(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 009 750 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
20.04.2016 Bulletin 2016/16

(51) Int Cl.:
F24D 19/00 *(2006.01)* ***F24D 19/10*** *(2006.01)*

(21) Application number: **15196496.2**

(22) Date of filing: **09.06.2011**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **10.06.2010 DK 201000503**

(62) Document number(s) of the earlier application(s) in accordance with Art. 76 EPC:
11004707.3 / 2 395 289

(71) Applicant: **Danfoss A/S**
6430 Nordborg (DK)

(72) Inventors:
- **HARTMANN, Michael**
  63526 Erlensee (DE)
- **JEDRZEJEWSKI, Mariusz**
  74693 Szczecin (PL)
- **OSOJNIK, Matjaz**
  1000 Ljubljana (SI)

Remarks:
This application was filed on 26-11-2015 as a divisional application to the application mentioned under INID code 62.

(54) METHOD TO REGULATE A ONE-PIPE HEAT SUPPLY SYSTEM

(57) Method to control the flow rate and of a heat exchanging fluid medium to a riser in a one-pipe system being a typical pipe set up in for example building cooperatives for supplying heat to the radiators of the flats. The method being to regulate the temperature of the supplied heat exchanging fluid medium in response to changes in external parameters (temperature) and the flow rate in response to the temperature of the heat exchanging fluid medium in an return line.

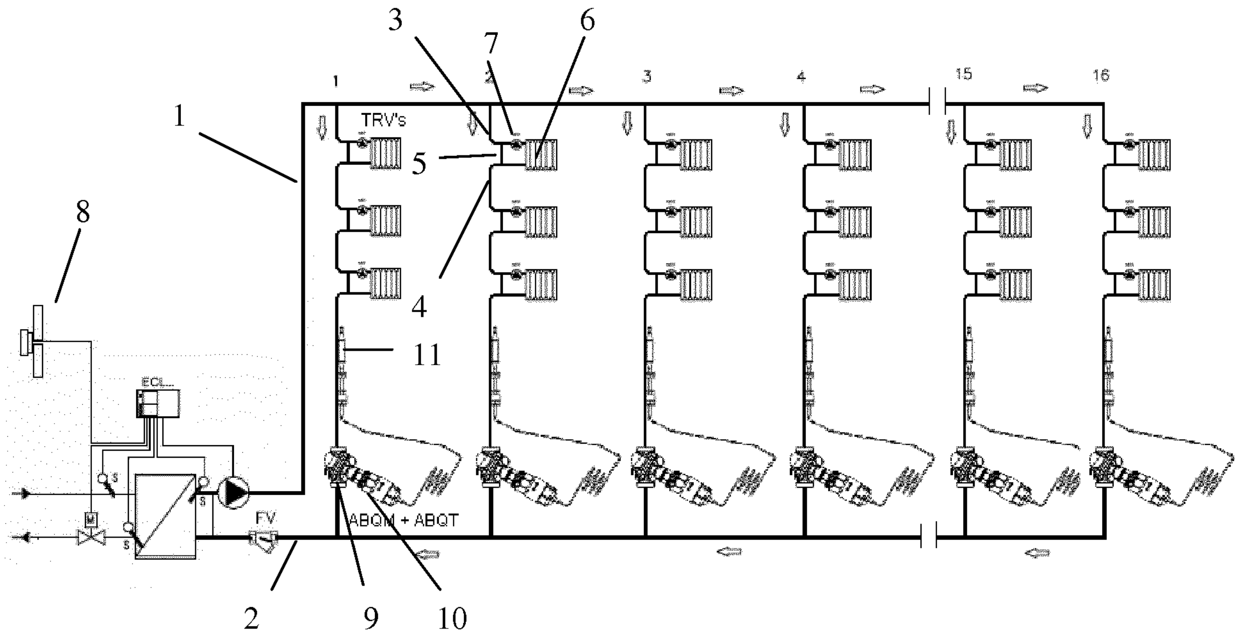

Fig. 2

EP 3 009 750 A1

Description

[0001] Method to control the flow rate and of a heat exchanging fluid medium to a riser in a one-pipe system being a typical pipe set up in for example building cooperatives for supplying heat to the radiators of the flats. The method being to regulate the temperature of the supplied heat exchanging fluid medium in response to changes in external parameters (temperature) and the flow rate in response to the temperature of the heat exchanging fluid medium in an return line.

BACKGROUND

[0002] Typical set ups of the pipes supplying radiators in e.g. housings or building cooperatives are either two-pipe systems or one-pipe systems. In the following there shall be referred in general to 'houses' meaning housings comprising a plural of flats, or any other places where such setups are typical.

[0003] In traditional two-pipe systems a set of parallel pipes forms supply pipes (or 'lines' in more general) and return pipes (or 'lines') to a collection of heat exchanging devices such as radiators. The pipes associated with each such collection of heat exchanging devices is referred to as risers, and in two-pipe systems the flow rates at each riser are in traditional systems regulated individually, thus giving dynamic flow rates in each riser matching the present loads.

[0004] In one-pipe systems, however, the supply line system feeds some heat exchanging fluid medium (typically water) and a supply temperature (typically water) at a flow rate to a collection of heat exchanging devices. The individual radiators are connected in series with one after the other, such that the return line of one radiator is the feeding line of a next radiator.

[0005] The flow rates of the heat exchanging fluid medium to each radiator are usually controlled by thermostats being set by the users of the radiators, but the overall flow in the supply and return lines is in traditional systems substantially permanent, meaning it is not reacting to changes in the load.

