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(54) **FRACTURING PUMP**

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(57) **ABSTRACT**

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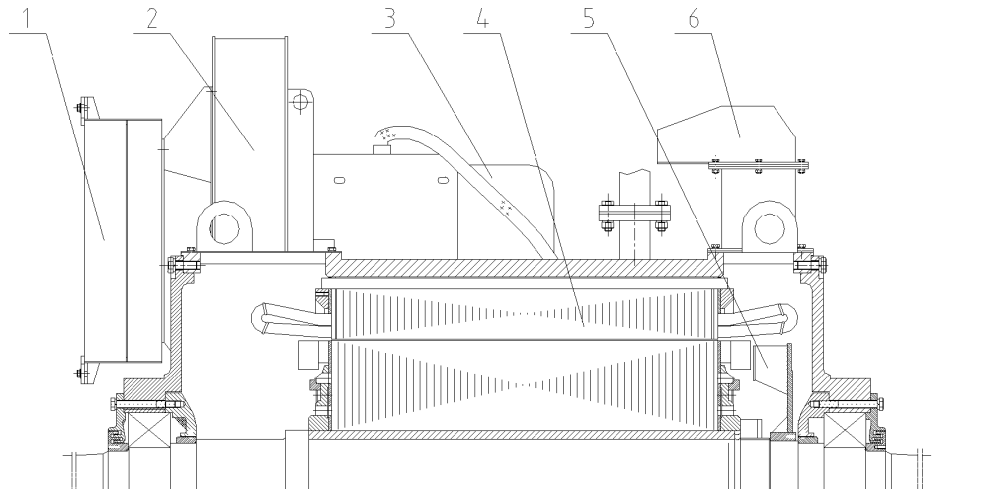
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The invention discloses a fracturing pump, comprising a cooling device and a control device, wherein a motor is connected on an shaft of the fracturing pump, the cooling device comprises an air-cooled device for cooling a rotor of the motor and a water-cooled device for cooling a stator of the motor, and the control device is connected with the motor and the cooling device, respectively. The fracturing pump in the invention adopts a structure directly driven by the motor, thus breaking the form of a transmission structure of a diesel engine of the conventional fracturing pump added with a transmission tank, simplifying the structure of the entire fracturing pump, reducing the apparatus mounted on a fracturing car, decreasing failure rate of the apparatus, and becoming more safe and reliable.



