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(54) **EJECTION DEVICE**

(57) Provided is an ejection device that can achieve lowered ejection sound. An ejection device (2) includes a high-pressure circuit (29, 60, 160) and a low-pressure circuit (50, 70, 170) for supplying compressed air to air nozzles (22) through which the compressed air is ejected to a track switch unit (10), a first solenoid valve (24A), a

second solenoid valve (24B), a third solenoid valve (53) and a fourth solenoid valve (54) provided in the high- or low-pressure circuit (29, 50, 60, 70, 160, 170) for controlling the pressure of the compressed air supplied to the air nozzles (22), and an ejection control device (20).

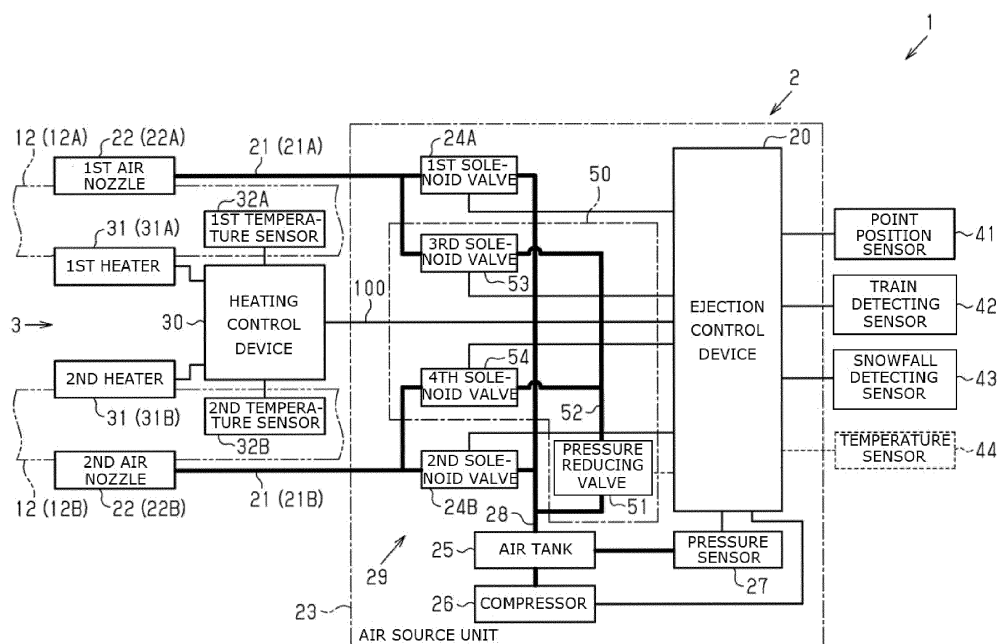


FIG. 1

Description

[0001] The present invention relates to an ejection device.

[0002] In a snow area, an ejection device is installed for the purposes of ejecting air to remove foreign matter such as snow in a track switch unit constituting part of tracks between stock rails and tongue rails, which are adjacent to the stock rails and can be brought into contact with and separated away from the stock rails.

[0003] The ejection device disclosed in Japanese Patent Application Publication No. Hei 6-240605 has a nozzle that opens toward the tip of the tongue rails. The ejection device ejects compressed air, which is provided by a compressor, through the nozzle to blow off and remove the snow between the stock rails and the tongue rails.

[0004] The above-described ejection device produces loud ejection sound when ejecting air. There is thus a demand for lowering the ejection sound. This problem is not limited to air ejection devices and shared by other ejection devices ejecting fluid such as water.

[0005] The present invention is made in view of the foregoing, and one object of the present invention is to provide an ejection device that can produce lowered ejection sound.

[0006] To solve the above-described problem, an ejection device includes a supply unit for supplying a fluid to an ejecting unit for ejecting the fluid to a track switch unit and also includes a pressure control unit for controlling a pressure of the fluid supplied to the ejecting unit.