[0006] For example on a hot day , or simply when internal gains in the room cause the radiator thermostat to close, the radiator thermostats in general is closed letting most of the heat exchanging fluid medium flow through the bypass lines, such a setup leads to an undesired high temperature of the heat exchanging fluid medium in the return line(s). A high temperature of the return heat exchanging fluid medium is not desired, since it leads to an uncontrolled heating of the living spaces and further to unnecessary losses of heat of the heat exchanging fluid medium in the lines, since the lines will continue to deliver heat though, the radiators are closed. This is especially the case where the lines are not well insulated. This would be a further discomfort to the inhabitants.

[0007] In two-pipe systems the valve actuator regulating the flow is placed centrally. This is not possible in a one-pipe-system, since it will cause underflow in parts of the system still having high load, and overflow in parts / risers with low load.

[0008] The present invention relates to introducing a solution giving a highly energy-efficient and load dependent one-pipe system.

SUMMARY OF THE INVENTION

[0009] The present invention solves the problems of one-pipe systems by introducing a two-part control, one being to regulate, or control, the temperature of the supplied heat exchanging fluid medium, the supply temperature, and another to control flow through a collection of heat exchanging devices in relation to the temperature of the heat exchanging fluid medium in the return line. The control of flow and return temperature is done "decentrally" in each riser.

[0010] The supply temperature control is based on external conditions comprising conditions influencing the system that cannot be influenced by the system itself, this preferably includes, for example, the weather by introducing a weather compensator (more especially the external temperature, being e.g. the outdoor temperature of a housing), but could also include other factors that would influence the expected needed heat to be supplied to the houses. The main, but not exclusive, embodiment is especially related to the external temperature, the system thus optionally including an external temperature sensor. In an even more advanced embodiment the system is coupled to a weather forecast system such as through the internet.

[0011] The present invention thus introduces a method of regulating a system comprising;

- a collection of heat exchanging devices connected in series, such that a return line of one radiator is a feeding line of a next radiator,
- a main supply line are connected to the feeding line of the first of the heat exchanging devices seen in the flow direction,
- a main return line connected to the return line of the last of the heat exchanging devices seen in the flow direction,

where a heat exchanging fluid medium with a supply temperature is feed from the main supply line to the collection of heat exchanging devices at a flow rate, wherein the supply temperature is regulated according to a supply set point temperature depending parameters external to the system, and the flow rate is regulated according to a return set point temperature depending on a temperature of the heat exchanging fluid medium down stream the first heat exchanging device in the collection.

[0012] To ensure an optimized set point of the system, in one embodiment the supply temperature is regulated according to a supply set point temperature depending on parameters external to the system, and / or the flow rate is regulated according to a return set point temperature depending on a temperature of the heat exchanging fluid medium downstream of the first heat exchanging device in the collection. The return temperature set point preferably is regulated in response to a regulation of the supply temperature set point.

[0013] To ensure that the system comprises the means to perform the regulation of the flow in relation to the temperature of the heat exchanging medium in the return line, the method in a further embodiment applies to a system further comprising

- a flow controller connected to a return line, the flow controller being adapted to control the flow rate through the return line,
- an actuating device operating the flow controller, and
- a temperature sensor positioned in heat exchanging connection to the heat exchanging fluid in the return line.

[0014] To ensure a permanent flow despite frequent changes in the loads to each of the heat exchanging devices, e.g. as they are adjusted by the users, the flow controller is further adapted to maintain a constant flow despite changes in the pressure in the main supply line.

[0015] To avoid feeding unnecessarily much energy into the system by rather meeting external conditions in advance, the system in one embodiment may comprise an external temperature sensor positioned to measure a temperature external to the system.

[0016] Especially, but not exclusively, to ensure regulation of the return temperature at set point depending on different parameters, the system in one embodiment may comprise an electronic controller connected to the actuating devices and the temperature sensors connected to the return lines. The electronic controller is optionally connected to a temperature sensor connected to the main supply line, and optionally also to the external temperature sensor.

[0017] In one embodiment the actuating device is pulse actuated, such as where the actuating device is an electro-magnetic, pneumatic, hydraulic or electrostrictive actuator.

[0018] To ensure an optimized set point of the system, in an embodiment the supply temperature is regulated according to a supply set point temperature depending on parameters external to the system, and the flow rate is regulated according to a return set point temperature depending on a temperature of the heat exchanging fluid medium downstream of the first heat exchanging device in the collection. The return temperature set point is preferably regulated in response to a regulation of the supply temperature set point.

[0019] In an alternative embodiment to the electronic controller, the actuating devices are connected directly to the temperature sensors and are self-acting and include means to adjust the return temperature set point. A natural choice is that the actuating device is a thermostat.