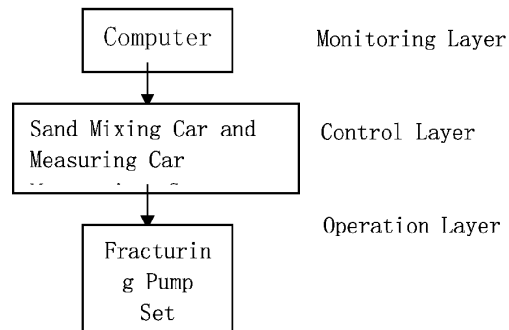


FIG. 1

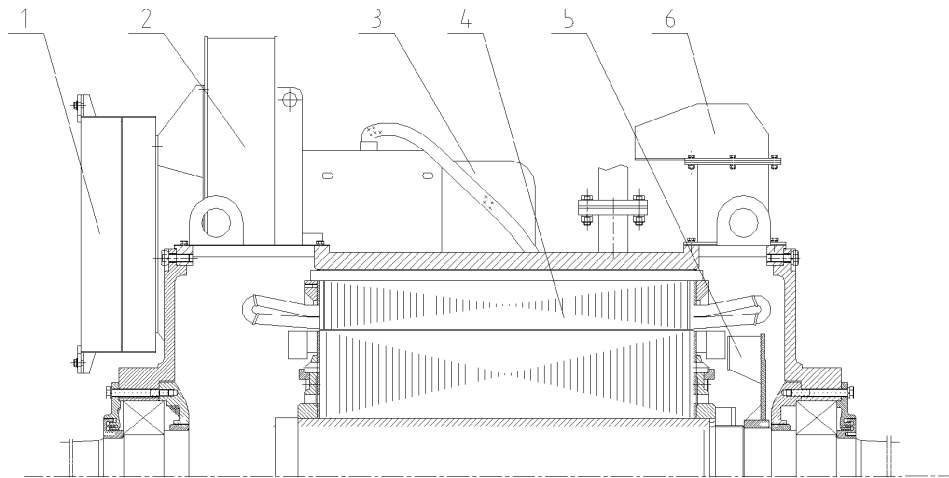


FIG. 2

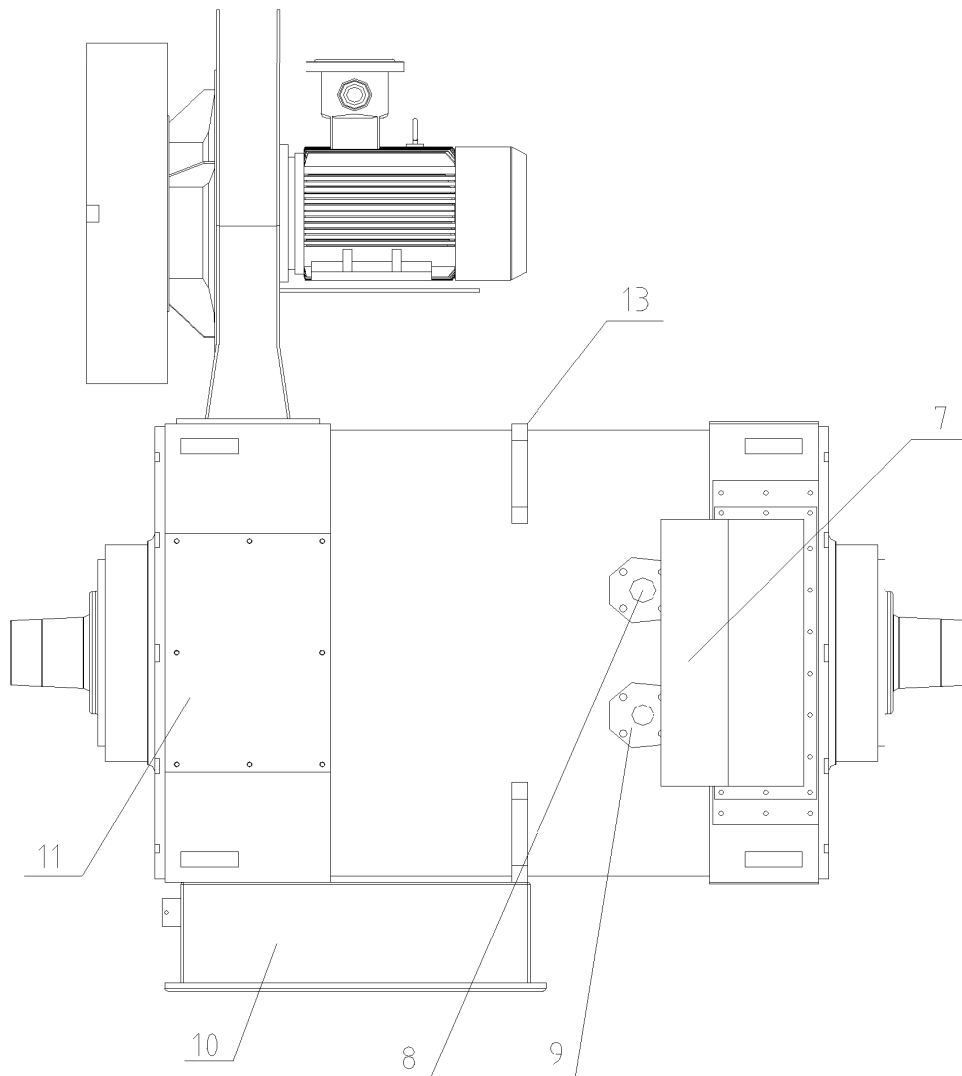


FIG. 3

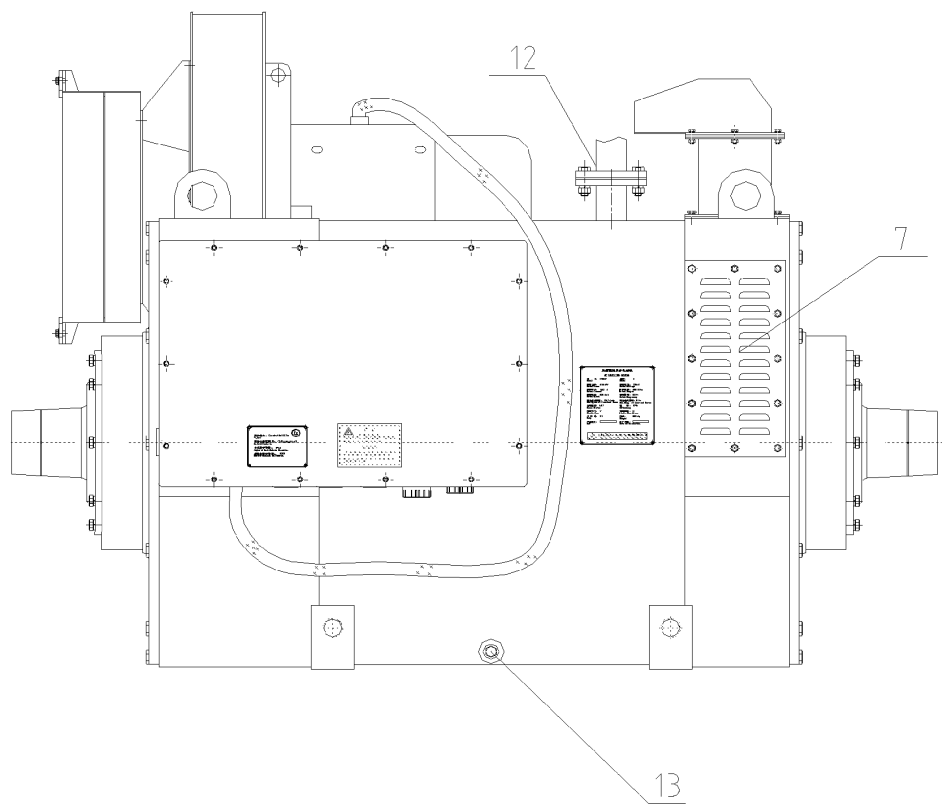


FIG. 4

FRACTURING PUMP

FIELD OF THE INVENTION

[0001] The invention relates to an oil-field fracturing apparatus, particularly to a fracturing pump.

BACKGROUND OF THE INVENTION

[0002] In order to improve the recovery of the oil and gas resources for the best economic benefits, a recovery process of oil and gas reservoir (i.e., fracturing) is widely used for output boosting for different geological structures and reservoir characteristics, of which a fracturing set is a key apparatus which includes a core apparatus—a fracturing pump car. currently, widely used fracturing pump cars are provided with 2000 hp–2500 hp fracturing pump. The fracturing pump cars have the same transmission structure, i.e., driven by a diesel engine on the car with a gearbox and a cardan shaft. The pump working displacement and the pressure is controlled by speed of the diesel engine with the gearbox. Due to restriction of mechanical structure, the capacity of car and roads and bridges, the single-machine power of the fracturing pump is hard to boost. For large-scale hydraulic fracturing operations, more fracturing pump cars are needed to meet the displacement requirements, this causes more and more occupied field area, more complicated pump manifold layout, long preparation, high cost, hard to control, low control accuracy, poor response, and high security risk.

[0003] A commonly used fracturing set comprises an engine, a hydraulic transmission box, a transmission device, a horizontal five-cylinder fracturing pump, an intake manifold, an exhaust manifold, a security system, a fuel system, and a power lubrication system etc. A car engine start-up oil pump is started by the power from the chassis, the oil pump drives a starting motor of the car engine to start the engine to drive the fracturing pump via the hydraulic transmission box and a transmission shaft. However, the transmission solution has the following defects: first of all, the fracturing set has a complicated structure and larger occupied space; secondly, there are many devices needed to be maintained regularly to cause high cost; furthermore, there is low accuracy for the fracturing pump speed and torque control due to the hydraulic transmission box.

SUMMARY OF THE INVENTION

[0004] The object of the invention is to overcome the above-mentioned defects in the prior art and provides a fracturing pump with large single-machine power, high working displacement, small occupied area, and high accuracy of speed and the torque control.

