



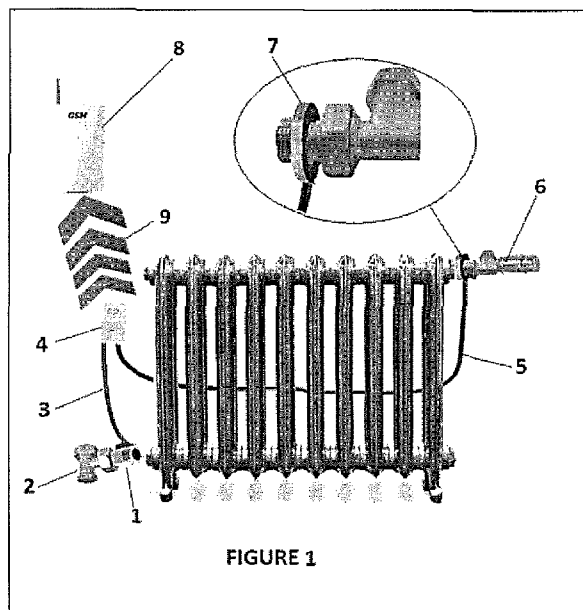
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(54) Title: MEASURING SYSTEM FOR ACTUAL ENERGY CONSUMPTION OF CENTRAL HEATING RADIATORS



(57) Abstract: A system for measuring the actual energy consumption of each individual radiator in central heating installations, wherein the energy consumption of a single radiator is measured in real and actual units of heat Kw/h by a digital control unit (4) for data processing, connected by means of an electric cable (3) to a metal part, where a flowmeter and temperature sensor (1) are installed at the radiator outlet and connected by means of an electric cable (5) to a metal ring with a temperature sensor (7) installed at the radiator outlet, and the digital control unit consists of a module in the form of an electric appliance (4) and data which is the data of real used Kcal/s or Kw/h by a central heating radiator in certain operating time and identification number of the device will be stored in the memory of the device until read by radio connection (9); transmitted to a collective device according to the settings, a device for collective reading and data transmission (8). Preferably a mechanical flowmeter (1) is equipped with rotating vanes (1 d) from which impulses are recorded by an electronic recording device (1f) and a temperature probe (1 g) measuring the temperature of the liquid outflow from a radiator. The electronic device (4) contains an electronic digital systems module (4a) with a program for processing data into the actual heat consumption data of a radiator, powered by a battery (4b). The internal flowmeter rim (1 e) has a diameter adapted to the internal diameter of the valve (2b) and a rubber or plastic gasket (1 c) applied on the rim (1 e), which, together with the radiator union, guarantees a tight connection. The system can be installed horizontally or vertically without loss or alteration of data, it can be mounted absolutely on



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Measuring system for actual energy consumption of central heating radiators

The object of the invention is a system for measuring the actual energy consumption of a radiator in central heating installations, designed to measure the actual amount of thermal energy flowing through the household, and also to measure the energy consumption of each individual central heating radiator regardless of the material of which the radiators are made. The system enables settlement between the supplier and the energy consumer.

Currently existing measuring devices for the individual consumption of heating energy by central heating radiators, known as heat cost allocators, are based on calculations which are variable and do not give any accuracy as to the real heat consumption of central heating radiators in column (vertical) or circular systems. Current heat settlement systems are based on the indications of devices called allocators which are not measuring instruments for heat energy because they do not measure any physical quantity of heat energy consumed - most often the increase of their indications (expressed in non-indicated minimum scale intervals) depends on the ambient temperature, the temperature of the radiator's surface in the place of allocator installation and the time of heat transmission by the radiator as well as many data which should be assigned to each allocator individually. These data should take into account both the size of the radiator (height, length, number of units, etc.), its power outlet, as well as its type and construction (cast-iron, steel, aluminium, etc.). Assigning so many different data to a device which, in addition, is not a thermal energy measuring instrument reasonably undermines its indication reliability. Distortion in indications will occur even if a central heating radiator is installed by some decorative furniture, or if a radiator is built-in. Final result does not calculate the actual energy consumed, but gives the figure as a "unit of consumption" (dimensionless number), which influenced the development of a solution changing the whole measuring system, which will guarantee an accurate and real measurement of the heat consumption of each individual central heating radiator without limits, no matter what material the radiator is made of, how powerful it is or where in a given room it is located. In this way, a digital system was created to measure the heat consumption of each individual radiator.

