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(54) **Cooling device and controlling method thereof for reefer container**

(57) A cooling device and a controlling method thereof for a reefer container are disclosed. The cooling device has a controlling circuit comprising a controller (4); a compressor relay (1), a condenser fan relay (2) and an evaporator fan relay (3) connected in parallel; a pressure switch (7) connected to the compressor relay (1) in series; and a pressure sensing and controlling device for controlling the pressure switch (7) to turn on or off. The pressure sensing and controlling device controls the pressure switch (7) to turn off when air pressure inside container drops to a preset pressure, and controls the pressure switch (7) to turn on when air pressure inside container rises higher than the preset pressure. The controlling method comprises steps of detecting and controlling air pressure inside container. The invention can be implemented in a simple structure and at a low cost, as only a few of electric elements are added to conventional controlling circuits.

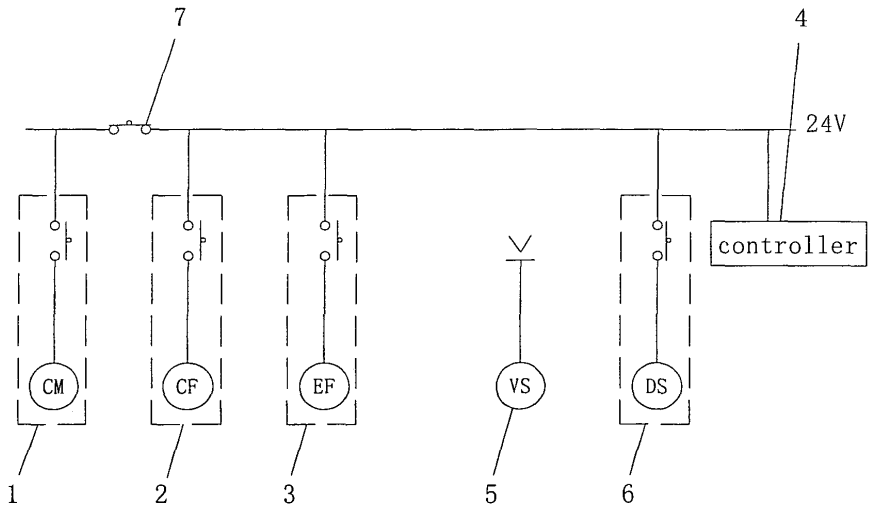

FIG. 2

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Description

FIELD OF THE INVENTION

[0001] The invention relates to a cooling device and a controlling method thereof for a reefer container, more specifically, relates to a controlling circuit and a controlling method of the cooling device.

BACKGROUND ART

[0002] A controlling circuit diagram of a conventional cooling device for a reefer container is shown in FIG. 1. When the reefer container or carriage is operated in a cooling mode, a compressor relay 1, a condenser fan relay 2 and an evaporator fan relay 3 of its cooling device are all in an ON state, and the compressor, the condenser fan and the evaporator fan are all in the condition of operation. The operating states of the compressor relay 1, the condenser fan relay 2 and the evaporator fan relay 3 are controlled by a controller 4.

[0003] During cooling process of the reefer container or carriage, a very high negative pressure will be generated inside the container if the cooling device is still operated in the cooling mode, after the door is closed. Side or top plates of the reefer container may even be crushed in the case that the negative pressure is too high.

[0004] However, the conventional cooling device can not detect and control the air pressure inside the container, and thus can not prevent the container body from being crushed due to an excessive negative pressure inside the container.

SUMMARY OF THE INVENTION

[0005] The first object of the invention is to provide a cooling device for a reefer container to detect the air pressure inside the container and stop operating if the air pressure inside the container is too low so as to prevent the container body from being crushed due to an excessive negative pressure inside the container.

[0006] The second object of the invention is to provide a method of controlling a cooling device for a reefer container, which allows detecting and controlling of the air pressure inside the container, so as to prevent the container body from being crushed due to an excessive negative pressure inside the container.

