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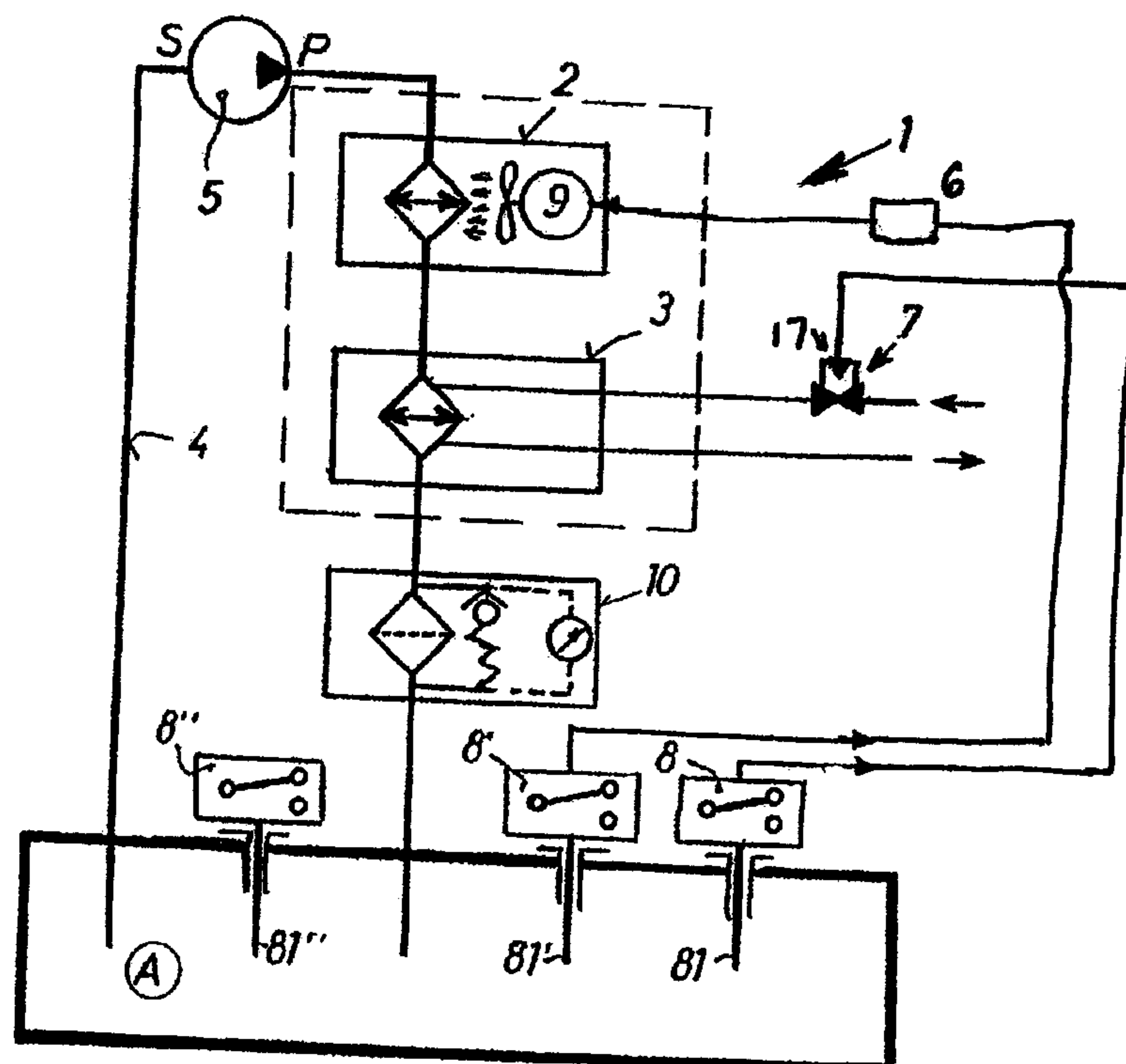
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(54) Titre : DISPOSITIF DE REFROIDISSEMENT D'UN FLUIDE DE TRAVAIL

(54) Title: COOLING DEVICE FOR A WORKING FLUID



(57) Abrégé/Abstract:

Cooling device and method for cooling a working fluid of a high-pressure pump with a pressure booster. The cooling device includes a conveyor system comprising at least one pump, at least two heat exchangers arranged in series along the conveyor system, and at least two switches coupled to the at least two heat exchangers. At least one controller is structured and arranged to selectively activate and deactivate the at least two heat exchangers via the at least two switches at an adjustably preset temperature of the working fluid.