FIGURES

[0020]

Fig. 1	Illustration of a standard one-pipe, or one-line, set up whereto the present invention would be suitable.
Fig. 2	Illustration of a number of parallel risers each associated with a collection of heat exchanging devices, and where each riser is controlled according to one embodiment of the present invention.
Fig. 3	Illustration of a flow controller used in one embodiment of the present invention, the flow controller being adapted to maintain a constant flow despite pressure changes.
Fig. 4	Illustration of set point dependences on external conditions.
Figs. 5A and 5B.	Illustrations of how the present invention relates the flow rate to better match the actual load in the system.
Fig. 6.	Illustration of the system introducing an electronic controller according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0021] Fig. 1 illustrates a typical set up of a one-pipe system, where a supply line (3) system feeds some heat exchanging fluid medium (typically water) at a supply temperature and at a flow rate, to a collection of heat exchanging devices (6), such as e.g. radiators, and adapted to heating up a number of living spaces. In the following, with out loss of generality, such heat exchanging devices (6) are frequently referred to as radiators. The individual radiators (6) are connected in series, one after the other, such that the return line (4) of one radiator (6) is the feeding line (3) of a next radiator (6). The feeding line (3) and return line (4) of each radiator (6) is additionally connected by a bypass line (5). A main supply line (1) is connected to the feeding line (3) of the first of the radiators (6) in the collection, seen in the flow direction, and a main return line (2) is connected to the return line (4) of last of the radiators (6) in the collection, seen in the flow direction.

[0022] Such a setup is in some places typical in houses comprising a number of rooms and flats, where e.g. a number of parallel risers are each connected to a number rooms / flats. In this text each of these rooms / flats is regarded as one heat exchanging device, the rooms / flats associated with a riser then comprising a 'collection' of heat exchanging devices, or radiators (6).

[0023] The individual radiators (6) within each room / flat may be connected according to a similar or a very different setup.

[0024] In houses comprising a plural of risers the system thus comprises a corresponding plural of collections of radiators in series and connected to the common main supply line (1) and the main return line (2), the flow through each of the collections being regulated individually.

[0025] The heat exchanging medium may be supplied directly to the radiators (6) (in the following referred to as the direct supply setup), or the system may introduce a substation comprising a heat exchanger separating the supplier lines from e.g. a house (in the following referred to as the substation setup), thus forming a closed loop for the heat exchanging fluid to circulate to the individual radiators (6). The flow rates of the heat exchanging fluid medium to each radiator (6) are controlled by flow regulating means (7), in the following being, without loss of generality, referred to as a the radiator thermostats.

[0026] The regulation of the flow rates to the radiators (6) in addition influences the flow in the bypass lines (5), by changing the flow to the radiators (6), the flow through the bypass lines (5) being changed accordingly.

[0027] On for example a hot day, or just when internal gains in the room cause the radiator thermostat (7) to close, the radiator thermostats (7) in general being closed to let most of the heat exchanging fluid medium flow through the bypass lines (5), such a setup leads to an undesired high temperature of the heat exchanging fluid medium in the return line(s) (4). A high temperature of the return heat exchanging fluid medium is not desired, since it leads to an uncontrolled heating of the living spaces and further to un-necessary losses of heat of the heat exchanging fluid medium in the lines, since the lines will continue to deliver heat though the radiators are closed. This is especially the case where the lines are not well insulated. This would be a further discomfort to the inhabitants.

[0028] The present invention solves this problem by introducing a two part control, one being to regulate, or control, the temperature of the supplied heat exchanging fluid medium, the supply temperature, and another to control the flow through a collection of heat exchanging devices (6) in relation to the temperature of the heat exchanging fluid medium in a return line (3).

[0029] The supply temperature control is based on external conditions comprising conditions influencing the system that cannot be influenced by the system itself, this preferably includes such as the weather (more especially the external temperature, being e.g. the outdoor temperature of a housing), by introducing a weather compensator, but could also include other factors that would influence the expected needed heat to be supplied to the houses. The main, but not exclusive, embodiment is especially related to the external temperature, the system thus optionally including an external temperature sensor (8). In an even more advanced embodiment the system is coupled to a weather forecast system such as through the internet.

[0030] The regulation of the flow to the risers in this manner are based on the actual demand(s), or load (2), in the riser(s), in that a changing demand changes the temperature of the heat exchanging fluid medium in the return line(s) (4).

[0031] Fig. 2 illustrates a set up according to the present invention, where a flow controller (9) is connected to a return line (4) associated with a collection of radiators (6) for controlling the flow of heat exchanging fluid in the lines supplying these radiators)6).

[0032] The flow controller (9) in one preferred but not limiting embodiment has two operations in that both a flow control valve and a pressure independent balancing valve. The flow controller (9) in this embodiment includes means to set a desired flow rate, and means to ensure this substantially constant flow rate despite pressure changes in the flow system. Such valves are available in the market, where examples are the AB-QM product series provided by Danfoss A/S, and disclosed in e.g. the patent DE 103 23 981.

[0033] Fig. 3 illustrates such a valve (9), or flow controller, consisting of two parts, a differential pressure controller and a control valve. The differential pressure controller maintains a constant differential pressure across the control valve (9). The control valve (9) comprises a spindle (31), stuffing box (32), plastic ring (33), control valve's cone (34), membrane (35), main spring (36), hollow cone (pressure controller) (37) and vulcanized seat (pressure controller) (38). The pressure difference ΔPcv (P2 - P3) on the membrane (35) is balanced with the force of the spring (36). Whenever the differential pressure across the control valve (9) changes (due to a change in available pressure, or movement of the control valve) the hollow cone (37) is displaced to a new position that brings a new equilibrium and therefore keeps the differential pressure at a constant level. The control valve (9) has a linear characteristic. It features a stroke limitation function that allows adjustment of the Kv value. The stroke limitation is changed by lifting the blocking mechanism and turning the top of the valve (9) to the desired position. A blocking mechanism automatically prevents unwanted changing of the setting.