The aim of the invention is to install a measuring system on each individual central heating radiator to measure the exact consumption of heat energy by each radiator, which allows for a real division of energy consumption costs into individual premises/apartments.

The system for measuring the actual energy consumption of a radiator in central heating installations, according to the invention, is characterised by that the measurement of energy consumption of a single radiator is expressed in real and actual units of heat Kw/h by a digital control unit for data processing, connected by means of an electric cable with a metal part in which a flowmeter and a temperature sensor is mounted at the radiator outlet and connected by means of an electric cable with a metal ring with a temperature sensor mounted at the radiator inlet on its connection.

The digital control unit consists of a module in the form of an electric appliance from which data are stored in the memory of the device until reading by radio connection to the device for collective reading and data transmission. The electronic module is connected by an electric cable to the second module in the form of a metal element in which a flowmeter is mounted with a temperature sensor connected to the valve on the radiator outlet by means of a radiator union, and is connected by an electric cable with the third module in the form of a metal ring with a temperature sensor mounted at the radiator inlet on the connection of the radiator's feed valve.

Preferably, the system has a mechanical vane flowmeter equipped with rotating vanes under the influence of liquid flow, from which impulses are recorded by an electronic recording device, and a temperature probe measuring temperature of liquid outlet from the heater.

The electronic device module contains an electronic module of digital systems with a program to process these data into the actual heat consumption data of a central heating radiator in Kcal or kW/h. The internal flow meter rim has a diameter adapted to the internal diameter of the valve and a rubber or plastic gasket applied on the rim, which, together with the radiator union, guarantees a tight connection.

The system measures the actual consumption of a single radiator and the information reaches a universal data receptor which converts it into figures.

On the basis of mathematical formula $P = m * C_p (\Delta T)$, where P is the energy consumed, M is the mass of the heated liquid, Cp is the specific heat of the heated liquid (in this case water), and ΔT is the difference in temperature of the liquid, this formula has been applied for a mini-meter which on one side calculates the amount of liquid mass flow through a central heating radiator, and on the other it calculates the temperature difference between the inlet water and outlet water during heating, we obtain the exact consumption of Kw/h Kcal of a radiator, without having to know the material from which the radiator is made or

the heat emission rate of the radiator, because we calculate exactly the power consumed by the radiator.

In the measuring system, according to the invention one of the modules is a metal element, in which there is a rotary-vane or ultrasonic liquid meter and a temperature sensor which on one side has a thread allowing direct installation into the connection of the radiator, while on the other side there is a union which allows connection to the valve. This module, through an integrated temperature sensor built into a metal body, provides data on the heating liquid temperature at the radiator outlet, this module is connected by an electric cable to a second element in the system, which is an electronic module for receiving/sending data. The third module is a metal ring with a temperature sensor mounted at the radiator inlet on the radiator's supply valve, also connected by an electric cable to the electronic module. In the case of a small water flow on the radiator inlet/outlet section (small radiators) the heat losses are negligible, then it is sufficient to base the measurement data on only one temperature measurement from a sensor located in the flow meter.

System components, i.e. the flow meter with temperature sensor mounted at the radiator's outlet and a second temperature sensor mounted at the radiator's inlet are connected by electric cables with the electronic module. This module processes data by calculating real energy consumption, the data is transferred to other information-collecting systems, or to a radio reading system for data collection and emission which transmits the consumption to the receiving central unit or data collection point and is received from there either by manual systems or by sending GSM data.