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ABSTRACT OF THE DISCLOSURE

Cooling device and method for cooling a working fluid of a high-pressure pump with a pressure booster. The cooling device includes a conveyor system comprising at least one pump, at least two heat exchangers arranged in series along the conveyor system, and at least two switches coupled to the at least two heat exchangers. At least one controller is structured and arranged to selectively activate and deactivate the at least two heat exchangers via the at least two switches at an adjustably preset temperature of the working fluid.

COOLING DEVICE FOR A WORKING FLUID

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The invention relates to a cooling device for a working fluid of a high-pressure pump with a pressure booster, comprising a conveyor system and heat exchangers for the working fluid.

2. Discussion of Background Information

[0003] High-pressure pumps, such as are used, for example, for water jet cutting installations are usually designed as a pressure booster with a working fluid. During operation, the fluid heats up so that a cooling of the same is preferably carried out in the return line or circulation in the provision tank. For example, with a high-pressure pump of the above-described type having a fed drive power of 37 kilowatts in the working fluid, approx. 11 kilowatts are released as thermal energy. However, for reasons of function and wear, the temperature of the working fluid should lie in a range of 55°C to 60°C.

[0004] It is known to provide a cooling of the working fluid with a heat exchanger operated with air. An adjustment of the provided fluid temperature can be carried out in a simple manner through an on/off switching of a fan. However, if there is the risk of a possibly only temporarily

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exceeding of the cool air temperature of approx. 35°C, a recooling by air is omitted for safety reasons and a heat exchanger that can be acted on with water is provided.

[0005] Heat exchangers of this type that are operated with cooling water also have the advantage that they can be built small or have a small space requirement with a necessary cooling capacity. However, the costs for the quantity of cooling water are often substantial.

SUMMARY OF THE INVENTION

[0006] The invention here intends to overcome the given disadvantages of cooling devices of the type mentioned at the outset for a working fluid and creates a cooling device that during the operation of the high-pressure pump with pressure booster, produces a regulation of a desired temperature of the fluid with the greatest economy and safety.

[0007] According to embodiments of the invention, a cooling device of the type mentioned at the outset is formed with at least two heat exchangers that are switched in series in the cooling circuit. The cooling circuit can be acted on in a targeted manner by at least one pump and has control units through which an activation or deactivation of the respective heat exchangers can be switched at temperatures that can be adjusted as desired.

[0008] It is advantageous that, through respectively connectable heat exchangers, a selected temperature of the working fluid can be adjusted in a simple and in a particularly cost-effective manner.

[0009] Even if the ambient air of the heat exchanger is insufficient to adequately recool the working fluid during periods of elevated outside temperature, which previously would have resulted in an interruption or decrease in the high-pressure pump capacity, a necessary pump capacity can be maintained according to the invention by connecting an additive water cooling.

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Tests have surprisingly shown that, despite increased equipment costs, the expenditure for the cooling medium in sustained operation of the high-pressure pump with a pressure booster can be kept much lower than with just water or air cooling and yet with increased cooling capacity.

[0010] If one heat exchanger can be activated by air flowing through and a further heat exchanger can be activated by water flowing through in a favorable manner, the desired temperature of the working fluid can be regulated in a particularly efficient manner.

[0011] According to an exemplary embodiment of the invention, the working fluid/air heat exchanger can be activated by electric motors or hydraulic motors. The hydraulic motors can preferably be switched in the cooling circuit, whereby a simple, safe and also economical connectability is achieved.

[0012] If the working fluid/water heat exchanger can be activated by impingement with water via switching means, an effective additional cooling for a desired temperature control of the working fluid units be ensured at low cost for the cooling.

[0013] Preferably, switching units with a simple on/off function are used because this has been found to render possible a particularly simple and safe as well as adequate control switching of the temperature within the desired limits.

[0014] Finally, it has proven to be particularly advantageous, in particular with respect to an energy supply in voltage ranges deviating from the norm, if the drive or the pump for the conveyor system of the working fluid is in active engagement with the drive motor for the high-pressure pump. In this manner it is ensured that a cooling of the working fluid is carried out at the same time as the operation of the high-pressure pump with pressure booster and no reduced capacity of the cooling system due to the feed can occur.

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[0015] Embodiments of the invention are directed to a cooling device for a working fluid of a high-pressure pump with a pressure booster. The cooling device includes a conveyor system comprising at least one pump, at least two heat exchangers arranged in series along the conveyor system, and at least two switches coupled to the at least two heat exchangers. At least one controller is structured and arranged to selectively activate and deactivate the at least two heat exchangers via the at least two switches at an adjustably preset temperature of the working fluid.

