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(54) System for the control of the temperature of distribution of hot water for sanitary uses disinfected from the Legionalla bacterium by means of a high temperature, centralized production

(57) The field of application of the invention is the distribution of hot water for sanitary uses with an optimal temperature between 48 and 50 ° Celsius in all (previously existent and/or new) hydraulic systems after it's centralized, high temperature production by any known means of heating at temperatures of 70° Celsius and above in order to disinfect the incoming water supply from any traces of the Legionella Bacterium and the associated risk of human infection.

The essential characteristics of the invention consist in the technically common use of the process of continuous, high temperature thermal disinfection at temperatures of 70° Celsius and above applied to the incoming water supply in order to rid it of the risk of human infection associated with the presence of the Legionella bacterium with the addition of an innovative system which preserves the disinfection until human use takes place, even though a sensible drop in the distribution temperature occurs. This system constitutes the subject of the present invention.

The following text refers to the attached drawing entitled "Fig. 1/1":

The hot water for sanitary uses is produced in an accumulation boiler Fig. 1/1(T) which is set at temperatures of 70° Celsius and above in order to disinfect it from the Legionella bacterium. The hot water produced is fed to the system through Fig. 1/1(G) and, by transiting in the secondary circuit of a plate based heat exchanger Fig. 1/1(SC) which comprises an automatic temperature control Fig. 1/1(VMA) placed on it's primary stage that is fed by the cold water from the incoming water supply and is then cooled to the optimal distribution temperature of 48-50 °Celsius before being supplied to the main feed of the sanitary water network Fig. 1/1(M) in a condition of total and certain absence of live Legionella bacterium.

The invention is completed by; the automatic temperature regulation of the water recycle Fig. (VMR) which avoids overheating in case of lack of use, the pump system Fig. 1/1(X) - Fig. 1/1(Y) which avoids any risk of temperature layering in the boiler's reservoir, the security block on the sanitary waters Fig. 1/1(TS) - Fig. 1/1(VS) and the alarm equipped temperature monitoring system Fig. 1/1(TA) which signals if the temperature falls below 70° Celsius, the two inspection taps Fig. 1/1(RU): one for system discharge and the other for obtaining water samples for analysis and the included electrical control panel Fig. 1/1(QE).

The present technology, while utilizing continuous high temperature disinfection at temperatures of 70° Celsius and above, is then rendered useless by the method generally used to cool the waters before their actual use by physically mixing the hot, disinfected waters with the incoming cold water feed from the main water supply thus exposing the resulting waters to the risk of infection by live Legionella bacterium potentially present in the main cold water feed.

Such bacterium, through the heating provoked by the physical combination of hot and cold waters, awakes to a state of momentary quiescence that causes its development, proliferation and, successively, the colonization on its behalf of all waters comprised in the hot water distribution segment of the entire hydraulic system, thus rendering useless the previous disinfection which took place in the boiler's reservoir at temperatures of 70° Cel-

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sius and above and renovating the high risk of human infection due to the survival of live Legionella bacterium.