[0007] In order to realize the first object mentioned above, the invention provides a cooling device with a controlling circuit for a reefer container, the controlling circuit comprising a compressor relay, a condenser fan relay and an evaporator fan relay which are connected in parallel, as well as a controller for controlling operating states of the compressor relay, the condenser fan relay and the evaporator fan relay. The controlling circuit further comprises a pressure switch which is connected to the compressor relay in series and a pressure sensing and controlling device which can control the pressure switch to turn on or off. When the air pressure inside the container drops to a preset pressure, the pressure sensing and controlling device controls the pressure switch to turn off; and when the air pressure inside the container rises higher than the preset pressure, the pressure sensing and controlling device controls the pressure switch to turn on.

[0008] In the cooling device for a reefer container according to the invention, the pressure switch and the compressor relay connected in series are connected to the condenser fan relay and the evaporator fan relay in parallel.

[0009] In the cooling device for a reefer container according to the invention, the pressure switch and the compressor relay connected in series are connected to the evaporator fan relay in parallel, and the condenser fan relay is connected to the compressor relay in parallel.

[0010] In the cooling device for a reefer container according to the invention, the compressor relay, the condenser fan relay and the evaporator fan relay connected in parallel are connected to the pressure switch in series.

[0011] In the cooling device for a reefer container according to the invention, the controlling circuit further comprises a time delay relay which is controlled by the pressure sensing and controlling device and can delay the pressure switch to turn on, the time delay relay being connected in parallel to the pressure switch and the compressor relay connected in series. When the air pressure inside the container drops to the preset pressure, the pressure sensing and controlling device controls a contact of the time delay relay to disconnect; and when the air pressure inside the container rises higher than the preset pressure, the pressure sensing and controlling device controls the contact of the time delay relay to connect, and the time delay relay delays the pressure switch to turn on.

[0012] In the cooling device for a reefer container according to the invention, the pressure sensing and controlling device is a vacuum pressure switch, and the vacuum pressure switch is disposed inside the container.

[0013] In the cooling device for a reefer container according to the invention, the pressure sensing and controlling device comprises a controlling device and a pressure sensor which is disposed inside the container. The controlling device can acquire information of the air pressure inside the container from the pressure sensor and transmit control signals.

[0014] In order to realize the second object mentioned above, the invention provides a method of controlling a cooling device with a controlling device for a reefer container, the controlling circuit comprising a compressor relay, a condenser fan relay and an evaporator fan relay which are connected in parallel, as well as a controller for controlling operating states of the compressor relay, the condenser fan relay and the evaporator fan relay. The controlling circuit further comprises a pressure switch which is connected to the compressor relay in series and a pressure sensing and controlling device which

can control the pressure switch to turn on or off. The method comprising the following steps:

a). detecting the air pressure inside the container by the pressure sensing and controlling device;
b). when the air pressure inside the container drops to a preset pressure, controlling the pressure switch to turn off by the pressure sensing and controlling device, and when the air pressure inside the container rises higher than the preset pressure, controlling the pressure switch to turn on by the pressure sensing and controlling device.

[0015] In the method of controlling a cooling device for a reefer container according to the invention, the controlling circuit further comprises a time delay relay which is controlled by the pressure sensing and controlling device and can delay the pressure switch to turn on, and which is connected in parallel to the pressure switch and the compressor relay connected in series. At the step b), when the air pressure inside the container drops to the preset pressure, a contact of the time delay relay is controlled to disconnect by the pressure sensing and controlling device, and when the air pressure inside the container rises higher than the preset pressure, the contact of the time delay relay is controlled to connect by the pressure sensing and controlling device, and the pressure switch is delayed to turn on by the time delay relay.

[0016] In the method of controlling a cooling device for a reefer container according to the invention, the pressure sensing and controlling device comprises a controlling device and a pressure sensor which is disposed inside the container. At the step a), the air pressure inside the container is detected by the pressure sensor, and the controlling device acquires information of the air pressure inside the container from the pressure sensor and transmits control signals.