The advantage of the system is that it measures actual and accurate energy consumption in Kcal or kW/h units, based on a universal formula for calculating energy consumption, reads actual and real data in order to determine the consumption, not depending on the type of installed central heating radiator, its size, power and the manufacturer.

The system does not record heat when there is no flow because the basis for the calculation is the quantity or volume that flows through a radiator. The system is used to measure heat, indicating the heat in legal units of measurement, accurately records the energy consumed in the flow and the corresponding data are based on the fact that 1 Kw/h of the universal measurement equals 859.84 kcal/h. In addition to the exact measurement of the energy consumption of each radiator, it allows us to accurately calculate the total heat consumption of premises/building/circuit including losses. For this purpose, the summed values from all readings of the systems

mounted on radiators should be subtracted from the main measurement from the boiler

room or district heating substation. After subtracting the sum of all measurement readings from the main measurement from the boiler room or district heating substation, we obtain accurate data on the amount of energy actually used and energy losses that are in the installation.

The system can be mounted horizontally or vertically without any data loss or alteration. It can be installed in either a column or circular installation and also in single-pipe systems.

If a radiator is too long for accurate reading, connect an additional temperature sensor via a ring and an additional cable in the input circuit which must be connected to the digital data receiver.

If a water circulation is very small with a small radiator, at the inlet and outlet of the radiator, the heat loss will be insignificant, therefore the temperature from the temperature sensor built into the flowmeter installed at the outlet from the radiator is sufficient.

The object of the invention has been exposed in the embodiment in the schematic diagram where fig. 1 shows a general scheme of the measuring system, fig. 2 shows an element of the liquid flowmeter and temperature sensor in view and cross-section, fig. 3 shows the method of connecting the flowmeter with the radiator outlet valve using a radiator union and a gasket to ensure tightness, fig. 4 shows the method of connecting the measuring system in a small radiator, where there is no need for a second temperature sensor on the radiator supply, fig. 5 shows the method of mounting the measuring system in a radiator in the installation of a single-pipe circuit with flow meter at the back of the radiator, and fig. 6 shows the method of mounting the measuring system in a steel panel radiator.

The measuring system consists of a module in the form of a metal element in which a flowmeter with temperature sensor 1 is fitted which measures the heating fluid flow and temperature and is connected to the valve 2 by means of a radiator union 1a with a thread 1b. Connection sizes used are the most standard ones, i.e. 1/2 "or 3/8". Heating fluid flows through a feed valve 6 into the radiator, its temperature is measured by a temperature sensor 7 which sends the measurement to an electronic device 4 via a cable 5. During the time when the valve 6 is open, the heating fluid flows through the radiator giving away the heat and then at the outlet from the radiator, the amount of heating fluid flow rate and temperature is measured through the flowmeter and temperature sensor 1. In a mechanical rotary-vane flowmeter 1, the vanes 1d rotate during the flow of liquid causing impulses to be generated, impulses are recorded by an electronic recording device 1f, while a temperature probe 1g measures the temperature of the liquid at the outlet. These data are supplied by the cable 3 to the electronic device 4, which contains

an electronic module of digital systems 4a with a program to process these data into data on the actual heat consumption of a central heating radiator in Kcal or kW/h, the device is powered by a battery 4b. The measuring system at the radiator outlet is connected to the valve 2 by a radiator union 1a, whereby the inner rim of the flowmeter 1e has a diameter matching the internal diameter of the valve 2b. In this connection, a rubber or plastic gasket 1c is applied on the rim 1e. This combination provides a complete guarantee of tightness. The electronic device module 4 is used to receive, process and send data; inside a plastic housing there is a digital systems board 4a with appropriate software for processing the information received from the temperature sensor at the inlet of liquid to the radiator 7, from the temperature sensor at the fluid outlet of the radiator 1g and the measurement of the amount of heating fluid flow from the flowmeter through impulses generated by the rotating flowmeter vanes 1g captured by a sensor 1f. The digital systems board 4a as well as the temperature sensors 1g are powered by a 5/12V Li-ion battery 4b allowing an optimal working time of 5 years. The electronic device processes all measurements into the correct data of Kcal or kW/h heat units in accordance with the programming, and this data will be stored in the device's memory until it is read by means of radio connection 9 to the device for collective reading and data transmission 8. These data are then transferred to an information system which accounts for each energy consumer according to the metering indications. This is the data of actually used Kcal or Kw/h by a central heating radiator. By summing up readings of all the radiators in an apartment/premises we get information about the actual heat consumption in the apartment/premises already expressed in Kcal or kW/h units.