[0007] With the above-described configurations, the pressure of the fluid supplied to the ejecting unit can be reduced by the pressure control unit. In this manner, within the controllable range of pressure, the ejection sound can be lowered from the level of the ejection sound produced when the pressure is relatively high to the level of the ejection sound produced when the pressure is relatively low.

[0008] In the above-described ejection device, the pressure control unit preferably includes a valve for reducing the pressure of the fluid supplied to the ejecting unit and a control unit for driving the valve.

[0009] With the above-described configurations, when the control unit drives the valve, the pressure of the fluid supplied to the ejecting unit can be reduced.

[0010] In the above-described ejection device, the pressure control unit preferably controls the pressure such that the pressure is lower in the nighttime than in the daytime.

[0011] Since the environmental sound is lower in the nighttime than in the daytime, the ejection sound of the fluid may possibly relatively stand out. With the above-described configurations, the pressure of the fluid to be ejected may be set lower in the nighttime than in the daytime, so that the fluid ejection sound can be prevented from standing out.

[0012] In the above-described ejection device, the pressure control unit preferably controls the pressure

such that the pressure is lower for preventive ejection than for follow-up ejection, and the preventive ejection involves ejecting the fluid every time a train passes through the track switch unit and the follow-up ejection involves ejecting the fluid when the track switch unit experiences changeover failure.

[0013] With the above-described configurations, as the pressure of the fluid to be ejected is lower for the preventive ejection than for the follow-up ejection, loud ejection sound can be produced a smaller number of times.

[0014] In the above-described ejection device, the supply unit includes a high-pressure circuit for supplying the fluid at a first pressure and a low-pressure circuit for supplying the fluid at a second pressure, where the second pressure is lower than the first pressure, and the pressure control unit preferably changes the pressure by adjusting a flow rate of the fluid supplied by the high-pressure circuit and a flow rate of the fluid supplied by the low-pressure circuit. With the above-described configurations, since the high-pressure circuit and the low-pressure circuit are included, the pressure of the fluid can be changed by adjusting the flow rates of the fluid supplied at different levels of pressure from these circuits.

[0015] In the above-described ejection device, the pressure control unit preferably includes a pressure adjusting valve for adjusting the pressure supplied to the ejecting unit.

[0016] With the above-described configurations, the pressure of the fluid supplied from the supply unit can be changed by driving the pressure adjusting valve. Accordingly, the pressure of the fluid can be changed without the need of providing circuits configured to supply the fluid at different levels of pressure.

[0017] In the above-described ejection device, when a heating device for heating the track switch unit is in operation, the pressure control unit preferably changes the pressure supplied to the ejecting unit to a low pressure, and the ejection device and the heating device cooperate.

[0018] With the above-described configurations, due to the cooperation between the ejection device and the heating device, the ejection device and the heating device can be effectively operated since wasteful operations and controls that may be carried out if the ejection device and the heating device are individually operated can be reduced.

Fig. 1 is a block diagram schematically showing the configuration of a snow removal device relating to a first embodiment.

Fig. 2 schematically shows the configuration of a track switch unit in which the snow removal device relating to the first embodiment is installed.

Fig. 3 shows the pressure levels of a variety of types of ejection performed by the ejection device relating to the first embodiment.

Fig. 4 is a block diagram schematically showing the configuration of a snow removal device relating to a

second embodiment.

Fig. 5 is a block diagram schematically showing the configuration of a snow removal device relating to a third embodiment.

Fig. 6 is a block diagram schematically showing the configuration of a snow removal device relating to a fourth embodiment.

<First Embodiment

[0019] The following describes a snow removal device including an ejection device relating to a first embodiment with reference to Figs. 1 to 5.

[0020] As shown in Fig. 1, a snow removal system 1 is installed in a track switch unit in a geographical area in which it snows. The snow removal system 1 is a snow removal device. The snow removal system 1 includes an ejection device 2 for ejecting a fluid to remove snow on the track switch unit and a heating device 3 for heating the rail in the track switch unit. Here, the term "snow" means snow and also ice resulting from solidification of melted snow.