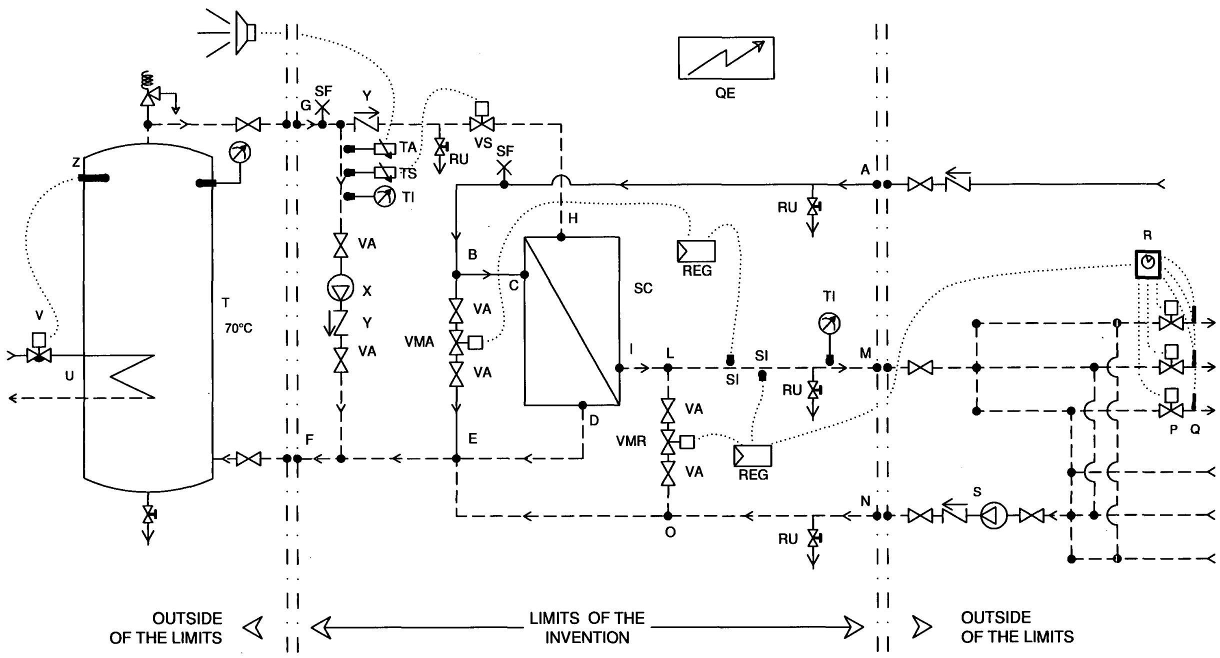


Fig. 1/1

Description

[0001] The Legionella bacterium may be found in all cold water fed hydraulic systems and may remain present in a state of relative quiescence up until the host temperature is inferior to 24° Celsius.

[0002] Once such temperature limit is overcome (between 25 and 42 ° Celsius), the bacteria develops and proliferates very quickly in the presence of oxygen, with a maximum peak at approximately 37° Celsius. When the temperature goes over 42° Celsius its development and proliferation decreases, and even if it survives at temperatures up to approximately 60 ° Celsius, it dies in a few minutes at 65° Celsius, and, instantaneously at 70° Celsius and above, according to the studies of Hodgson and Casey and their famous Diagram of Temperatures. Such studies are recognized to be scientifically valid and accepted by all parties without exception (W.H.O: World Health Organization; E.W.G.L.I. European Group for Legionella Infection; A.R.P.A. Italian Regional Environmental Protection Agency).

[0003] The innovation introduced by the system subject of this invention, in the field of the processes involved in the production and distribution of hot water for sanitary uses, is represented by the possibility that it offers to avoid any introduction of the Legionella bacterium through physical mixing between hot disinfected waters (disinfected at 70° Celsius by the boiler and then stocked in its reservoir) and potentially infected cold water coming from the main water supply feed, by means of a heat exchanger which consists of two parallel internal hydraulic circuits that avoid such physical contact while providing an adequate cooling in order to reach the ideal distribution temperature of 48-50 ° Celsius. This permits to eliminate the use of any of the other techniques of disinfection from the Legionella bacterium (such as the presently used disinfection methods which include: treatment with chemical agents, exposition to radiation, filtration or various additive-based solutions) Such techniques, while contributing to an improvement in the defences against Legionella based infections (with the downside of not only generating high implementation and maintenance costs but also by causing a degradation of the quality of the drinkable water itself) cannot constitute a definitive solution to the problem posed by Legionella based infections in sanitary water distribution systems.

[0004] With the system subject of the present invention, represented schematically by the attached drawing labelled "Fig. 1/1" which is referred to in the present text, the cold water fed by the main water supply, arriving from the primary incoming water connection Fig. 1/1(A), goes through the primary circuit Fig. 1/1(C-D) of the plate based heat exchanger Fig. 1/1(SC) is pre-heated and then, afterwards, is sent to the primary output of the system Fig. 1/1(F) and, from here, directly to the boiler with reservoir Fig. 1/1(T) (outside of the limits of the present invention) where it is heated and definitively disinfected at a temperature equal to or higher than 70°Celsius.