[0034] Introducing such a flow controller (9) has one further advantage, in that, for example, the flow in the risers is regulated / controlled mutually independently, despite being connected to common main supply (1) and return (2) lines.

[0035] Returning to Fig. 2, the figure shows the flow controller attached to the return line (4) of the last of the radiators (6) seen in the direction of flow, an actuating device (10) being connected to the flow controller (9), optionally by the use of an adapter. Further seen is a temperature sensor (11) adapted to be positioned in thermal exchange connection to the return line (4).

[0036] The actuating devices (10) may be actuators, and may be self-acting or controlled, and operating in any manner as known in the arts, such as electro-magnetic, pneumatic, hydraulic, electroactive etc.

[0037] Fig. 2 thus shows a system where the control is based on two parts, one being related to regulating the supply temperature in dependence of external conditions, such as the external temperature, the second being to regulate the flow associated with each collection of heat exchangers (6), in dependence of the return temperature, the temperature of the heat exchanging fluid medium in a return line (4). The system thereby becomes a variable flow system with individual flow control for each riser depending on the load on each of the individual risers.

[0038] Fig. 4 shows two curves illustrating the regulation according to the present invention. The upper curve (12) illustrates a regulation dependence of the supply temperature to the external temperature. Or at least illustrates how a set point of the supply temperature changes with changing external temperature. The exact curve and dependence would depend on a number of factors, such as e.g. the state of insulation of the housing, and would typically be optimized to the conditions of the actual system.

[0039] It is an advantage to change the temperature set point of the return temperature according to the changing of the set point of the supply temperature for several reasons, such as problems caused by excess heat.

[0040] In the same manner the lower line (13) therefore illustrates a dependence of the regulation of the return temperature set point, the curve being an update of basic return temperature control where the return temperature set point actively follows the result of the control of the supply temperature based on the external temperature. It is therefore a control of the set point of the return temperature. The aim is that the performance of control where flow is adjusted to load in each riser remains perfect throughout the heating season.

[0041] The lower curve (13) thus changes based on two factors, supply temperature and load in riser(s), as the load in the risers is unpredictable and changes from 100% to 0%,.

[0042] The system of the present invention thus introduces a 'super' control being the control of the supply temperature set point in relation to external conditions, and a 'sub' control correcting the system by changing the flow according to the return temperature, being related to the load in the riser(s), and where the set point of the return temperature in embodiments of the present invention actively changes according to the change of the set point of the supply temperature.

[0043] Fig 5A shows a graphic representation of flow to load relation in a traditional one-pipe system without any regulation according to the present invention, where the dashed line (14) illustrates the actual flow rate fluctuating unpredictably since these systems are dynamic due to the radiator thermostat (7) actions. The wavy line (16) is the actual load clearly seen to be uncorrelated to the actual flow rate.

[0044] The straight line (15) is caused by the introduction of the pressure independent flow controller (9) according to the present invention.

[0045] Fig. 5B shows the situation according to the present invention, where the flow is controlled in dependence of the return temperature, thus controlling the flow according to the demand, or load. This gives a flow rate (17) much more matching the actual demand, and thus giving a much more efficient system.

[0046] The illustrated system in Fig. 2 shows a simple setup of the present invention, where the actuating device (10) operating flow rate setting of the flow controller (9) is a thermostat of any kind as known in the arts, the system thus being self acting. The temperature sensor (11) being directly connected to the actuating device (10).

[0047] Such a setup has the advantage of not needing any additional energy source for operation, and each riser may be regulated individually. Using a standard thermostat as actuating device (10) as known in the arts, further gives the advantages that such devices often include means to set a temperature set point, the set point of the return temperature therefore being adjustable according to a dependence as, for example, illustrated in Fig. 4.

[0048] Fig. 6 shows an embodiment where all sensors (8), (9) and (19) (temperature sensor measuring the temperature of the heat exchanging medium in the main supply line (1)) and flow controllers (9), or alternatively the actuating devices (10) are connected to an electronic controller (18) adapted to individually regulate the flows in response to the measured temperatures. Introducing such an electronic controller (18) gives a number of advantages in relation to the self acting actuating device.

[0049] The electronic controller (18) comprises the needed means for electronic controllers (18) as they are well known in the arts of electronic controllers.

[0050] The set point of the return temperature is automatically adjustable according to the actual conditions by the electronic controller (18), whereas in the self-acting embodiment the set point of the return temperature is usually set manually. This gives a huge potential in saving energy, since the system would optimize the set point of the return temperature according to an optimized curve (13) as illustrated in Fig 4.

[0051] In this electronic version principle, the supply temperature is controlled by the external temperature measurement (the 'super control'). Based on these 'super'-control actions the return temperature set point is controlled to appropriate setting that makes it possible to optimize the system performance throughout the year, the performance therefore not depending on system load (outside temperature). The 'sub'-controls of the flows in the risers is related to the individual collection of radiators

(6) / riser loads, and thus correlates flow to heat demand, and thereby converts this one-pipe system from a traditional constant flow system into a highly energy efficient variable flow system.

[0052] Another advantage is that the electronic controller (18) allows monitoring and registering temperatures and flows for control and system monitoring, in order to actively optimise the system parameters over time.

[0053] For protection of the pump of the system, in the case that all risers are closed, the electronic controller (18) may in one embodiment automatically open valves / flow controllers (9) located in at least one of the risers to ensure minimum flow.