[0016] According to embodiments, the at least two heat exchangers can include a first heat exchanger operable via air flowing through and a second heat exchanger operable via water flowing through.

[0017] One of the at least two heat exchangers can be activated by one of electric motors and hydraulic motors. Further, the hydraulic motors are switched in series along the conveyor system.

[0018] In accordance with the embodiments, one of the at least two heat exchangers may be activated by impingement with water via a valve.

[0019] According to embodiments of the invention, the at least two switches can include a switch having an on/off function.

[0020] Further, the pump may be arranged in active engagement with a drive motor for the high-pressure pump with the pressure booster.

[0021] A method of cooling a working fluid can include the above-described cooling device. The method includes selectively activating at least one of the at least two heat exchangers along the conveyor path.

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[0022] A high-pressure pump with pressure booster may include the above-discussed cooling device.

[0023] Embodiments of the invention are directed to a method of cooling a working fluid of a high-pressure pump with a pressure booster. The method includes conveying a working fluid along a conveyor path of a cooling circuit, switchably activating a first heat exchanger arranged along the conveyor path when a temperature of the working fluid exceeds a first predetermined temperature, and switchably activating a second heat exchanger arranged in series with the first heat exchanger along the conveyor path when a temperature of the working fluid exceeds a second predetermined temperature. The first and second predetermined temperatures are adjustable.

[0024] According to embodiments of the invention, the first predetermined temperature can be greater than the second predetermined temperature.

[0025] In accordance with other embodiments, the method can also include switchably deactivating the first heat exchanger when the temperature of the working fluid is below a first predetermined low temperature. Alternatively, the method can also include switchably deactivating the high pressure pump when a temperature of the working fluid exceeds a third predetermined temperature that is greater than the second predetermined temperature.

[0026] In accordance with still yet other embodiments of the present invention, the first heat exchanger can use air. Further, the second heat exchanger can use water.

[0027] Other exemplary embodiments and advantages of the present invention may be ascertained by reviewing the present disclosure and the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWINGS

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[0028] The present invention is further described in the detailed description which follows, in reference to the noted drawing by way of a non-limiting example of the exemplary embodiment of the present invention, wherein:

[0029] The Figure shows a cooling device according to the invention in principle.

DETAILED DESCRIPTION OF THE PRESENT INVENTION

[0030] The particulars shown herein are by way of example and for purposes of illustrative discussion of the embodiments of the present invention only and are presented in the cause of providing what is believed to be the most useful and readily understood description of the principles and conceptual aspects of the present invention. In this regard, no attempt is made to show structural details of the present invention in more detail than is necessary for the fundamental understanding of the present invention, the description taken with the drawings making apparent to those skilled in the art how the several forms of the present invention may be embodied in practice.

[0031] The Figure diagrammatically illustrates a vessel 11 containing working fluid A. A cooling circuit 4 for working fluid A includes a working fluid conveyer formed by a pump 5 to draw working fluid A from vessel 11 through a line (or working fluid conveyor) 14 and to produce the circulation of working fluid A through a cooling device 1 on its return to vessel 11. Cooling circuit 4 can also include a filter device 10 for particles with a diameter of, e.g., greater than 5 μm . Advantageously, filter device 10 can be switchably activatable in cooling circuit 4.

[0032] As illustrated, cooling device 1 can include at least two heat exchangers 2 and 3 arranged in series, relative to a working fluid circulation direction, in cooling circuit 4. Heat exchanger 2 can be operated with an air coolant produced, e.g., by a fan 9, while heat exchanger

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3 can be operated with a water coolant supplied through, e.g., a valve 7. Fan 9 and valve 7 are activated/deactivated through the opening/closing of switching units 6 and 17.

[0033] A control unit 8', which can be coupled to a temperature sensor 81', and a control unit 8, which can be coupled to a temperature sensor 81, can be connected to selectively open/close respective switching units 6 and 17 when predefined temperatures of working fluid A in vessel 11 is exceeded. A control unit 8'' coupled to a temperature sensor 81'' can be provided as a safety device to activate a switch to turn off the high-pressure pump when an upper limit temperature of working fluid A in vessel A is exceeded.

[0034] In the operation of, e.g., a high-pressure pump with a pressure booster, working fluid A is guided or drawn into cooling circuit 4 and can be continuously cleaned in a filter 10.

Alternatively, filter 10 can be switchably activated to selectively clean working fluid A in cooling circuit 4. Temperature sensors 81, 81', and 81'' are arranged in vessel 11 to measure or detect the temperature working fluid A, and control units 8, 8', and 8'' are designed to monitor the temperature of working fluid A to activate/deactivate heat exchangers 2 and 3 or pump 5.