[0005] It is then fed to the secondary feed Fig. 1/1(G) of the system, and, from here, to the plate based heat exchanger Fig. 1/1(SC) where it is cooled to an optimal distribution temperature between 48 and 50° Celsius (such temperature can be regulated to different values, if deemed necessary) by means of the incoming cold water flow which feeds the primary circuit of the plate based heat exchanger, to be then sent, finally, to the secondary output of the system Fig. 1/1(M), and , from here, directly to the end user's utilities without ever entering in physical contact with the incoming cold water feed from the main water supply thus without any risk of successive pollution.

[0006] The water recirculation system Fig. 1/1(S) (outside the limits of the present invention), through the secondary system feed Fig. 1/1(N) and the primary output Fig. 1/1(F) feeds its whole flow (Already 100% disinfected) to the boiler Fig. 1/1(T) without any mixing in case of no demand from the attached utilities, or , with a partial mix taking place at point Fig. 1/1(E) with the water fed by the primary output of the plate based heat exchanger Fig. 1/1(SC), if the demand from the utilities is present. After this action takes place, it is newly fed to the boiler which provides a new cycle of disinfection at a temperature equal or greater than 70° Celsius. The whole flow of the water recirculation system, after the heating/disinfecting cycle is complete, through the secondary Fig. 1/1 (H-I) of the plate based heat exchanger Fig. 1/1(SC), is also cooled by water induced thermal exchange produced by the passage of the incoming cold water feed and is distributed to the utilities at a temperature of 48-50 ° Celsius, completely ridden of the Legionella bacterium.

[0007] In the system all flows are regulated in function of the water drawn from point Fig. 1/1(M) with the exception of the fixed flow at point Fig. 1/1(N) and all temperatures are fixed, at points Fig. 1/1(T) (boiler reservoir), on the secondary feed Fig. 1/1(G) and on the output towards distribution Fig. 1/1(M), with the exception of the variable flow at point Fig. 1/1(A), which is differs from system to system, and, for each case, different in time as per variable environmental conditions.

[0008] The equilibrium between all water flows and temperatures is provided by a regulation present within the limits of the invention, which consists, essentially, in a motorized two-way modulating hydraulic valve Fig. 1/1 (VMA) which derives water from the main cold water supply and bypasses Fig. 1/1(B-E) on the primary stage of the plate based heat exchanger Fig. 1/1(SC) (which functions as a cooler) that modulates the total flow of residual waters from the main cold water supply in the heat exchanger itself and thus its cooling capacity according to the setting of the regulator Fig. 1/1(REG) and the data provided by the submerged sensor probe Fig. 1/1(SI) in order to maintain the temperature of the hot water for sanitary uses to be sent to the utilities Fig. 1/1(M) constant (usually at a temperature between 48 and 50° Celsius, or at a different setting since it remains completely configurable). The constancy of the aforementioned temperature is independent from the total flow rate due to use and the aqueduct's Fig. 1/1(A) slow fluctuations in temperature.

[0009] The above described system for the control of the temperature of distribution of hot water for sanitary uses, actuated on the primary stage of the heat exchanger Fig. 1/1(SC) by modulating part of the total flow rate of the cold water supplied by the main water feed (aqueduct Fig. 1/1(A)) and its cooling effect, with respect to the control (also possible) actuated on the secondary stage of the heat exchanger which is fed by the hot water accumulated in the boiler's reservoir, presents the following advantages:

> Given that the ideal distribution temperature of hot water for sanitary uses is approximately 50° Celsius, the temperature in the boiler's reservoir is of 70° Celsius and above and the average temperature of water originating from the aqueduct or main water supply feed is of approximately 10° Celsius , the thermal excursion from 10 to 50 ° Celsius with respect the one from 70 to 50 ° Celsius would require a greater amount of regulation and therefore, in comparison, would require a higher ratio of temperature variation, rendering it less efficient and more expensive. The less ample temperature variation required by this temperature control system on the primary stage of the heat exchanger causes a quicker and more linear response in temperature regulation and a greater simplification, security and cost effectiveness in its manufacturing by avoiding to have to use additional temperature regulations by means of additional heat exchangers (cascaded or in parallel), regulators or successive mixings of any kind. The result is a cost effective, reliable system which may be easily and economically proportioned to meet custom total flow rate requirements.