[0005] In order to achieve the above-mentioned goals, the invention provides technical solutions as below:

[0006] a fracturing pump comprises a cooling device and a control device, a motor is coupled on a shaft of the fracturing pump, the cooling device comprises an air-cooled device for cooling a rotor of the pump motor and a water-cooled device for cooling a stator of the pump motor, and the control device is connected with the pump motor and the cooling device, respectively.

[0007] Preferably, the cooling device is mounted between the two fracturing pumps.

[0008] Preferably, a control system of the pump motor is controlled by a middle-voltage numerical control frequency converter.

[0009] Preferably, a temperature sensor and a pressure sensor are mounted on the fracturing pump, the temperature sensor, the pressure sensor and the frequency converter of the pump motor are connected with a PLC via a field bus cable, and the PLC is connected with a man-machine input device.

[0010] Preferably, the field bus is a Profibus.

[0011] Preferably, a monitoring device is connected to a communication interface of the Profibus, the monitoring device and the communication interface of the Profibus are connected remotely via an Ethernet network, a distribution-type I/O device is communicated with the PLC control layer for information transmission to a measuring car PLC, the car PLC is communicated with a monitoring layer via the field bus.

[0012] Preferably, the man-machine input device is an industrial touch screen.

[0013] Preferably, the air-cooled device comprises an air blower which its outlet is connected with the inner part of the pump motor, on which its case is also mounted with one radial fan, which draws air out of the inner part of the pump motor.

[0014] Preferably, the water-cooled device comprises a water pump which its water inlet is connected with a water tank and water outlet connected with a pump motor water jacket which its inner part is provided with an S-shaped passage and its water outlet connected with a heat sink which its water outlet is connected with the water tank.

[0015] Preferably, a drainage port is also provided for the water jacket.

[0016] Compared with the prior art, the invention has the following effects:

[0017] 1. The fracturing pump of the invention adopts a structure directly driven by a motor, thus breaking the form of a transmission structure of a diesel engine of the conventional fracturing pump added with a transmission tank, simplifying the structure of the entire fracturing pump, reducing the apparatus mounted on a fracturing car, decreasing failure rate of the apparatus, and becoming more safe and reliable.

[0018] 2. The fracturing pump of the invention has more power and working displacement to make one pump/car or two pumps/car available, to simplify the fracturing pump manifold layout, to reduce occupied area and to reduce connection pipelines between the fracturing pumps, greatly to boost large-scale operations, to meet requirements of modern green and environmental protection.

[0019] 3. The cooling device of the fracturing pump comprises the air-cooled device and the water-cooled device. The air-cooled device takes part of the heat generated by the pump motor during operation while the water-cooled device takes the rest by water recycling through the pump motor water jacket. For some preferred embodiments, the cooled air enters into the air blower via an air inlet of the air-cooled device and compressed by a centrifuge and the compressed cooling air enters into the inner part of the pump motor to take away the heat generated by the pump motor core. The fan near the air outlet rotates to provide centrifugal force to make a lower pressure area on one side of the fan to fast flow of the air in the inner part of the pump motor to draw more air out of the pump motor to fast the pump motor heat dissipation. The cooled water from the water tank of the water-cooled device is pressurized by a water pump and enters into the motor water jacket via the water inlet and passes through the S-shaped passage (which elongates heat dissipation route for better heat dissipation) of the motor water jacket and takes away the heat of an inner surface of the motor water jacket. The cooled

water passes through an S-shaped water passage and flows out of the water outlet to be cooled by the heat sink with its temperature substantially equals to that of the water jacket inlet and the water flows back to the water tank. If the pump motor does not work in a certain period in cold environment such as temperature lower than Zero degrees Celsius, the water in the motor water jacket must be discharged through the drainage port to avoid the water icing to break the motor water jacket.

DESCRIPTION OF THE DRAWINGS

[0020] FIG. 1 illustrates a fracturing pump control system.

[0021] FIG. 2 illustrates an air-cooled device of the fracturing pump.

[0022] FIG. 3 illustrates a water-cooled device of the fracturing pump.

[0023] FIG. 4 illustrates a side view of the water-cooled device.