[0035] By way of example, control unit 8' can be set so that, at a predefined working fluid temperature of, e.g., 50°C, switching unit 6 can be closed to activate a cooling air impingement in heat exchanger 2, e.g., by turning on a fan 9 to blow cooling air into cooling circuit 4. Further, control unit 8' can also be set so that, at a predefined working fluid temperature of, e.g., 45°C, switching unit 6 can be opened to deactivate the cooling air impingement in heat exchanger 2. With this selective control of the cooling air impingement in heat exchanger 2 by control unit 8', an advantageous temperature stability of working fluid A and, thus, a gentle continuous operation at full load of a high-pressure pump can easily be achieved in normal cases.

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[0036] However, because sometimes the cooling air temperature in heat exchanger 2 may be too high or the cooling air quantities are too low, the temperature of working fluid A may rise or continue to rise to a temperature greater than the cooling air impingement of heat exchanger 2 can adequately cool. Thus, when control unit 8 detects a temperature of working fluid A in vessel 11 of greater than, e.g., 60°C, switching unit 17 can be closed in order to activate valve 7 to allow cooling water to flow into heat exchanger 3. In this way, additional cooling of working fluid A is performed or carried out in heat exchanger 3 so as to achieve further heat removal from the working fluid A.

[0037] It is understood that control units 8, 8', and 8'' can be combined into a single control unit to monitor the temperature of working fluid A, and to selectively activate/deactivate cooling in heat exchangers 2 and 3, and/or pump 5. In this manner, activation and coordination of the cooling fluid (air or water) into its respective heat exchanger can be easily controlled according to an on/off function of the control unit 8. Further, a single temperature sensor can be utilized with a single or multiple control units.

[0038] It is noted that the foregoing examples have been provided merely for the purpose of explanation and are in no way to be construed as limiting of the present invention. While the present invention has been described with reference to an exemplary embodiment, it is understood that the words which have been used herein are words of description and illustration, rather than words of limitation. Changes may be made, within the purview of the appended claims, as presently stated and as amended, without departing from the scope and spirit of the present invention in its aspects. Although the present invention has been described herein with reference to particular means, materials and embodiments, the present invention is not intended to be limited to the particulars disclosed herein; rather, the present invention extends to all

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functionally equivalent structures, methods and uses, such as are within the scope of the appended claims.

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Listing of Reference Numerals

A	Working fluid
1	Cooling device
2	Heat exchanger working fluid/air
3	Heat exchanger working fluid/water
4	Cooling circuit for working fluid
5	Pump
6	Switching unit
7	Valve
8, 8', 8''	Control units
81, 81' 81''	Temperature sensor
9	Motor for a fan
10	Filter
11	Vessel
14	Working fluid line
17	Switching unit

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A cooling device for a working fluid of a high-pressure pump with a pressure booster, comprising:
 - a conveyor system comprising at least one pump;
 - at least two heat exchangers arranged in series along the conveyor system;
 - at least two switches coupled to the at least two heat exchangers; and
 - at least one controller structured and arranged to selectively activate and deactivate the at least two heat exchangers via the at least two switches at an adjustably preset temperature of the working fluid.
2. The cooling device in accordance with claim 1, wherein the at least two heat exchangers comprise a first heat exchanger operable via air flowing through and a second heat exchanger operable via water flowing through.
3. The cooling device in accordance with claim 1 or 2, wherein one of the at least two heat exchangers is activated by one of electric motors and hydraulic motors.
4. The cooling device in accordance with claim 3, wherein the hydraulic motors are switched in series along the conveyor system.
5. The cooling device in accordance with claim 1 or 2, wherein one of the at least two heat exchangers is activated by impingement with water via a valve.
6. The cooling device in accordance with any one of claims 1 to 5, wherein the at least two switches comprise a switch having an on/off function.

7. The cooling device in accordance with claim 1, wherein the at least one pump is arranged in active engagement with a drive motor for the high-pressure pump with the pressure booster.
8. A method of cooling a working fluid in a cooling device as defined in any one of claims 1 to 7, the method comprising:
selectively activating at least one of the at least two heat exchangers along the conveyor path.
9. A high-pressure pump with a pressure booster having a cooling device as defined in any one of claims 1 to 7.
10. A method of cooling a working fluid of a high-pressure pump with a pressure booster, the method comprising:
conveying a working fluid along a conveyor path of a cooling circuit;
switchably activating a first heat exchanger arranged along the conveyor path when a temperature of the working fluid exceeds a first predetermined temperature; and
switchably activating a second heat exchanger arranged in series with the first heat exchanger along the conveyor path when a temperature of the working fluid exceeds a second predetermined temperature;
wherein the first and second predetermined temperatures are adjustable.
11. A method in accordance with claim 10, wherein the first predetermined temperature is greater than the second predetermined temperature.
12. A method in accordance with claim 11, switchably deactivating the first heat exchanger when the temperature of the working fluid is below a first predetermined low temperature.