[0010] Within the limits of the present invention there is also a two-way, servo-assisted flow modulating valve Fig. 1/1(VMR), on the output and deriving the secondary feed of the water recirculation system Fig. 1/1(N), which , depending on the rate of flow drawn from Fig. 1/1(M) deviates Fig. 1/1(O-L) partially or totally towards the recirculation system, thus avoiding to feed its total flow back towards the boiler's reservoir, which holds the water at a temperature of 70°C or above, and from here, by means of the secondary stage Fig. 1/1(H-I) of the heat exchanger (which functions as a cooler) to the water distribution network without adequate temperature regulation caused by low or total lack of demand from the utilities and so, also of the corresponding flow rate of the incoming cold water feed and its cooling effect on the primary stage Fig. 1/1(C-D) of the heat exchanger Fig. 1/1(SC).

[0011] The partial or full conveyance of the flow from the water recirculation system directly to the distribution network Fig. 1/1(L-M) ,having been previously disinfected from the Legionella bacterium by means of continuous cycles of disinfection at a high temperature of 70° Celsius and above, does not cause any risk of pollution.

[0012] Such two-way valve Fig. 1/1(VMR), with an adequate programmable timer-driven stop mechanism, activated by a signal outside of the limits of the present invention, can also be used to cancel (once its closing has been forced) the deviation of the water recirculation system's flow towards the distribution Fig. 1/1(O-L) for a time which corresponds to the programmed lack of demand, sending it, instead, all back to the boiler's reservoir (which maintains the water at a temperature of 70° Celsius and above) and to the secondary feed of the Fig. 1/1(G) system, and from here (without any cooling by means of thermal exchange with the incoming cold water feed from the main water supply or aqueduct because of the programmed block of its flow in the absence of demand from utilities) directly to the distribution and water re-circulating systems, to initiate the periodical disinfection by high temperature "thermal shock", during which (always outside of the limits of the present invention) the automatic closure of the normally open solenoid exclusion valves Fig. 1/1(P) may be activated, by means of the programming device Fig. 1/1(R) and its probes Fig. 1/1(Q) which are mounted on the outputs towards each utility, and in absence of demand from the utilities, in order to avoid the possibility of accidental burns due to the high temperatures reached by the waters during use of the technique of programmed cycles of disinfection of the water distribution network by "thermal shock".

[0013] In the above mentioned system, during its open circuit operation, the conveyance of water for sanitary uses is ensured directly and exclusively by the aqueduct's water pressure (or by the main cold water supply's pressure, obtained by any means). When operating in closed circuit mode, the necessary conveyance (pressure) is obtained by the pump units Fig. 1/1(S) which operate exclusively in this mode, in order to feed the water recirculation system (such closed circuit operating mode , at the present stage of technology, is obligatory and always installed).

[0014] Additionally, always within the limits of the present invention and immediately after the incoming water feed Fig. 1/1(G) and before the system's secondary output Fig. 1/1(F), there is the pumping unit Fig. 1/1(X) with its pertinent check valves Fig. 1/1(Y), having a minimal flow rate just sufficient to avoid temperature layering inside the boiler's high temperature (70° Celsius and above) reservoir Fig. 1/1(T) in order to eliminate, in any condition of demand, or even in the absence of demand, any stagnation of water at a lower temperature which could cause the survival of the Legionella bacterium.

[0015] Always within the limits of the present invention, but as an option for particularly critical uses (which demand absolute protection), the normally closed solenoid valve Fig. 1/1(VS), commanded by the security thermostat Fig. 1/1(TS), is inserted immediately after the secondary incoming water feed Fig. 1/1(G) in order to intercept the water fed to the utilities from the boiler's reservoir, in case its temperature falls below the programmed temperature (70° Celsius and above).