[0054] The illustrated system comprises an external temperature sensor (8) for measuring outdoor temperature. The regulation of the supply temperature in the main supply line (1) may be done in any manner as it would be obvious according to the actual set up. In the illustrated substation setup system this could be by regulating the primary flow of fluid to the primary side of the heat exchanger (20) of the substation.

[0055] The electronic controller (18) is connected to the individual actuating devices (10), and is adapted to induce an actuation. In one embodiment the state of the actuating devices (10) is further registered by the electronic controller (18).

[0056] The electronic controller (18) is further connected to the temperature sensors (9) (19) measuring the supply temperature of the main supply line (1) and the return of the individual risers. Optionally it could also be connected to the external condition / temperature sensor (8).

[0057] In one embodiment, the actuating device (10) attached to the flow controller (9) is pulse actuated. Pulse width modulation as mean of control uses pulses at some frequency to modulate control the flow precisely. The actuating device (10) is adapted to slowly close or open the flow controller (9) in that it closes off or opens for the flow in the riser, a pulse making the actuating device (9) open or close a little for the flow. The frequency of the pulses then defines the opening status of the flow controller (9). The more frequent the pulses, the more open a flow controller (9) or alternatively the more closed a flow controller (9). The situation where the pulses make the actuating member (10) close the flow controller (9) is preferred since, in the case of a failure of the system, there would still be a flow, but the present invention is not limited to this.

Claims

1. Method of regulating a system comprising a plural of risers each consisting of; a collection of heat exchanging devices (6) connected in series, such that a return line (4) of one heat exchanging device (6) is a feeding line (3) of a next heat exchanging device (6),

   and where feeding line (3) of the first of the heat exchanging devices (6) of each riser, seen in the flow direction, is connected to a main supply line (1),

   and where return line (4) of the last of the heat exchanging devices (6) of each riser, seen in the flow direction, is connected to a main return line (2),

   where a heat exchanging fluid medium is feed from the main supply line (1) to the collection of heat exchanging devices (6) at of each riser at a supply temperature,

   wherein the supply temperature is regulated according to a supply set point temperature depending of parameters external to the system, and the flow rates of the individual risers are regulated according to a return set point temperature depending on a temperature of the heat exchanging fluid medium downstream of the first heat exchanging device (6) in the collection.

2. Method according to claim 1, wherein the system further comprises

   - a flow controller (9) connected to a return line (4) of each riser, the flow controller (9) being adapted to control the flow rate through the return line (4),
   - an actuating device (10) operating the flow controller (9), and
   - a temperature sensor (11) positioned in a heat exchanging connection to the heat exchanging fluid in the return line (4).

3. Method according to claim 2, wherein an electronic controller (18) is connected to each actuating devices (10) and the temperature sensor (11) is connected to the return line (4) of the heat exchanging device (6) where it is positioned in heat-exchange connection.

4. Method according to claim 3, wherein the electronic controller is connected to a temperature sensor (19) connected to the main supply line (1).

5. Method according to one of claims 1 or 4, wherein the supply set point temperature is regulated in dependence of an external temperature to the system.

6. Method according to claim 5, wherein the return set point temperature is regulated in response to a regulation of the supply set point temperature.

7. Method according to one of claims 4 to 6, wherein an external temperature sensor (8) is positioned to measure a temperature external to the system.

8. Method according to any of the preceding claims, wherein the flow rate in a riser is regulated according to a set point temperature of the return temperature

of the heat exchanging fluid medium after the last of the heat exchanging devices (6) seen in the flow direction.

9. Method according to any of claims 2-8, wherein at least one actuating device (10) is an electro-magnetic, pneumatic, hydraulic or electrostrictive actuator.

10. Method according to any of claims 2-9, wherein each actuating device (10) is connected directly to a temperature sensor (11) and is self-acting and includes means to adjust the return temperature set point and where the actuating device (10) is a thermostat.