[0024] FIG. 5 illustrates a water flow in the inner part of a motor water jacket in the water-cooled device of the fracturing pump.

DETAILED DESCRIPTION OF THE INVENTION

[0025] The aforementioned and other aspects, solutions, and advantages of the present invention will become apparent from the following descriptions and corresponding drawings. The embodiments further clarify the present invention and shall not be construed to limit the scope of the present invention.

Embodiment 1

[0026] A fracturing pump and its support apparatus comprise three fracturing cars, a sand mixing car, a measuring car and their control systems. The fracturing pump comprises a cooling device and a control device. A motor is coupled on a shaft of the fracturing pump. The cooling device comprises an air-cooled device for cooling a rotor of the pump motor and a water-cooled device for cooling a stator of the pump motor. The control device is connected with the pump motor and the cooling device. A token ring is made with a shielded twisted pair by a Profibus for connection for the fracturing pump, the sand mixing car and the measuring car etc to make a network stable and easy scalable. Each of the apparatus is connected to the network with a Network Access device with bandwidth of 1.5 Mb/s.

[0027] The signal of a sensor of the fracturing pump is transmitted to a S7-300PLC of the measuring car via a distribution-type I/O apparatus. The S7-300PLC is connected with the Profibus monitoring layer. The monitoring layer is communicated with the S7-300PLC by a communication interface of the Profibus. Fracturing process parameters are set and monitored in a graphical way. The historical output data is stored by the network. After analyzing onsite real-time data and simulating fracture expansion and proppant migration with a fracture simulation software, a solution is made for optimizing fracturing design to improve the fracturing quality and operation efficiency.

[0028] The monitoring layer comprises an industrial control computer with a communication interface of the Profibus to communicate with the S7-300PLC. The monitoring layer is communicated with the PLC of the control layer via the communication interface of the Profibus. The monitoring layer is communicated with the PLC of the control layer

through the communication interface of the Profibus. A software platform of system operation adopts configuration software of Windows NT+WINCC, disposes and monitors a parameter of a process with a graphical way, stores the historical data of production, carries out field analysis for real-time data, simulates the expansion of complicate oil and gas reservoir gap and the migration of a propping agent by means of a fracturing simulation software, and optimizes the design of fracturing construction, thereby improving the quality of the fracturing construction and operation efficiency.

[0029] Remote control and information processing can be realized by remote transmission effectively to cut apparatus maintenance time and cost and save time and space to get the information.

[0030] The sensors comprise a pressure sensor and a temperature sensor.

Example 2

[0031] Being the same with example 1, preferably, two fracturing pumps are provided on a fracturing car. A cooling device is mounted between the two fracturing pumps.

Example 3

[0032] Being the same with Example 2, preferably, a cooling device on a fracturing pump comprises an air-cooled device for the pump motor and a water-cooled device for the pump motor.

[0033] As shown in FIG. 2, the air-cooled device for the pump motor comprises a fan motor 3 and a pump motor core 4. One end of the fan motor 3 is provided with a fan 2 on which an air inlet 1 is provided. The pump motor core 4 is also provided thereon with a fan 5 on which an air outlet 6 is provided. The working principle of the air-cooled device for the pump motor is as follows: cooled air enters into the fan 2 via the air inlet 1 to make the cooled air compressed by the centrifugal force of the fan 2, and the compressed air enters into the inner part of the pump motor, and takes away the heat generated by the pump motor core 4. The centrifugal force generated by the rotation of the fan 5 makes a lower pressure area near the fan 5 to fast the flow of the air in the pump motor, and discharges the heat out of the pump motor through the air outlet 6 for heat dissipation.