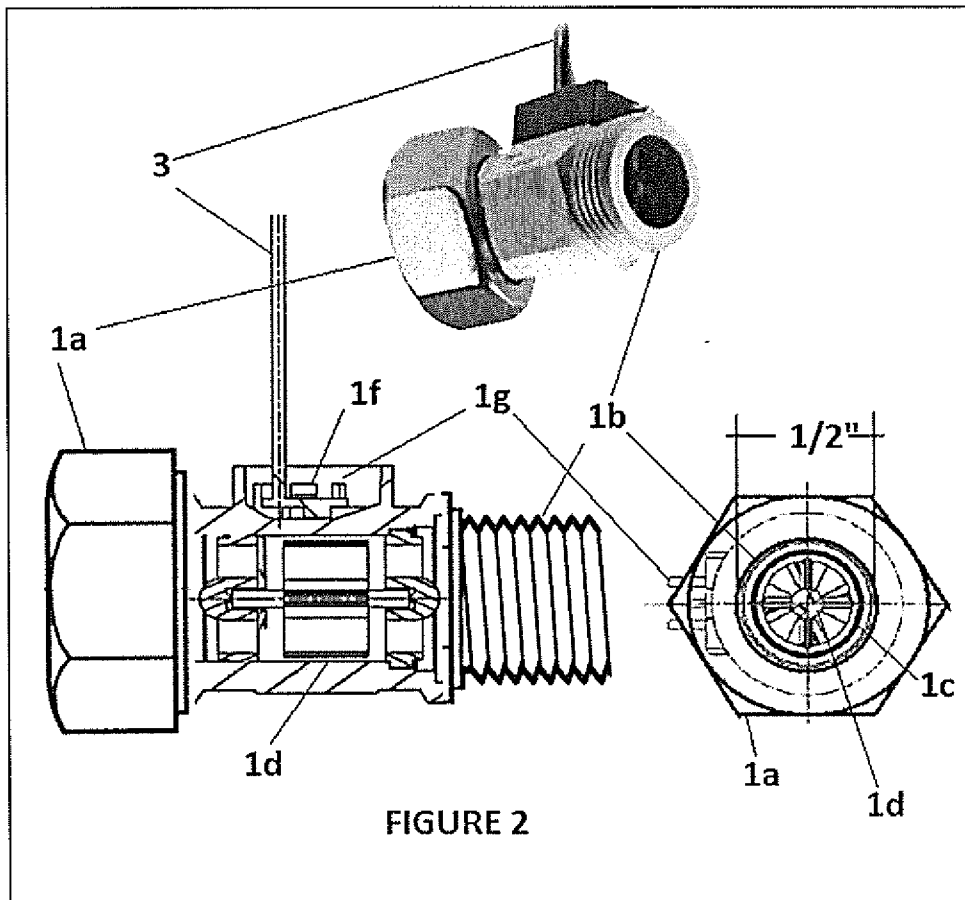
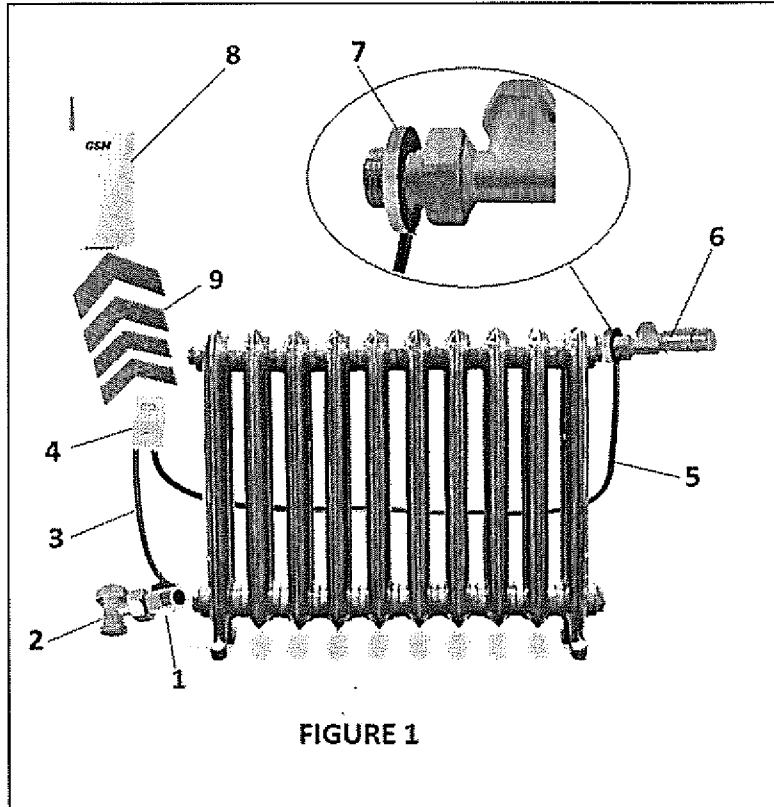
List of designations:

- 1 – flowmeter with temperature sensor
- 1a – screw
- 1b – thread
- 1c – gasket
- 1d – vanes in flowmeter
- 1f – electronic recorder
- 1g – temperature probe
- 1e – rim of the flowmeter
- 2 – valve
- 2a – external diameter of the valve
- 2b – internal diameter of the valve
- 3 – cable
- 4 – Electronic device
- 4a – digital systems board
- 4b – battery
- 5 – cable
- 6 – feed valve
- 7 – temperature sensor at the inlet to the radiator
- 8 – data transmission
- 9 – radio connection

Patent Claims

1. A system for measuring the actual energy consumption of each individual radiator in central heating installations, **characterised in that** the energy consumption of a single radiator is measured in real and actual units of heat Kw/h by a digital control unit (4) for data processing, connected by means of an electric cable (3) to a metal part, where a flowmeter and temperature sensor (1) are installed at the radiator outlet and connected by means of an electric cable (5) to a metal ring with a temperature sensor (7) installed at the radiator outlet, and the digital control unit consists of a module in the form of an electric appliance (4) and data which is the data of real used Kcals or Kw/h by a central heating radiator in certain operating time and identification number of the device will be stored in the memory of the device until read by radio connection (9); transmitted to a collective device according to the settings, a device for collective reading and data transmission (8).
2. The measuring system according to claim 1 is **characterised by that** preferably a mechanical flowmeter (1) is equipped with rotating vanes (1d) from which impulses are recorded by an electronic recording device (1f) and a temperature probe (1g) measuring the temperature of the liquid outflow from a radiator.
3. The measuring system according to claim 1 is **characterised by that** the electronic device (4) contains an electronic digital systems module (4a) with a program for processing data into the actual heat consumption data of a radiator, powered by a battery (4b).
4. The measuring system according to any of claims 1 and 2 is **characterised by that** the internal flowmeter rim (1e) has a diameter adapted to the internal diameter of the valve (2b) and a rubber or plastic gasket (1c) applied on the rim (1e), which, together with the radiator union, guarantees a tight connection.
5. The measuring system according to claim 1 is **characterised by that** it can be installed horizontally or vertically without loss or alteration of data, it can be mounted absolutely on every central heating radiator without limits of what material

the radiator is made of, of what the power is or where it is located in a given room and also without the need to enter additional technical data of the radiator into the software in the data receiver.