[0017] The cooling device and the controlling method thereof for a reefer container according to the invention can achieve the following advantageous effects:

1. The invention can be implemented in a simple structure and at a low cost, since only a few of electric elements are added to the conventional controlling circuit for controlling the air pressure inside the container.
2. There is no modification to the structures of the container body and carriage, so it is not necessary to change the processes for manufacturing the container and carriage at present.
3. It is easy to apply the invention to old container and old lorry.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] A further description of the invention will be given below in combination of drawings and embodiments, where in the drawings:

FIG. 1 is a diagram schematically showing a controlling circuit of a conventional cooling device for a reefer container or a refrigerated lorry.
FIG. 2 is a diagram schematically showing a controlling circuit of a cooling device for a reefer container according to a first embodiment of the invention.
FIG. 3 is a diagram schematically showing a controlling circuit of a cooling device for a reefer container according to a second embodiment of the invention.
FIG. 4 is a diagram schematically showing a controlling circuit of a cooling device for a reefer container according to a third embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

First Embodiment:

[0019] In the following, the embodiments of the cooling device and the controlling method thereof for a reefer container according to the invention are described referring to FIGs. 2 to 4. In addition, the cooling device and the controlling method thereof can be applied to refrigerated lorry, but here only the description for the reefer container is given below by way of example.

[0020] The controlling circuit of the cooling device for the reefer container according to the first embodiment of the invention is shown in FIG. 2. As shown in FIG. 2, the controlling circuit of the cooling device comprises a compressor relay 1, a condenser fan relay 2, an evaporator fan relay 3, a controller 4, a vacuum pressure switch 5 and a pressure switch 7. The controller 4 can control operating states of the compressor relay 1, the condenser fan relay 2 and the evaporator fan relay 3. The vacuum pressure switch 5 is disposed inside the container for controlling the pressure switch 7 to turn on or off according to the air pressure inside the container. In this embodiment, the pressure switch 7 and the compressor relay 1 connected in series, are then connected to the condenser fan relay 2 and the evaporator fan relay 3 in parallel.

[0021] An action value for the vacuum pressure switch 5, e.g. 300mm - 400mm water column, is preset according to the air pressure inside the container to be controlled (this value will be referred as preset pressure below). When the air pressure inside the container drops to the preset pressure, the vacuum pressure switch 5 controls the pressure switch 7 to turn off. At this time, the compressor relay 1 is disconnected, and the compressor is caused to stop operating. When the air pressure inside the container rises higher than the preset pressure, the vacuum pressure switch 5 controls the pressure switch 7 to turn on. At this time, the controller 4 controls the compressor relay 1 to turn on, and the compressor begins operation. Thereby it is ensured that the air pressure inside the container is not lower than the preset pressure so as to ensure safety of the container body.

[0022] To further control the air pressure inside the container, the controlling circuit of the cooling device may

be provided with a time delay relay 6 therein. The time delay relay 6 is controlled by the vacuum pressure switch 5, and can delay the pressure switch 7 to turn on. The time delay relay 6 is connected in parallel to the pressure switch 7 and the compressor relay 1 connected in series.

[0023] When the air pressure inside the container drops to the preset pressure, the vacuum pressure switch 5 controls a contact of the time delay relay 6 to disconnect. When the air pressure inside the container rises higher than the preset pressure, the vacuum pressure switch 5 controls the contact of the time delay relay 6 to connect so that the time delay relay 6 is energized, and the time delay relay 6 delays the pressure switch 7 to turn on, that is, makes the pressure switch 7 turn on after a period of time has elapsed. Therefore, the cooling system will stop operating for a period of time after the air pressure inside the container drops to the preset pressure. Thereby such a risk is prevented that the container body is damaged due to the temperature inside the container dropping and the air pressure inside the container rapidly dropping in the case that the cooling system continuously operates.

[0024] Furthermore, in the case that a time delay relay is provided, the pressure switch can be replaced by another contact of the time delay relay.

[0025] The vacuum pressure switch 5 can be replaced by a common pressure sensor in combination with a controlling device. In operating state, the pressure sensor detects the air pressure inside the container and transmits information of the air pressure inside the container to the controlling device. When the air pressure inside the container drops to the preset pressure or rises higher than it, the controlling device sends control signals respectively to the pressure switch 7 and the time delay relay 6 for controlling them.

Second Embodiment:

[0026] As shown in FIG. 3, the second embodiment is almost the same as the first embodiment except that: the pressure switch 7 and the compressor relay 1 connected in series are connected to the evaporator fan relay 3 in parallel, and the condenser fan relay 2 is connected to the compressor relay 1 in parallel.