11. System including the features of any of the preceding claims and adapted to operate according to the method.

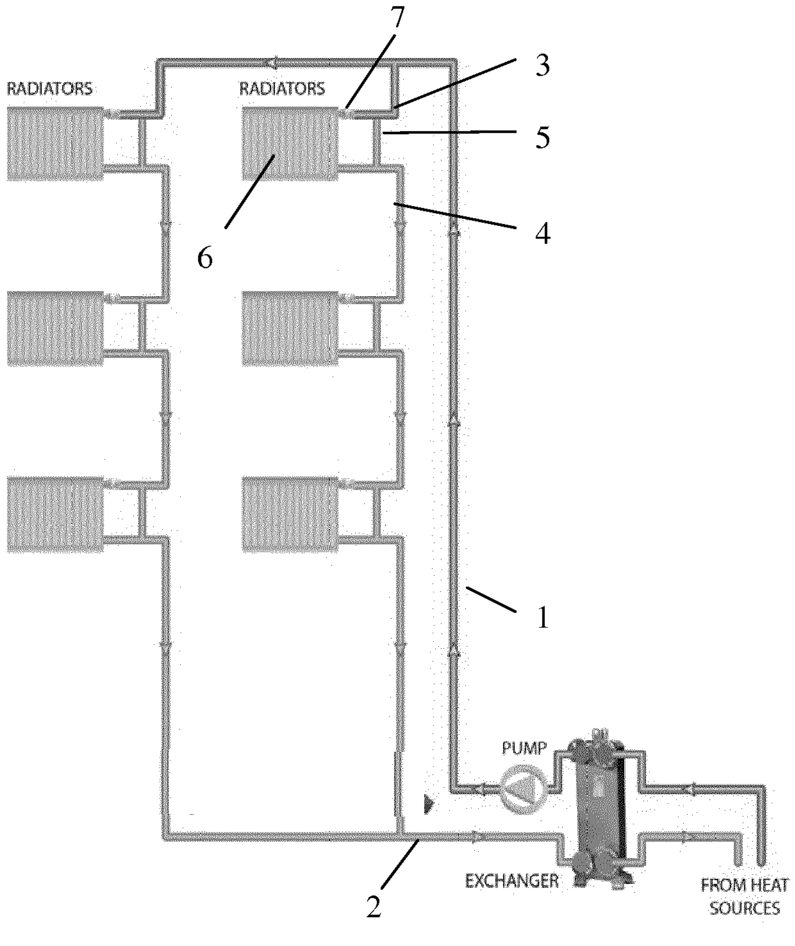
7
3
RADIATORS
RADIATORS
5
4
6
1
PUMP
EXCHANGER
2
FROM HEAT
SOURCES

Fig. 1

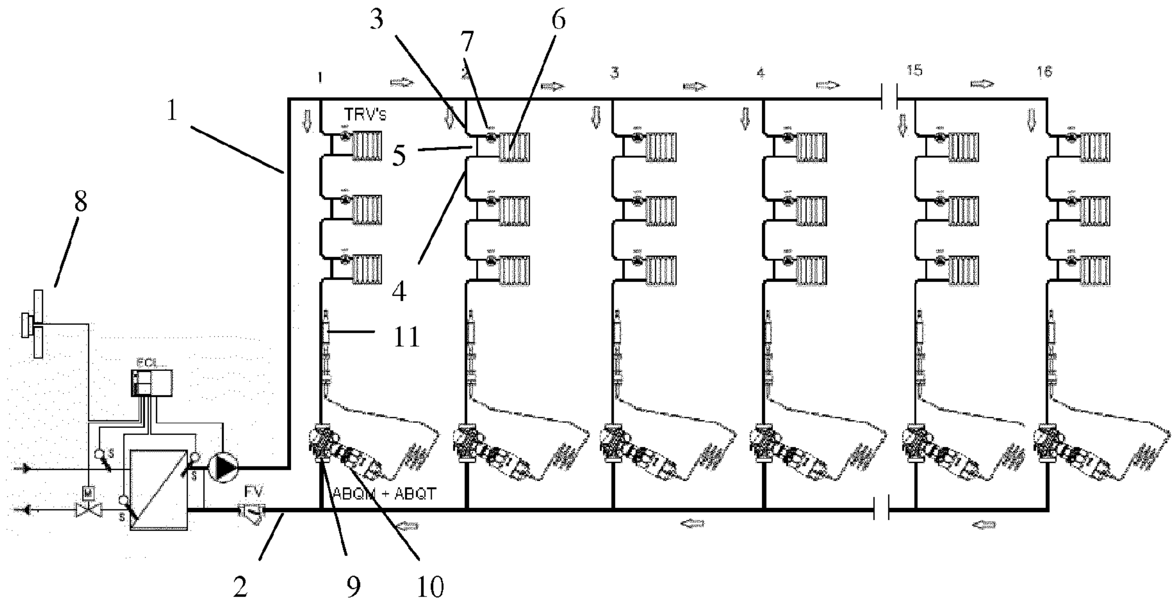

Fig. 2

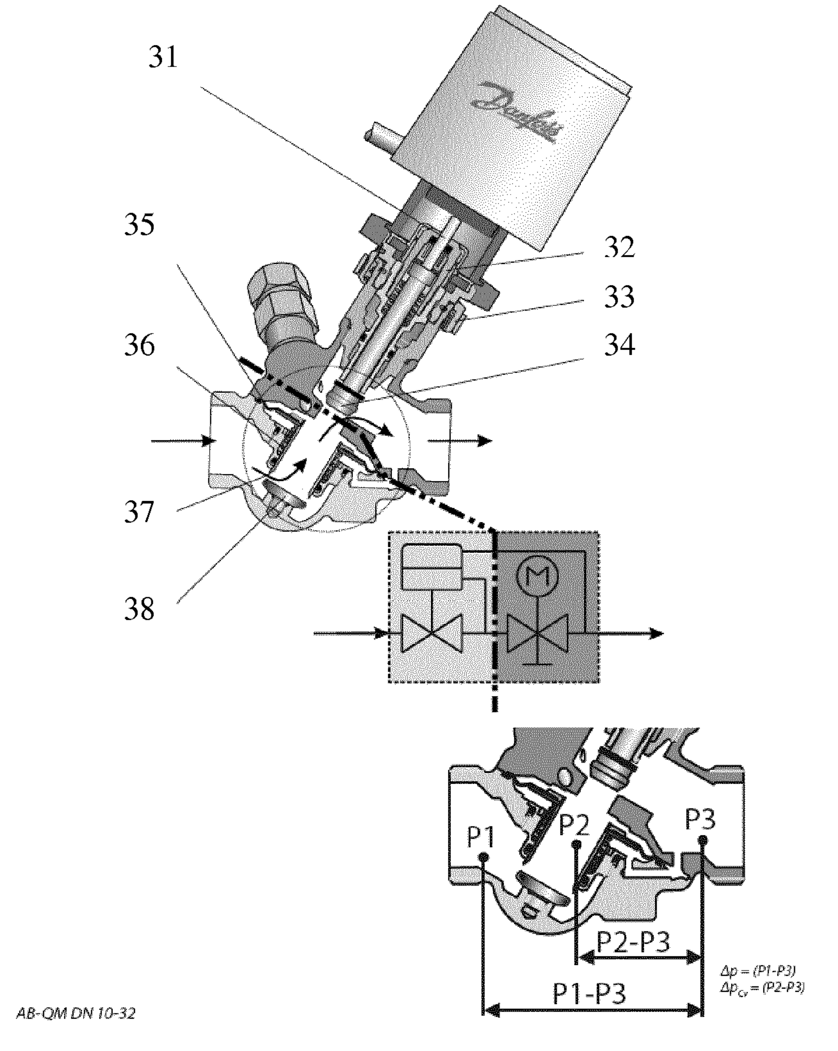
31
32
33
34
35
36
37
38
P1
P2
P3
P2-P3
P1-P3
$\Delta p = (P1-P3)$
$\Delta p_{Cv} = (P2-P3)$
AB-QM DN 10-32

