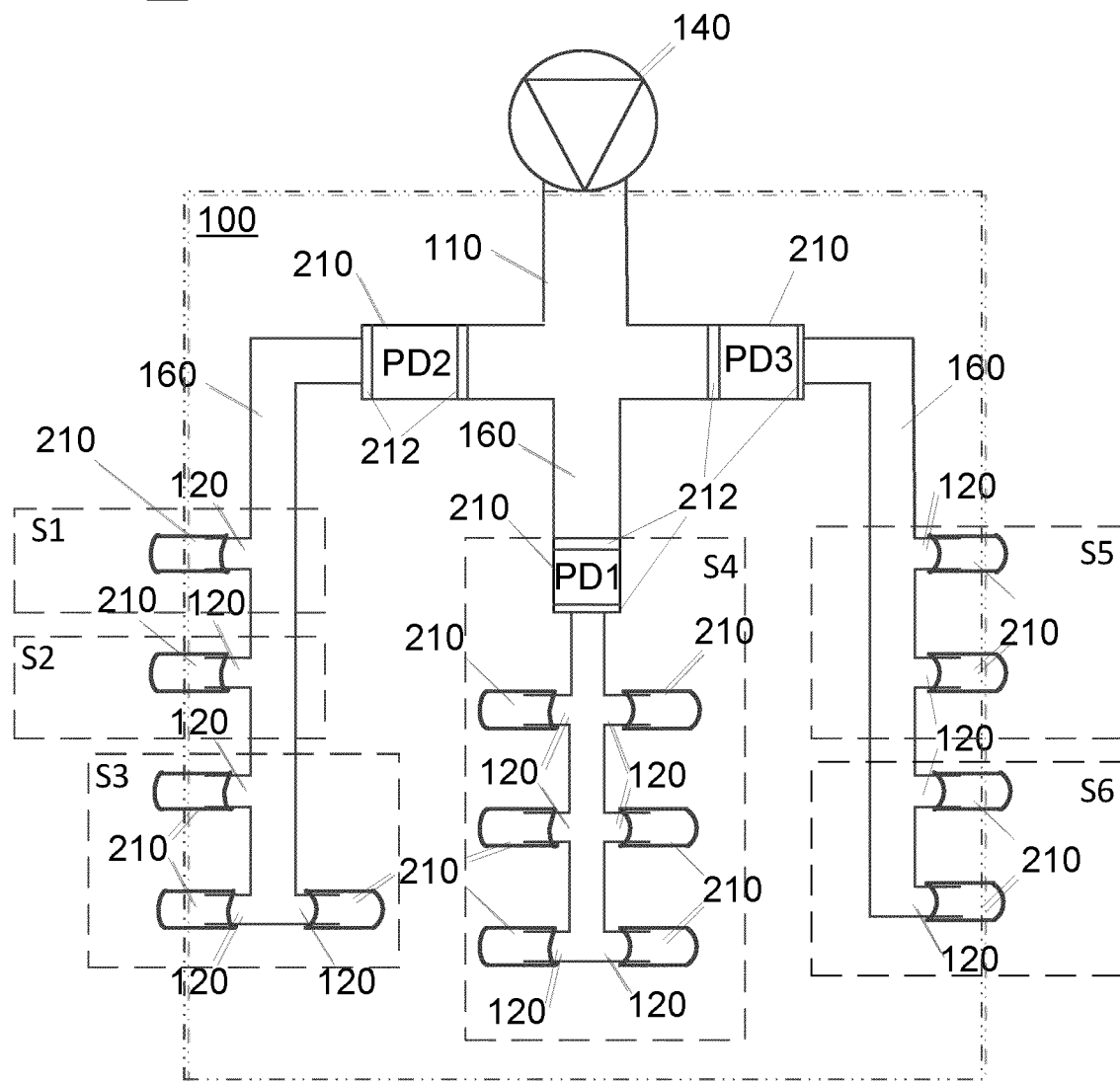
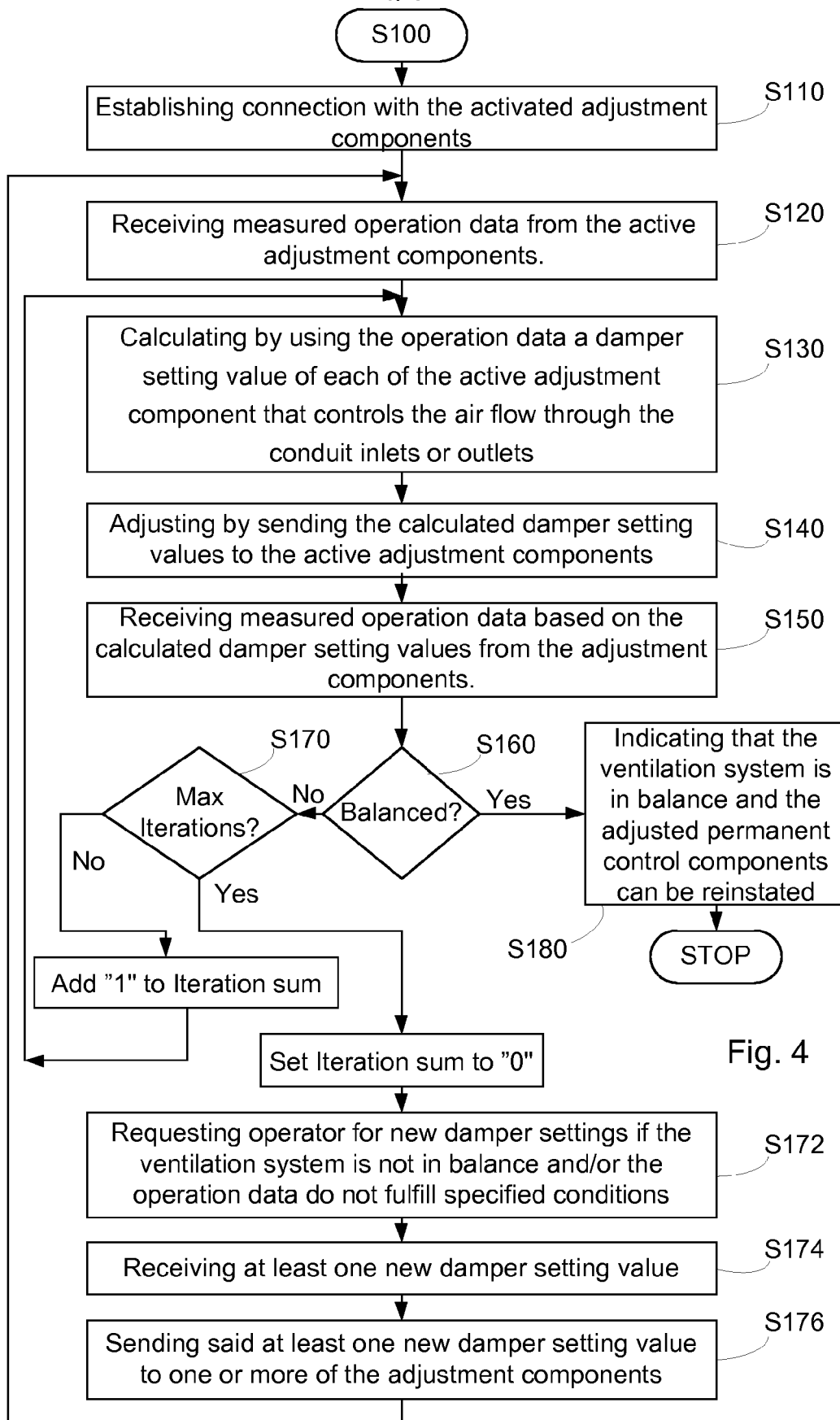


Fig. 3





EUROPEAN SEARCH REPORT

Application Number
EP 18 18 8742

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			F24F
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 6 February 2019	Examiner Anconetani, Mirco
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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