[0034] As shown in FIGS. 3, 4, the water-cooled device of the motor comprises the pump motor water jacket 7 and a water pump 12. The pump motor water jacket 7 is also provided thereon with a water inlet 8 and a water outlet 9. A heat sink 10, is connected with a water tank 11, which are also provided outside of the pump motor. The water tank 11 is connected with the water inlet 8. A drainage port 13 is also provided on the pump motor water jacket. The working principle of the water-cooled device of the motor is as follows: the cooled water in the water tank 11 is pressurized by the water pump 12 and enters into the pump motor water jacket 7 via the water inlet 8; as shown in FIG. 5, the cooled water passes through an S-shaped passage (which elongates the heat dissipation route for better heat dissipation) of the pump motor water jacket 7, and takes away the heat of an inner surface of the pump motor water jacket; The cooled water passes through an S-shaped water passage, flows out via the water outlet 9, and the water is cooled by the heat sink 10 with its temperature substantially equals to that of the water jacket inlet and the water flows back to the water tank 11. If the pump motor does not work in a certain period in cold environment

such as temperature lower than Zero degrees Celsius, the water in the motor water jacket 7 must be discharged through the drainage port 13 to avoid the water icing to break the motor water jacket 7.

1-10. (canceled)

11. A fracturing pump comprising a cooling device and a control device, wherein:

a pump motor is coupled on a shaft of said fracturing pump, said cooling device comprises an air-cooled device for cooling a rotor of said pump motor and a water-cooled device for cooling a stator of said pump motor, and said control device is coupled with said pump motor and said cooling device, respectively.

12. A fracturing pump of claim 11, wherein said cooling device is mounted between said two fracturing pumps.

13. A fracturing pump of claim 11, wherein said pump motor is controlled by a middle-voltage numerical control frequency converter.

14. A fracturing pump of claim 12, wherein said pump motor is controlled by a middle-voltage numerical control frequency converter.

15. A fracturing pump of claim 13, wherein a temperature sensor and a pressure sensor are mounted on said fracturing pump; said temperature sensor, said pressure sensor and said frequency converter are connected to a PLC (Programmable Logic Controller) via a field bus cable; and said PLC is connected with a man-machine input device.

16. A fracturing pump of claim 14, wherein a temperature sensor and a pressure sensor are mounted on said fracturing pump; said temperature sensor, said pressure sensor and said frequency converter are connected to a PLC (Programmable Logic Controller) via a field bus cable; and said PLC is connected with a man-machine input device.

17. A fracturing pump of claim 15, wherein said field bus is Profibus.

18. A fracturing pump of claim 16, wherein said field bus is Profibus.

19. A fracturing pump of claim 17, wherein a monitoring device is connected to a communication interface of said Profibus; said monitoring device and said communication interface of said Profibus are connected remotely via an Ethernet network; a distribution-type I/O device is communicated with said PLC control layer for information transmis-

sion to a measuring car PLC; and said car PLC is communicated with a monitoring layer via said field bus.

20. A fracturing pump of claim 18, wherein a monitoring device is connected to a communication interface of said Profibus; said monitoring device and said communication interface of said Profibus are connected remotely via an Ethernet network; a distribution-type I/O device is communicated with said PLC control layer for information transmission to a measuring car PLC; and said car PLC is communicated with a monitoring layer via said field bus.

21. A fracturing pump of claim 19, wherein said man-machine input device is an industrial touch screen.

22. A fracturing pump of claim 20, wherein said man-machine input device is an industrial touch screen.

23. A fracturing pump of claim 11, wherein said air-cooled device comprises an air blower; an air outlet of said air blower is connected with an inner part of said pump motor; a radial fan is also mounted on a casing of said pump motor; and said radial fan draws air out of said inner part of said pump motor.

24. A fracturing pump of claim 12, wherein said air-cooled device comprises an air blower; an air outlet of said air blower is connected with an inner part of said pump motor; a radial fan is also mounted on a casing of said pump motor; and said radial fan draws air out of said inner part of said pump motor.

25. A fracturing pump of claim 11, wherein said water-cooled device comprises a water pump; a water inlet of said water pump is connected with a water tank; a water outlet thereof is connected with a motor water jacket; said water jacket is provided with an S-shaped passage; said water outlet is connected with a heat sink; and said water outlet is connected with said water tank.

26. A fracturing pump of claim 12, wherein said water-cooled device comprises a water pump; a water inlet of said water pump is connected with a water tank; a water outlet thereof is connected with a motor water jacket; said water jacket is provided with an S-shaped passage; said water outlet is connected with a heat sink; and said water outlet is connected with said water tank.

27. A fracturing pump of claim 25, wherein a drainage port is also provided for said water jacket.

28. A fracturing pump of claim 26, wherein a drainage port is also provided for said water jacket.

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