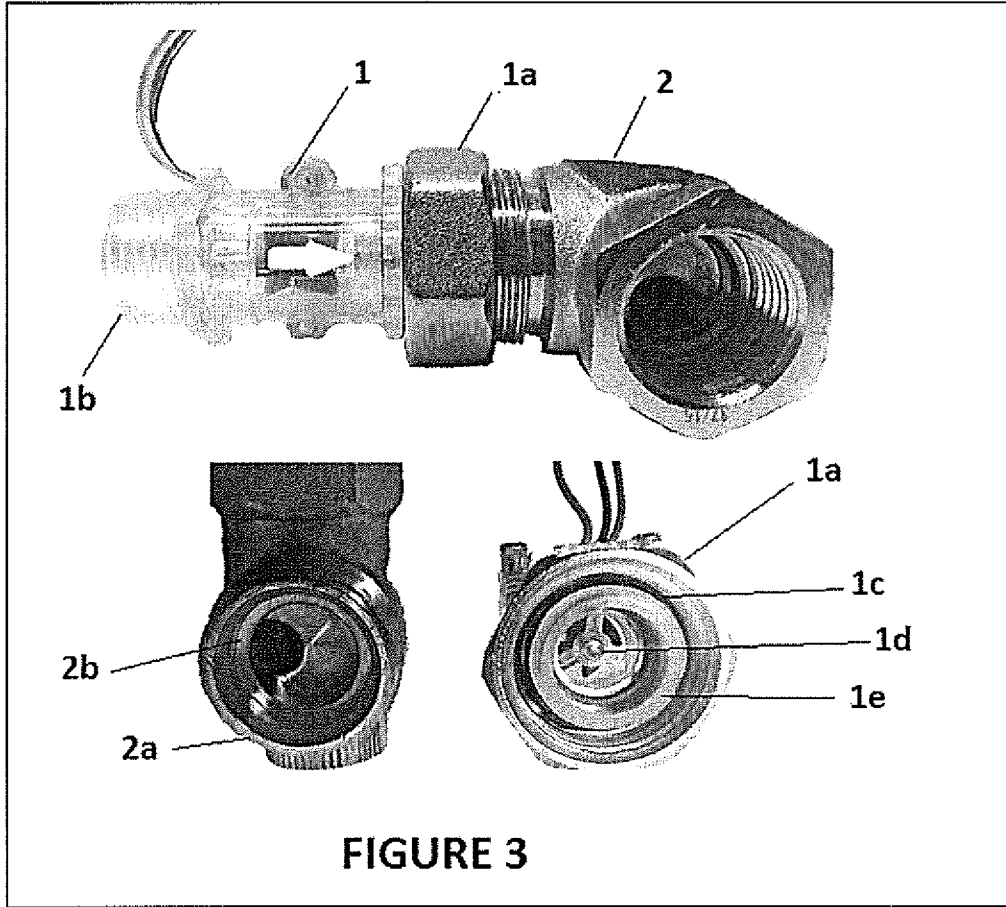


FIGURE 3

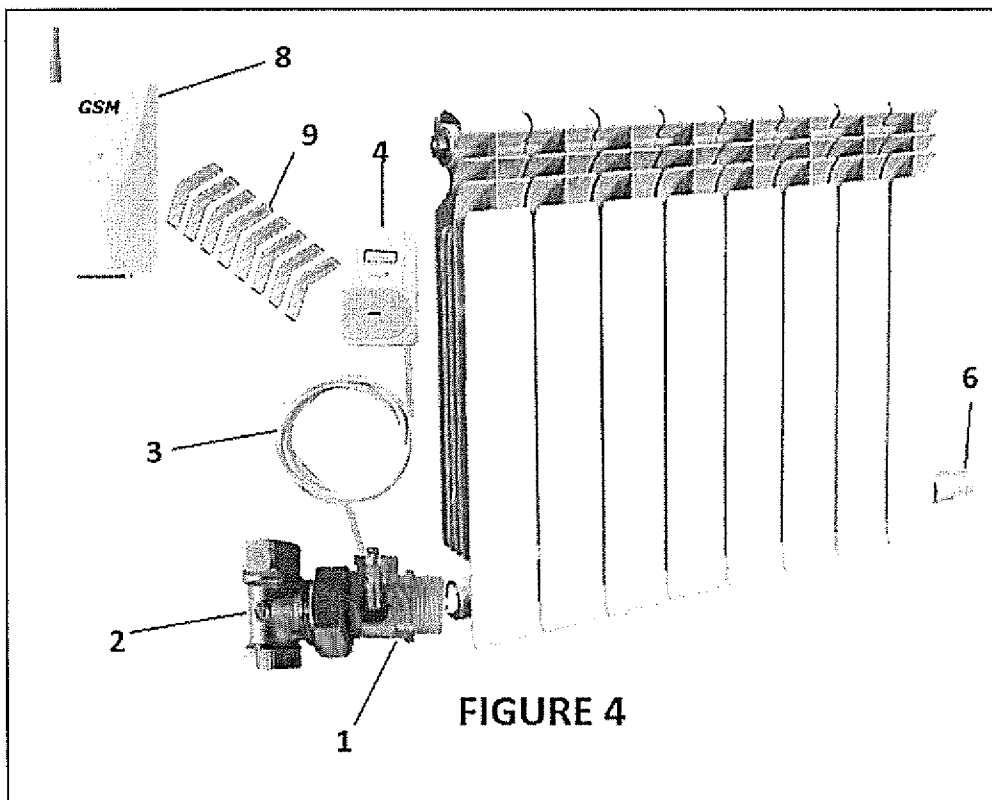