Fig. 3

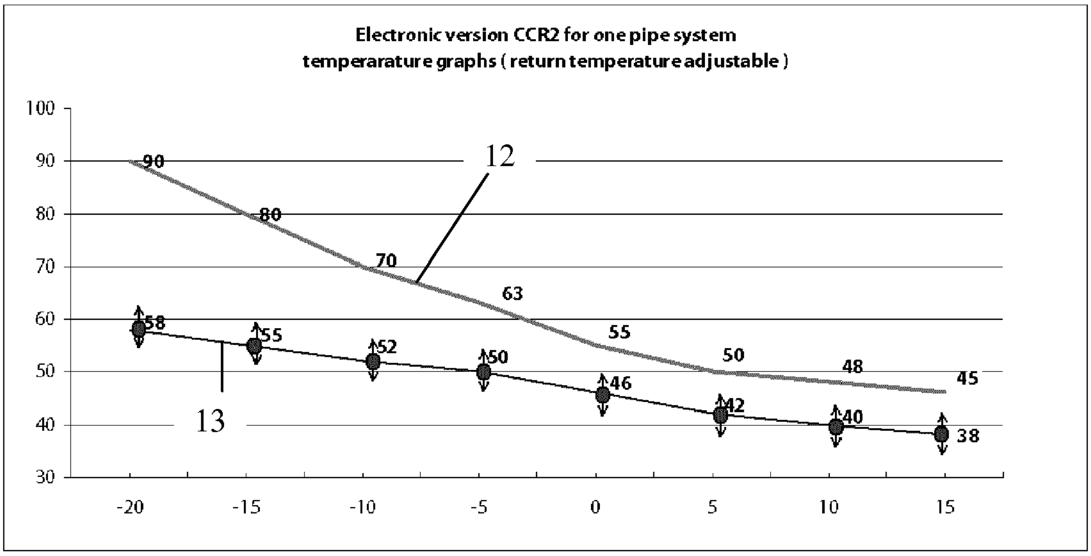
Electronic version CCR2 for one pipe system
temperarature graphs (return temperature adjustable)
100
90
80
70
60
50
40
30
-20
-15
-10
-5
0
5
10
15
90
80
70
63
55
50
48
45
58
55
52
50
46
42
40
38
12
13

Fig. 4

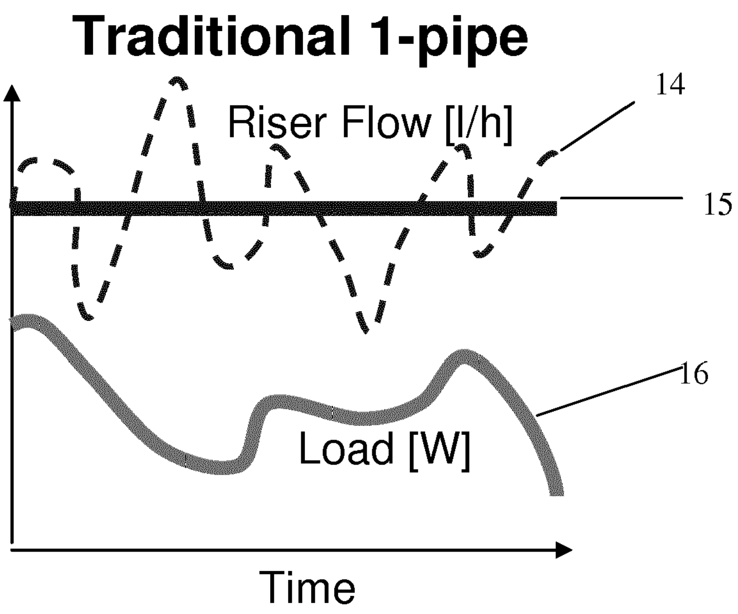
Traditional 1-pipe
Riser Flow [l/h]
Load [W]
Time
14
15
16