[0021] As shown in Fig. 2, a track switch unit 10 is where tracks branch off and configured to switch tracks. The track switch unit 10 includes a pair of stock rails 12 fixed onto sleepers 11, a pair of tongue rails 13 movable relative to the stock rails 12, and a point machine 14 for moving the tongue rails 13. The track switch unit 10 is configured to switch tracks in such a manner that the point machine 14 moves the tongue rails 13. The point machine 14 is of an electric type and uses a motor to move the tongue rails 13. When a train passes through the track switch unit 10, the train moves from the stock rails 12 to the tongue rails 13 and vice versa, which induces vibration and resultantly causes the snow under the floor of the train comes off and falls. The snow adhering to the train under the floor includes hard snow. Here, the term "changeover failure" means a case where foreign matter such as snow between the stock rails 12 and the tongue rails 13 does not allow the tracks to be switched in the track switch unit 10.

[0022] The ejection device 2 uses compressed air and is designed to eject compressed air, which is one of available fluids, to blow off the snow between the stock rails 12 and the tongue rails 13 in the track switch unit 10. The ejection device 2 includes pipes 21 installed on the side surface of the stock rails 12 and air nozzles 22 installed at the tip of the pipes 21. The openings of the air nozzles 22 are positioned between the stock rails 12 and the tongue rails 13 when the stock rails 12 are in close contact with the tongue rails 13. The openings of the air nozzles 22 are directed toward the tip of the tongue rails 13 so that snow is blown off toward the tip of the tongue rails 13. A plurality of sets of the pipe 21 and the air nozzle 22 are installed on the stock rails 12. The air nozzles 22 correspond to an ejecting unit.

[0023] The heating device 3 includes electrothermal heaters 31. The heaters 31 are installed on the side sur-

face of the stock rails 12 and designed to melt snow and ice by heating the stock rails 12. The target to be heated by the heaters 31 is not limited to the stock rails 12 and may include the tongue rails 13. Alternatively, heater panels or the like may be provided between the sleepers 11 for heating the stock and tongue rails 12 and 13. The heaters 31 may not be limited to an electrothermal type and may be alternatively a gas type.

[0024] As shown in Figs. 1 and 2, in the ejection device 2, a first pipe 21A is disposed on the side surface of a normal-side stock rail 12A, which is one of the paired stock rails 12, and a second pipe 21B is disposed on the side surface of a reverse-side stock rail 12B. On the tip of the first pipe 21A, a first air nozzle 22A is disposed. On the first pipe 21A, a first solenoid valve 24A is disposed for opening and closing the first pipe 21A. On the tip of the second pipe 21B, a second air nozzle 22B is disposed. On the second pipe 21B, a second solenoid valve 24B is disposed for opening and closing the second pipe 21B. The first and second solenoid valves 24A and 24B are connected with an air tank 25 in which compressed air is stored. The air tank 25 is directly connected with the first and second solenoid valves 24A and 24B through a first supply pipe 28.

[0025] The ejection device 2 includes a low-pressure circuit 50 for supplying compressed air at a second pressure. The second pressure is lower than a first pressure, which is supplied to the first and second solenoid valves 24A and 24B via the first supply pipe 28. In the following, the first pressure refers to a relatively high pressure, and the second pressure refers to a relatively low pressure. The circuit including the first supply pipe 28 and the first and second solenoid valves 24A and 24B is referred to as a high-pressure circuit 29.

[0026] The low-pressure circuit 50 includes a second supply pipe 52 that branches off the first supply pipe 28 and is connected to the first and second pipes 21A and 21B via a pressure reducing valve 51. The second supply pipe 52 branches to be connected to the first pipe 21A via a third solenoid valve 53 and to be connected to the second pipe 21B via a fourth solenoid valve 54. The third and fourth solenoid valves 53 and 54 each open and close a corresponding one of the branch pipes. The pressure reducing valve 51 reduces the first pressure supplied by the air tank 25 to the predetermined second pressure and supplies the resulting second pressure to the second supply pipe 52. The second pressure achieved by the pressure reducing valve 51 may be variable. In the ejection device 2, the high-pressure circuit 29 and the low-pressure circuit 50 are connected in parallel with each other between the air tank 25 and the first and second pipes 21A and 21B. The high- and low-pressure circuits 29 and 50 together serve as a supply unit.