[0016] The following elements, always within the limits of the present invention, complete the schematic diagram:

[0017] The second alarm triggering thermostat Fig. 1/1 (TA) (always installed) which controls the disinfection temperature (70° Celsius and above) of the incoming feed of the system and which eventually, in case of an anomaly, sends the alarm signal to the control room.

[0018] The immersed temperature probes Fig. 1/1(TI)

[0019] The water sample retrieval taps Fig. 1/1(RU) placed in the most significative points in the system (in order to analyze water samples), also used for system discharge and the manual air bleed taps Fig. 1/1(SF)

[0020] The standard on/off valves Fig. 1/1(VA)

[0021] The electrical panel Fig. 1/1(QE) which feeds and controls all devices within the present invention

[0022] The following elements, outside of the limits of the present invention, complete the schematic diagram:

[0023] The boiler Fig. 1/1 (T) heating system Fig. 1/1 (U), its temperature regulation system Fig. 1/1(V) and Fig. 1/1(Z) (which may be of any type, with any means of regulation and any method of heating which present day technology consents e.g. direct flame, electricity, fluid exchange induced by heating waters, superheated waters, steam etc.) the water re-circulating unit Fig. 1/1(S) and the burn prevention system Fig. 1/1(R), Fig. 1/1(P), and Fig. 1/1(Q).

[0024] All possible filtration, treatment and conditioning of incoming drinkable water feed devices which are consented by present day technology and sanitation laws should be applied to the incoming feed of the system in order to avoid the formation of deposits, sedimentation and bio films in the sanitary hot water distribution and recycling networks (such devices are not represented in the schematic diagram "Fig. 1/1").

[0025] The greatest and most evident advantages of the system, subject of the present invention are:

a) The system can be industrially produced, being its operation totally autonomous, in the form of one element which comprises the electrical control panel, the hydraulic manifolds and the electrical connections which can be pre-configured for immediate installation and connection to the other elements of water distribution networks (namely the centralized hot water production, distribution and recycling systems for sanitary uses).

b) The system can be industrially produced in series and in standard forms, using similar productions models, differentiated only by size and performance capability in discrete and commercially compatible quantities.

c) The system is a standalone solution which can be in-factory certified without any need or danger of successive modifications or adaptive alterations. This is due to the fact that it is, by default, factory pre-configured for immediate installation. The installation involves attaching the preconfigured hydraulic manifolds and electric connections to the new or pre-existent centralized hot water production, distribution and recycling systems for sanitary uses and regulating, if necessary, the temperature of the water contained in the reservoir of the water heating system (outside of the limits of the present invention) to a value of 70° Celsius or above.

d) The system's constructive simplicity and its consequential reliability and safety during operation, in addition to it's extreme ease of installation and low maintenance cost.

e) Its small footprint and the consequential advantage of being able to be installed in small or restricted spaces.

f) It can be installed in a very simple and fast way in new or pre-existent systems (which must be upgraded in order to comply with sanitary laws) without needing to modify or transform the rest of the system (if it is already efficient). The only other intervention necessary is to ascertain that the temperature of the water contained in the reservoir of the water heating system is set to a value of 70° Celsius or above.

g) The evident energy saving obtainable by the system subject of the present invention with respect to all other possible systems of disinfection from the Legionella bacterium presently used (e.g. adding chemicals, filtering, exposure to disinfecting radiations etc.) due to the complete absence of subsidiary energy required to make it function, except for a minimum power draw required by the electronic control devices and the anti thermal layering pump Fig. 1/1 (X).

[0026] The energy spent in order to overheat the hot water for sanitary uses from the optimal distribution temperature (48-50° Celsius) to that of the boiler's reservoir (70° Celsius and above, in order to disinfect it from the Legionella bacterium) is almost totally recouped by the pre-heating of the incoming cold water feed before its conveyance towards the boiler Fig. 1/1(T) for the following cycles of heating and disinfection with the exception of the insignificant losses due to the limits in efficiency of the system's thermal isolation. The remaining net energy consumption is due only to the heating of the incoming water in order to reach the optimal distribution temperature between 48 and 50 ° Celsius, which is implicitly common to any system that produces hot water for sanitary uses which is out of the limits of the present invention.