Fig. 5A

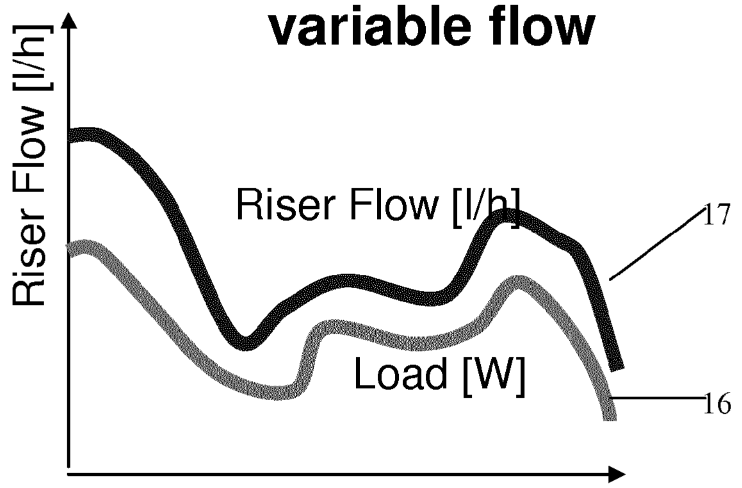
variable flow
Riser Flow [l/h]
Riser Flow [l/h]
17
Load [W]
16

Fig. 5B

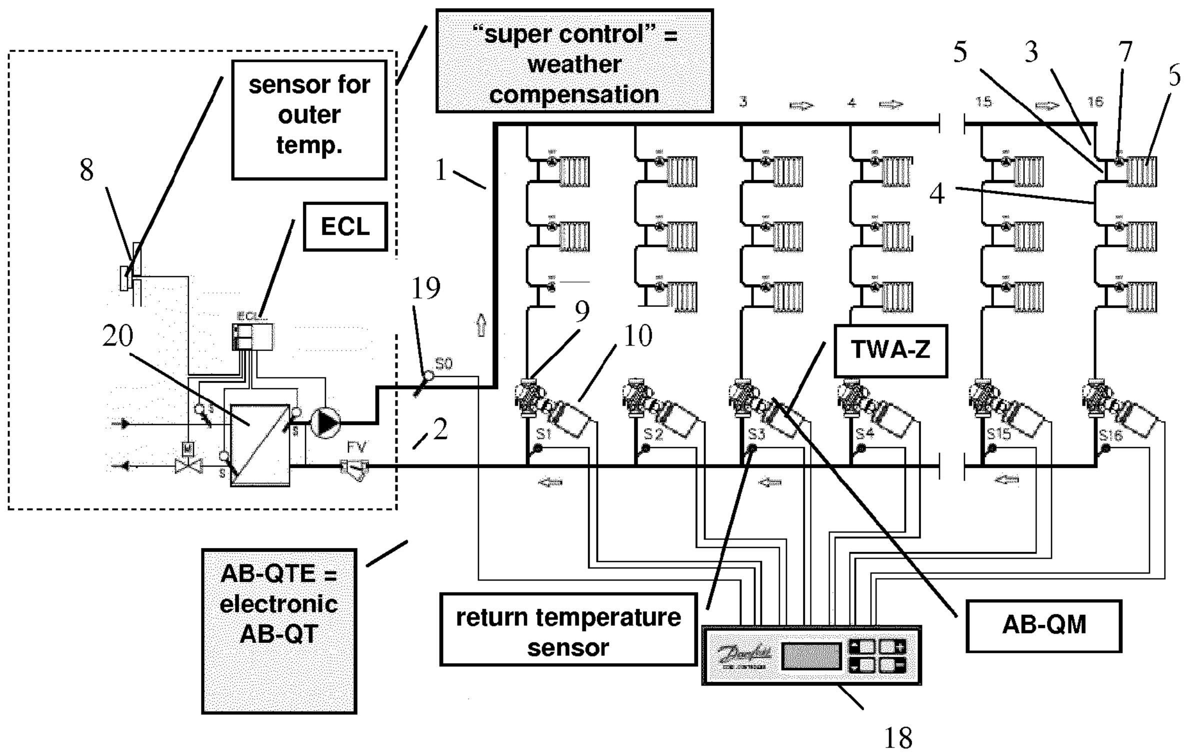
"super control" = weather compensation
sensor for outer temp.
ECL
8
1
19
20
2
9
10
TWA-Z
5
3
7
5
4
AB-QTE = electronic AB-QT
return temperature sensor
AB-QM
18
S0
FV
S1
S2
S3
S4
S15
S16

Fig. 6

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 15 19 6496

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y A	DE 296 13 632 U1 (NEHEIM GOEKE & CO METALL [DE]) 19 September 1996 (1996-09-19) * pages 2-3; figure 4 *	1-5,7-11 6	INV. F24D19/00 F24D19/10
Y A	DE 38 30 606 A1 (GENIE CLIMATIQUE THERMIQUE [FR]) 13 April 1989 (1989-04-13) * pages 1-2; figure 1 *	1-5,7-11 6	
Y	US 2008/179415 A1 (JOHNSON DAVID E [US] JOHNSON JR DAVID E [US]) 31 July 2008 (2008-07-31) * pages 1-3; figures 1,2 *	1,4,7	
A	EP 0 014 612 A1 (MESSIER SA [FR]) 20 August 1980 (1980-08-20) * abstract; figure 1 *	1,6,11	

TECHNICAL FIELDS SEARCHED (IPC)

F24D

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	17 February 2016	Blot, Pierre-Edouard

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

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 15 19 6496

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

17-02-2016

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
DE 29613632	U1	19-09-1996	NONE		
DE 3830606	A1	13-04-1989	DE 3830606	A1	13-04-1989
			GB 2209821	A	24-05-1989
US 2008179415	A1	31-07-2008	NONE		
EP 0014612	A1	20-08-1980	NONE		

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- DE 10323981 **[0032]**