[0027] The air tank 25 is provided with a pressure sensor 27 for detecting the pressure of the air tank 25. A compressor 26 becomes operational when the pressure of the air tank 25 becomes equal to or lower than a threshold value to supply the compressed air to the air tank 25.

More specifically, the compressed air supplied from the compressor 26 is stored in the air tank 25, and the first, second, third and fourth solenoid valves 24A, 24B, 53 and 54, which are connected to the air tank 25, are turned on and off so that the air is ejected from the first and second air nozzles 22A and 22B. The ejection device 2 can change the pressure at which, the number of times and the duration during which the ejection is performed. When only the first solenoid valve 24A is opened, the compressed air at the first or high pressure is ejected through the first air nozzle 22A. When only the second solenoid valve 24B is opened, the compressed air at the first or high pressure is ejected through the second air nozzle 22B. When only the third solenoid valve 53 is opened, the compressed air at the second or low pressure is ejected through the first air nozzle 22A. When only the fourth solenoid valve 54 is opened, the compressed air at the second or low pressure is ejected through the second air nozzle 22B. In other words, the first, second, third and fourth solenoid valves 24A, 24B, 53 and 54 together serve as a pressure control unit.

[0028] The ejection device 2 includes an ejection control device 20 for controlling the ejection of the compressed air. The ejection control device 20 includes a programmable logic controller (PLC), which is a sequence control device, and is operated in accordance with a dedicated program, which is referred to as a ladder program. The PLC includes a central processing unit (CPU) and a storage. The ejection control device 20 is connected to input devices such as the pressure sensor 27, a point position sensor 41, a train detecting sensor 42 and a snowfall detecting sensor 43. The ejection control device 20 is also connected to output devices such as the first, second, third and fourth solenoid valves 24A, 24B, 53 and 54, the compressor 26 and the pressure sensor 27. The ejection control device 20 uses the ladder program to control these to-be-controlled devices. The ejection control device 20 turns on and off the first, second, third and fourth solenoid valves 24A, 24B, 53 and 54, so that the pressure, number and duration of the ejections of the compressed air are controlled. The ejection control device 20 serves as a pressure control unit and a control unit.

[0029] In the heating device 3, a first heater 31A is disposed on and extends along the extending direction of the side surface of the normal-side stock rail 12A, which is one of the paired stock rails 12, and a second heater 31B is disposed on and extends along the extending direction of the side surface of the reverse-side stock rail 12B. In the heating device 3, a first temperature sensor 32A for detecting the temperature of the normal-side stock rail 12A is disposed on the normal-side stock rail 12A, and a second temperature sensor 32B for detecting the temperature of the reverse-side stock rail 12B is disposed on the reverse-side stock rail 12B. The first and second temperature sensors 32A and 32B output a temperature signal including the detected temperature information. In the above, the first and second temperature

sensors 32A and 32B are constituents of the heating device 3, but may alternatively be constituents of the ejection device 2 as long as they are constituents of the snow removal system 1.

[0030] The heating device 3 includes a heating control device 30 for controlling the heating. The heating control device 30 includes a programmable logic controller (PLC), which is a sequence control device, and is operated in accordance with a dedicated program, which is referred to as a ladder program. The PLC includes a central processing unit (CPU) and a storage. The heating control device 30 is connected to input devices such as the first and second temperature sensors 32A and 32B. The heating control device 30 is also connected to output devices such as the first and second heaters 31A and 31B. The heating control device 30 uses the ladder program to control these to-be-controlled devices. The heating control device 30 controls the heating by turning on and off the first and second heaters 31A and 31B.