13. The method in accordance with claim 11, further comprising switchably deactivating the high pressure pump when a temperature of the working fluid exceeds a third predetermined temperature that is greater than the second predetermined temperature.
14. The method in accordance with claim 10, wherein the first heat exchanger uses air.
15. The method in accordance with claim 10, wherein the second heat exchanger uses water.

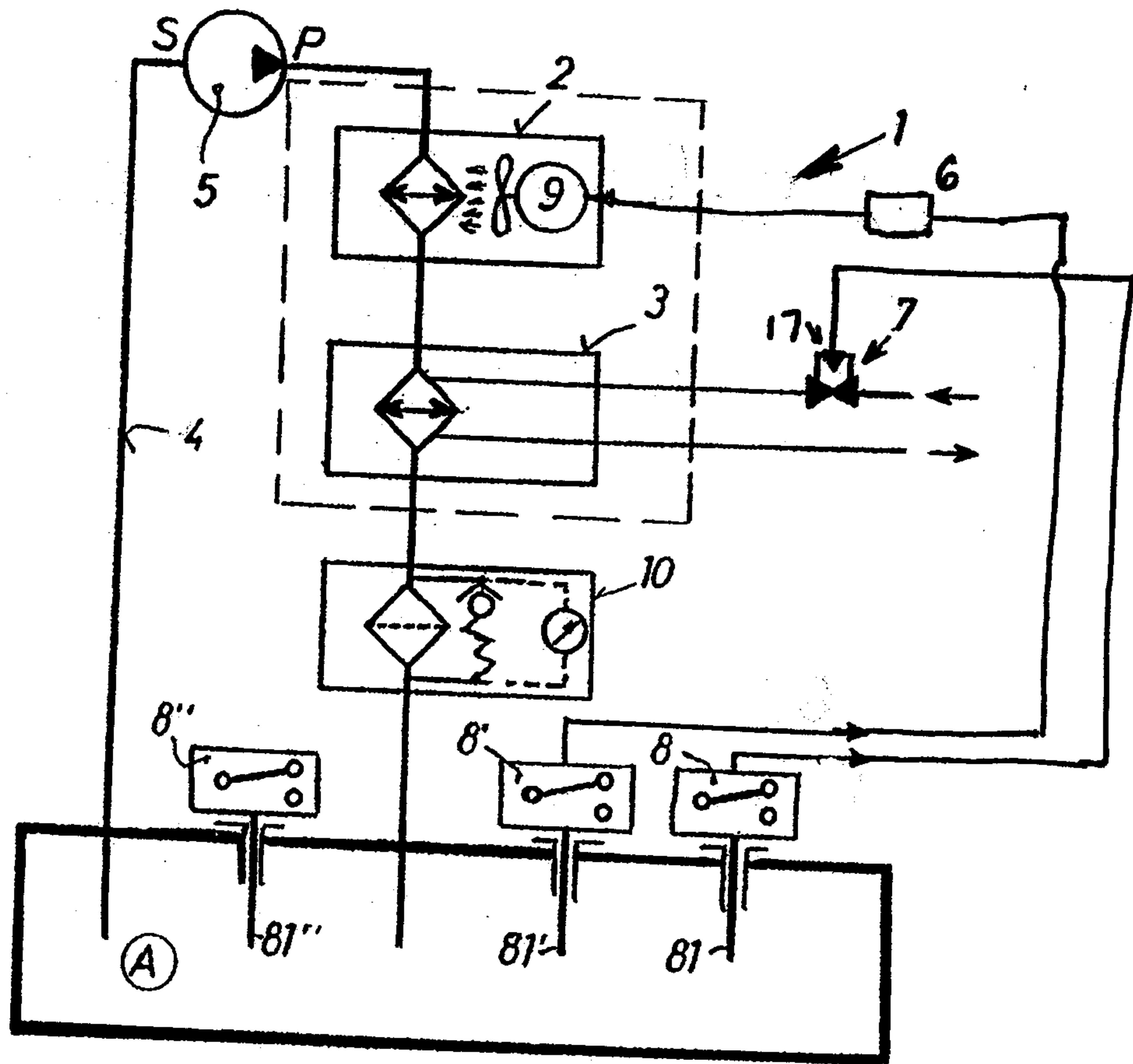


Fig. 1