[0027] In this way, when the air pressure inside the container drops to the preset pressure, the vacuum pressure switch 5 controls the pressure switch 7 to turn off. At this time, the compressor relay 1 and condenser fan relay 2 are disconnected, and the compressor and the condenser fan are caused to stop operating. When the air pressure inside the container rises higher than the preset pressure, the vacuum pressure switch 5 controls the pressure switch 7 to turn on. At this time, the controller 4 controls the compressor relay 1 and the condenser fan relay 2 to turn on, and the compressor and the condenser fan begin operation. Thereby it is ensured that the air pressure inside the container is not lower than the preset pressure, so as to ensure safety of the container body.

Third Embodiment:

[0028] As shown in FIG. 4, the third embodiment is almost the same as the first embodiment except that: the compressor relay 1, the condenser fan relay 2 and the evaporator fan relay 3 connected in parallel, are then connected to the pressure switch 7 in series.

[0029] In this way, when the air pressure inside the container drops to the preset pressure, the vacuum pressure switch 5 controls the pressure switch 7 to turn off. At this time, the compressor relay 1, the condenser fan relay 2 and the evaporator fan relay 3 are disconnected, and the compressor, the condenser fan and the evaporator fan are caused to stop operating. When the air pressure inside the container rises higher than the preset pressure, the vacuum pressure switch 5 controls the pressure switch 7 to turn on. At this time, the controller 4 controls the compressor relay 1, the condenser fan relay 2 and the evaporator fan relay 3 to turn on, and the compressor, the condenser fan and the evaporator fan begin operation. Thereby it is ensured that the air pressure inside the container is not lower than the preset pressure, so as to ensure safety of the container body.

[0030] A method of controlling a cooling device for a reefer container according to the invention will be described below. The controlling circuit of the cooling device comprises a compressor relay, a condenser fan relay and an evaporator fan relay connected in parallel as well as a controller for controlling operating states of the compressor relay, the condenser fan relay and the evaporator fan relay. The controlling circuit further comprises a pressure switch which is connected to the compressor relay in series and a pressure sensing and controlling device which can control the pressure switch to turn on or off. The controlling method comprises the following steps: measuring the air pressure inside the container by the pressure sensing and controlling device; when the air pressure inside the container drops to the preset pressure, controlling the pressure switch to turn off by the pressure sensing and controlling device, when the air pressure inside the container rises higher than the preset pressure, controlling the pressure switch to turn on by the pressure sensing and controlling device. By way of the above controlling method, the air pressure inside the container can be ensured to be not lower than the preset pressure value, and so to ensure safety of the container body.

[0031] The controlling circuit may be provided with the time delay relay 6 which is controlled by the pressure sensing and controlling device and can delay the pressure switch 7 to turn on. The time delay relay 6 is connected in parallel to the pressure switch 7 and the compressor relay 1 connected in series. In this case, when the air pressure inside the container drops to the preset pressure, the pressure sensing and controlling device controls a contact of the time delay relay to disconnect; and when the air pressure inside the container rises higher than the preset pressure, the pressure sensing and

controlling device controls the contact of the time delay relay to connect, and the time delay relay 6 delays the pressure switch 7 to turn on. By way of the above controlling method, the cooling system will stop operating for a period of time after the air pressure inside the container drops to the preset pressure. Thereby such a risk is prevented that the container is damaged due to the temperature inside the container dropping and the air pressure rapidly dropping in the case that the cooling system continuously operates.

[0032] The pressure sensing and controlling device comprises a controlling device and a pressure sensor which is disposed inside the container. At this case, the air pressure inside the container is detected by the pressure sensor, and the controlling device acquires information of the air pressure inside the container from the pressure sensor and transmits control signals. Furthermore, the pressure sensing and controlling device can be a vacuum pressure switch.