[0027] The following parts are claimed as being essential, non-dispensable and innovative in the invention above described (represented in all its functional completeness in the attached drawing "Fig. 1/1") and therefore must form the subject of the patent:

Claims

1. The cooling system for sanitary hot water (produced and stocked at a temperature equal or above 70° Celsius, thus disinfected from the Legionella bacterium, outside of the present discovery) by means of thermal exchange induced in circuits hydraulically separated from each other (primary and secondary) contained in the plate based heat exchanger Fig. 1/1 (SC), including the automatic temperature regulation, actuated at the primary on the flow rate of the incoming cold water supply, of the waters fed towards the utilities, with the exclusion of any possibility of mixing (and thus contamination) with the same (incoming cold water supply) waters, always potentially infected by Legionella bacterium.

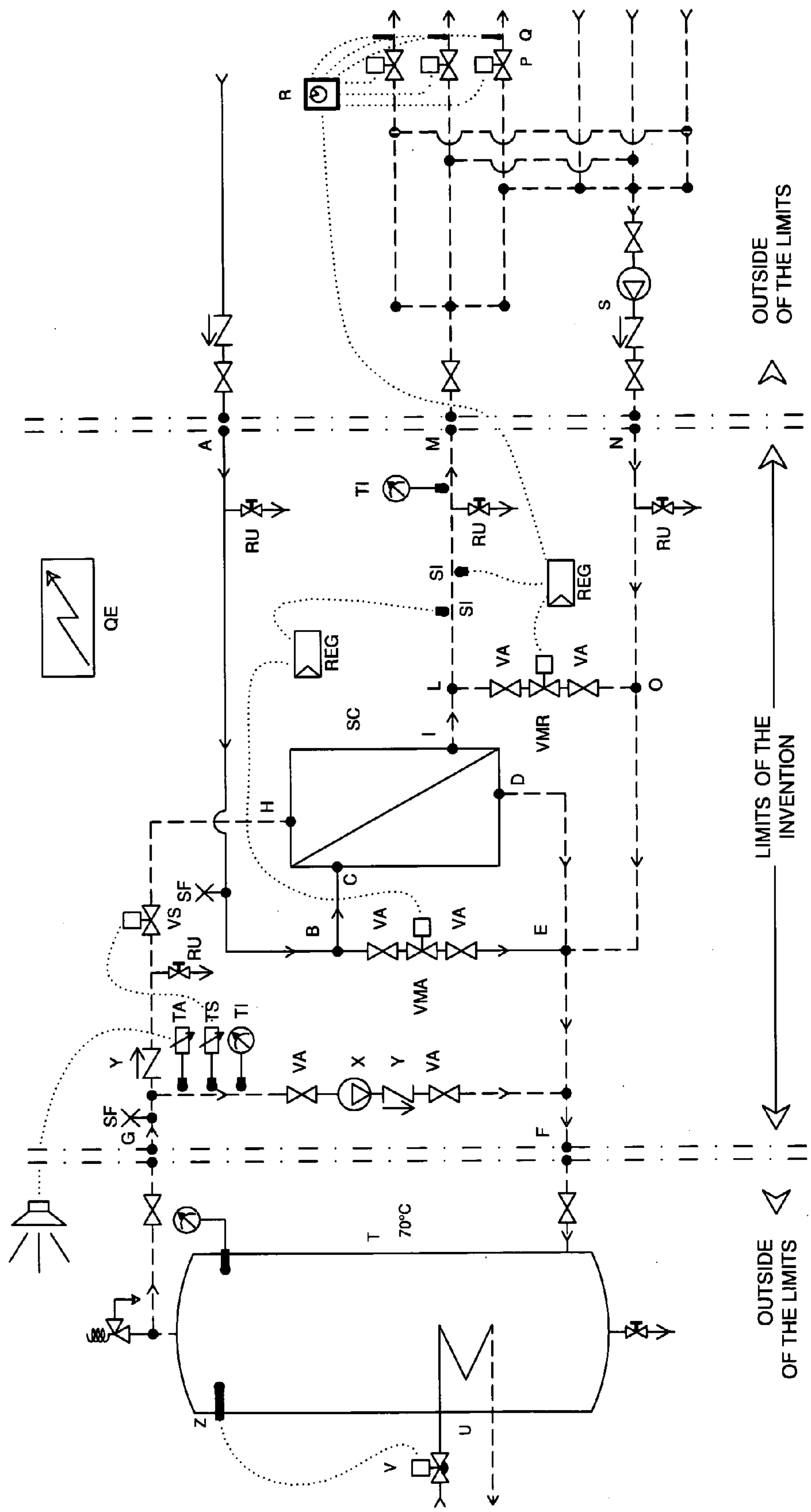
2. Together with CLAIM 1: the system for the control of the optimal temperature (between 48 and 50° Celsius) of distribution for sanitary hot water systems towards utilities "**characterized by** means of the two-way modulating valve Fig. 1/1(VMA) with the regulation device Fig. 1/1(REG) and the probe Fig. 1/1(SI), by deviating the flow of the incoming cold waters from the water supply or aqueduct and bypassing the primary stage of the heat exchanger, and the consequential modulation of the residual cold water flow on the primary stage of the heat exchanger and its cooling effect, in function of the flow of hot water disinfected at a high temperature (70° Celsius and above) fed, after its cooling and at a proportional rate of flow as per demand on behalf of the utilities , through the secondary stage of the heat exchanger, to point Fig. 1/1(M)".