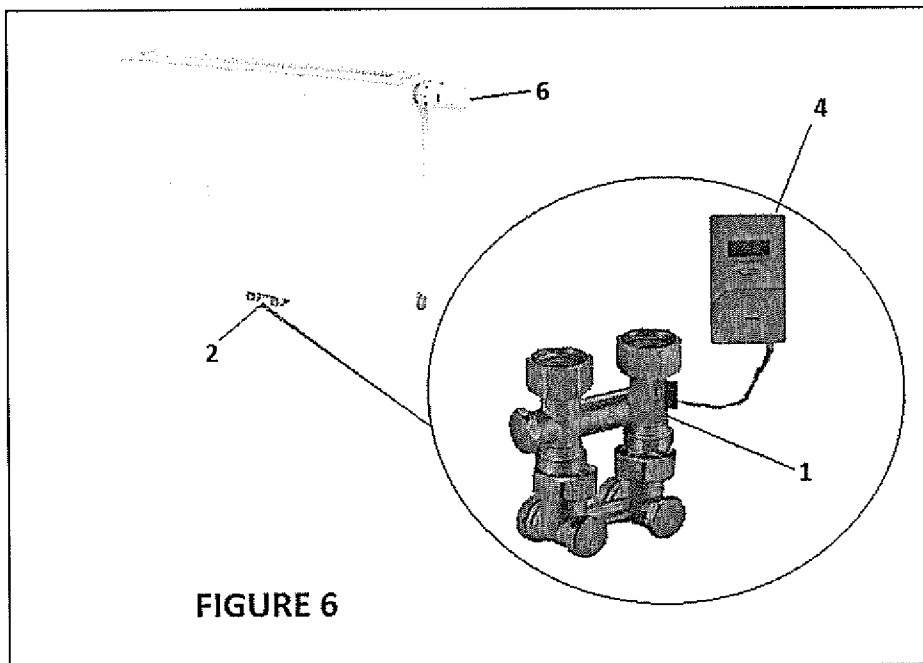
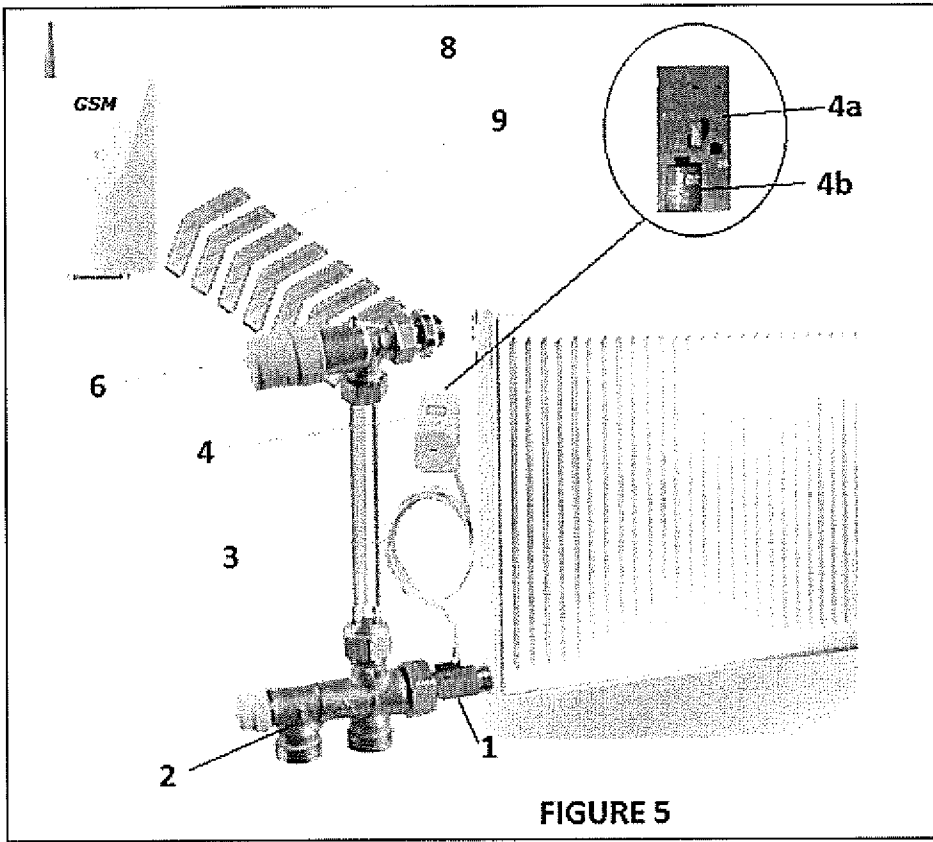