Claims

1. A cooling device with a controlling circuit for a container, the controlling circuit comprising a compressor relay, a condenser fan relay and an evaporator fan relay which are connected in parallel, as well as a controller for controlling operating states of the compressor relay, the condenser fan relay and the evaporator fan relay, the controlling circuit further comprising:

> a pressure switch which is connected to the compressor relay in series; and
> a pressure sensing and controlling device which can control the pressure switch to turn on or off,

wherein, when the air pressure inside the container drops to a preset pressure, the pressure sensing and controlling device controls the pressure switch to turn off; and when the air pressure inside the container rises higher than the preset pressure, the pressure sensing and controlling device controls the pressure switch to turn on.

2. The cooling device for a reefer container according to claim 1, wherein the pressure switch and the compressor relay connected in series are connected to the condenser fan relay and the evaporator fan relay in parallel.

3. The cooling device for a reefer container according to claim 1, wherein the pressure switch and the compressor relay connected in series are connected to the evaporator fan relay in parallel, and the condenser fan relay is connected to the compressor relay in parallel.

4. The cooling device for a reefer container according to claim 1, wherein the compressor relay, the condenser fan relay and the evaporator fan relay connected in parallel are connected to the pressure switch in series.

5. The cooling device for a reefer container according to one of claims 1-4, the controlling circuit further comprises:

> a time delay relay which is controlled by the pressure sensing and controlling device and can delay the pressure switch to turn on, the time delay relay being connected in parallel to the pressure switch and the compressor relay connected in series,

wherein, when the air pressure inside the container drops to the preset pressure, the pressure sensing and controlling device controls a contact of the time delay relay to disconnect; and when the air pressure inside the container rises higher than the preset pressure, the pressure sensor controls the contact of the time delay relay to connect, and the time delay relay delays the pressure switch to turn on.

6. The cooling device for a reefer container according to claim 5, wherein the pressure sensing and controlling device is a vacuum pressure switch, and the vacuum pressure switch is disposed inside the container.

7. The cooling device for a reefer container according to claim 5, wherein the pressure sensing and controlling device comprising a controlling device and a pressure sensor which is disposed inside the container, wherein the controlling device can acquire information of the air pressure inside the container from the pressure sensor and transmit control signals.

8. A method of controlling a cooling device with a controlling device for a reefer container, the controlling circuit comprising a compressor relay, a condenser fan relay and an evaporator fan relay which are connected in parallel, as well as a controller for controlling operating states of the compressor relay, the condenser fan relay and the evaporator fan relay, the controlling circuit further comprising a pressure switch which is connected to the compressor relay in series and a pressure sensing and controlling device which can control the pressure switch to turn on or off, the method comprising the following steps:

> a). detecting the air pressure inside the container by the pressure sensing and controlling device;
> b). when the air pressure inside the container

drops to a preset pressure, controlling the pressure switch to turn off by the pressure sensing and controlling device, and when the air pressure inside the container rises higher than the preset pressure, controlling the pressure switch to turn on by the pressure sensing and controlling device.

9. The method of controlling a cooling device for a reefer container according to claim 8, wherein, the controlling circuit further comprises a time delay relay which is controlled by the pressure sensing and controlling device and can delay the pressure switch to turn on, and which is connected in parallel to the pressure switch and the compressor relay connected in series,
wherein, at the step b), when the air pressure inside the container drops to the preset pressure, controlling a contact of the time delay relay to disconnect by the pressure sensing and controlling device, and when the air pressure inside the container rises higher than the preset pressure, controlling the contact of the time delay relay to connect by the pressure sensing and controlling device so that the time delay relay 6 is energized, and delaying the pressure switch to turn on by the time delay relay.

10. The method of controlling a cooling device for a reefer container according to claim 8, wherein the pressure sensing and controlling device comprises a controlling device and a pressure sensor which is disposed inside the container,
wherein, at the step a), the air pressure inside the container is detected by the pressure sensor, and the controlling device acquires information of the air pressure inside the container from the pressure sensor and transmits control signals.