3. Together with CLAIMS 1 and 2: The system of automatic control and deviation of the flow of re-circulated sanitary waters in order to avoid their overheating when there is a low or absent demand from utilities "**characterized by** regulating the flow rate of the two-way modulating valve Fig. 1/1(VMR) with the regulator Fig. 1/1(REG) and the probe Fig. 1/1(SI), including its ability (within the limits of the present invention) to receive an external input in order to command its forced closure, causing the conveyance of the total flow of the water recirculation system towards the boiler's high temperature (equal or above 70° Celsius) reservoir and the following conveyance towards the water distribution network and the water recirculation system in order to obtain their disinfection by programmed high temperature (thermal shock) cycles".

4. Together with CLAIMS 1, 2 and 3: The insertion, at the main feed, of the shunting and circulation group Fig. 1/1(X), Fig. 1/1(Y), "**characterized** to obtain the elimination of any possible thermal layering or stagnation of waters in the boiler's high temperature (equal or above 70° Celsius) reservoir and the associated risk of infection due to the presence of the Legionella bacterium".

5. Together with CLAIMS 1, 2, 3 and 4: The insertion, in the system, of all the already described, necessary devices for its completion and which are represented (within the limits of the present invention) in the attached schematic drawing "Fig. 1/1" "**characterized in that**: The thermostat Fig. 1/1(TA) which drives the alarm signal (which may also be done remotely) in case of an excessively low temperature of the waters fed to the system on its main feed, the water sample retrieval and system discharge taps Fig. 1/1(RU), the manual air bleed devices Fig. 1/1(SF), the standard on/off valves Fig. 1/1(VA), the temperature measurement instruments Fig. 1/1(TI) and the electrical power supply and control panel Fig. 1/1(QE)".

6. Together with CLAIMS 1, 2, 3, 4 and 5: The optional insertion, in the system, of the solenoid valve Fig. 1/1(VS) "**characterized in that** acts as a security block and prevents the conveyance of sanitary hot waters towards utilities in case of an accidental temperature drop (below 70° Celsius) of the incoming waters at point Fig. 1/1(G), sensed by the second security thermostat Fig. 1/1(TS) thus ensuring absolute protection in case of such demand applied to "mission critical" installations".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