FIGURE 4



INTERNATIONAL SEARCH REPORT

International application No.

PCT/PL2017/000051

A. CLASSIFICATION OF SUBJECT MATTER G01K17/10 (2006.01)		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) G01K17, G06K13		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPODOC		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP2000788A1 (KAMSTRUP AS [DK]) 2008-12-10 the whole document	1-5
Y	GB2329023A (THERMOCOUPLE INSTR LIMITED [GB]) 1999-03-10 the whole document	1-5
Y	CN201368783Y (UNIV SHANDONG AGRICULTURE [CN]) 2009-12-23 the whole document	1-5
Y	EP2743661A1 (CHEREPNIN OLEG MIKHAILOVYCH [UA]) 2014-06-18 the whole document	1-5
Y	WO2014180484A1 (KAMSTRUP AS [DK]) 2014-11-13 the whole document	1-5
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 07 February 2018 (07.02.2018)		Date of mailing of the international search report 08 February 2018 (08.02.2018)
Name and mailing address of the ISA/ Visegrad Patent Institute / Branch Office PL Al. Niepodległości 188, 00-950 Warsaw, Poland Facsimile No. +48 22 579 00 01		Authorized officer Arkadiusz Kwapisz Telephone No. +48 22 579 06 10

INTERNATIONAL SEARCH REPORT
Information on patent family members

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		DK2994724 (T3)	2017-10-16
		EP2994724 (A1)	2016-03-16
		PL2994724 (T3)	2017-12-29
		US2016084693 (A1)	2016-03-24
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