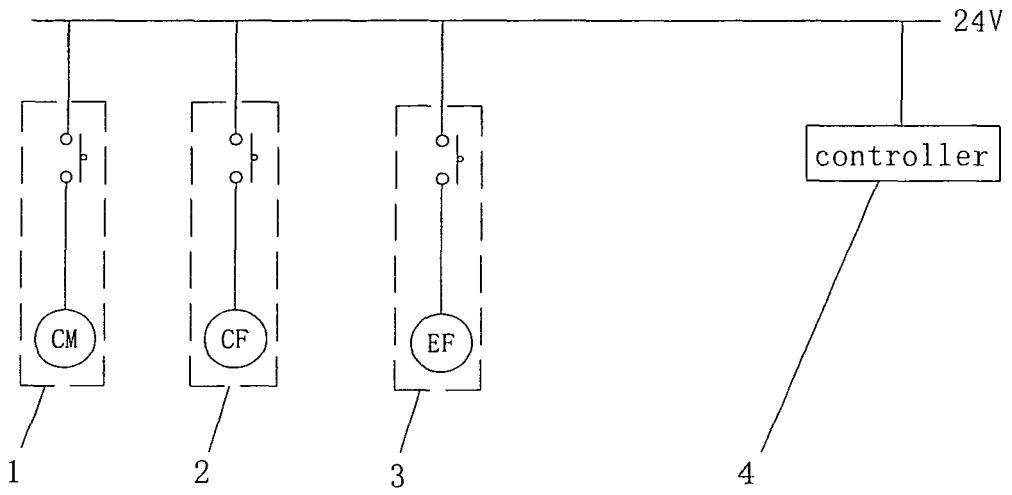
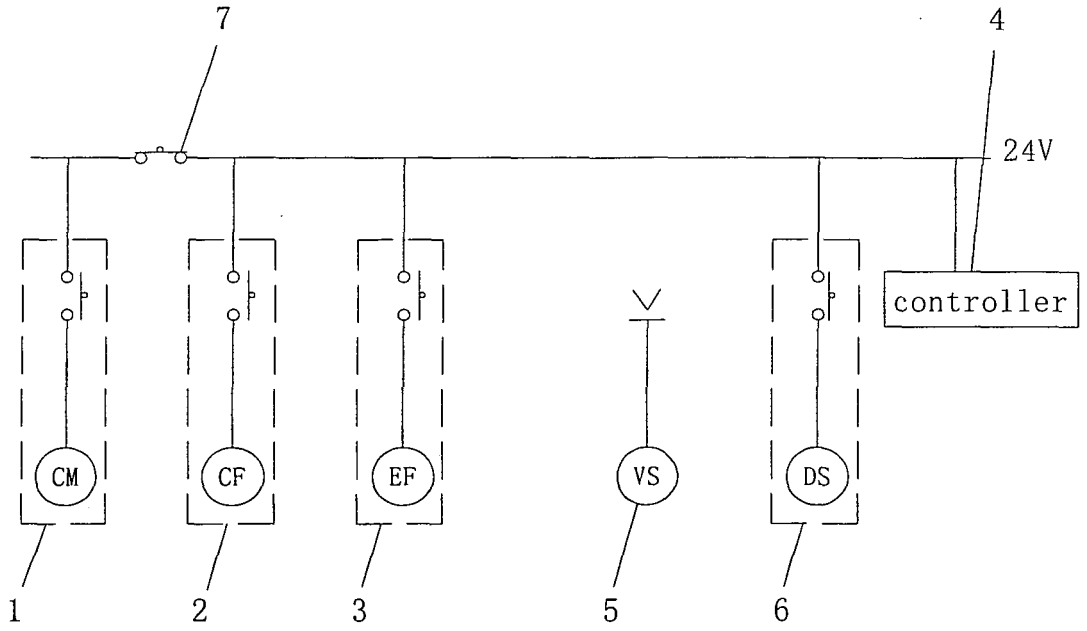

24V
controller
CM
CF
EF
1
2
3
4

FIG. 1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controller
CM
CF
EF
VS
DS
1
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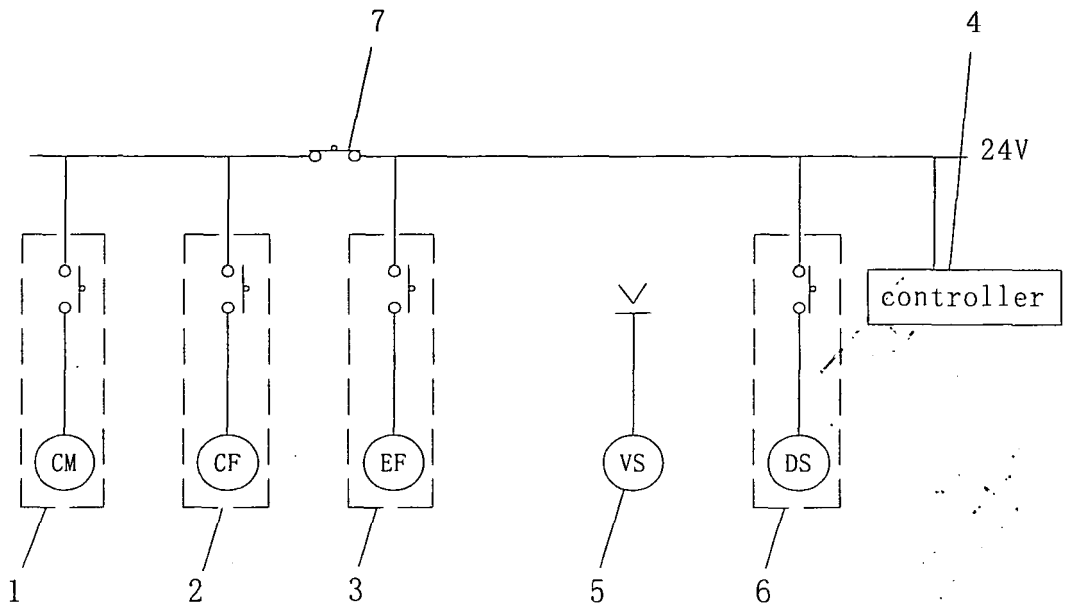
5
6

FIG. 2


7
4
24V
controller
CM
CF
EF
VS
DS
1
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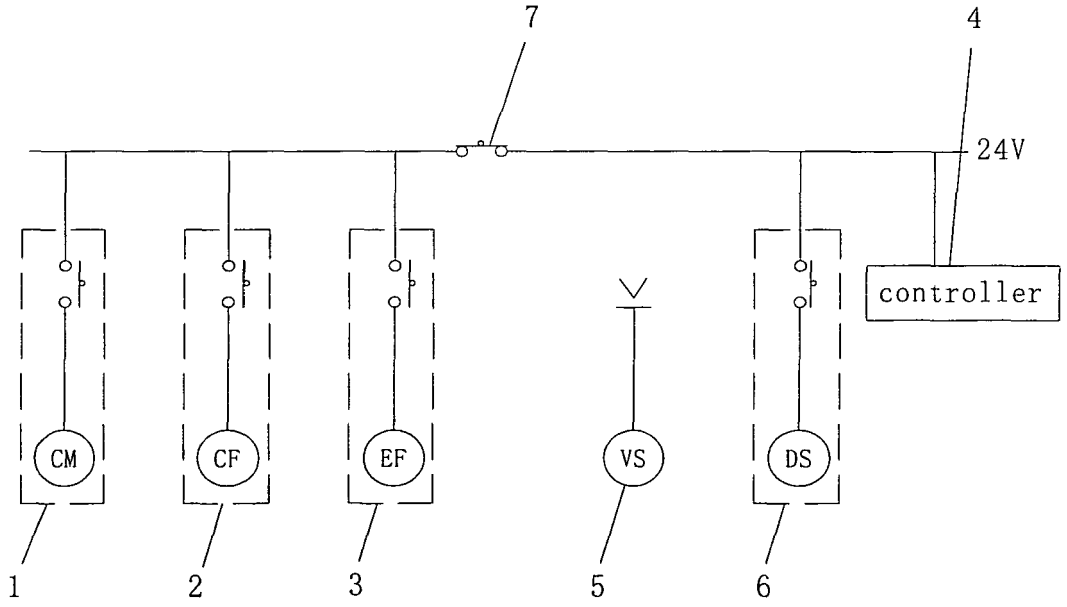
5
6

FIG. 3


7
4
24V
controller
CM
CF
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1
2
3
5
6

FIG. 4