[0031] The point position sensor 41 detects, based on the value of the current flowing through the motor of the position machine 14, where the tongue rails 13 are positioned between the normal-side stock rail 12 and the reverse-side stock rail 12 and outputs a position signal including the position information. The ejection control device 20 determines whether changeover has been completed based on the position signal input from the point position sensor 41. For example, if there is snow or ice between the stock rails 12 and the tongue rails 13 and the tongue rails 13 thus can not move, the point position sensor 41 outputs a position signal including position information indicating that the tongue rails 13 have been unable to move. If changeover failure occurs, the track switch unit 10 transmits, to an operation direction center or the like, a changeover signal including information regarding the changeover failure or a retry instruction to make another changeover attempt.

[0032] The train detecting sensor 42 includes, for example, a supersonic sensor and is configured to output a train passing detection signal when a train passes.

[0033] The snowfall detecting sensor 43 is installed in and around the track switch unit 10 and is configured to detect snowfall based on the water content of the snow adhering to the detecting unit and outputs a snowfall signal including the detected snowfall. The snowfall detecting sensor 43 is not limited to the water content detecting type and may be alternatively an infrared type. In the latter case, the snowfall is detected by detecting the infrared rays reflected by the snow. The ejection control device 20 obtains the information regarding the snowfall indicated by the snowfall signal input from the snowfall detecting sensor 43. Here, the ejection control device 20 may obtain, in addition to the snowfall in and around the track switch unit 10, the snow accumulation in and around the track switch unit 10. The snowfall refers to the amount of snow falling within a predetermined period of time and can tell the amount of currently falling snow. The snow accumulation, on the other hand, refers to the amount of

snow that has accumulated and can tell the amount of snow that has accumulated so far.

[0034] As shown in Fig. 3, the ejection control device 20 controls the ejection device 2 to perform "follow-up ejection," "preventive ejection" and "intermittent ejection." The term "follow-up ejection" refers to ejection of the compressed air carried out when the track switch unit 10 experiences changeover failure for the purposes of removing any existing snow and ice. If the track switch unit 10 performs a retry operation in response to changeover failure, "retry ejection" is carried out, where the compressed air is ejected every time the track switch unit 10 performs the retry operation. The term "preventive ejection" refers to ejection of the compressed air every time a train passes through the track switch unit 10 for the purposes of preventing changeover failure, since snow may possibly come off the train and fall when the train passes through the track switch unit 10. The term "intermittent ejection" refers to ejection of the compressed air at constant intervals for the purposes of preventing snow from accumulating while snow is falling. In addition, a field worker may perform "manual ejection" in the track switch unit 10, where the field worker manually operates the ejection device 2 to eject the compressed air. The ejection control device 20 refers to the temperature of the rails and the snowfall information and, if necessary, cooperates with the heating device 3 so that snow and the like is no longer found in the track switch unit 10.

[0035] For "follow-up ejection, retry ejection" and "manual ejection," the ejection control device 20 performs a control such that the high-pressure compressed air is ejected through the first and second air nozzles 22A and 22B. More specifically, the ejection control device 20 closes the third and fourth solenoid valves 53 and 54 and opens the first and second solenoid valves 24A and 24B, so that the high-pressure compressed air is ejected through the first and second air nozzles 22A and 22B. In the case of "preventive ejection" and "intermittent ejection," the ejection control device 20 performs a control such that the low-pressure compressed air is ejected through the first and second air nozzles 22A and 22B. More specifically, the ejection control device 20 closes the first and second solenoid valves 24A and 24B and opens the third and fourth solenoid valves 53 and 54, so that the low-pressure compressed air is ejected through the first and second air nozzles 22A and 22B.

[0036] As shown in Fig. 2, the ejection control device 20 does not allow the compressed air to be ejected through both the first and second air nozzles 22A and 22B simultaneously but through only one of the first and second air nozzles 22A and 22B. The ejection control device 20 turns on and opens either the first and third solenoid valves 24A and 53 or the second and fourth solenoid valves 24B and 54 such that the compressed air is supplied to the pipe 21 disposed on one of the stock rails 12 from which the tongue rails 13 are separated. Since only one of the two air nozzles is used for the ejection of the compressed air as described above, the re-

quired air pressure or amount of air can be reduced. Note that, if it is required to eject the compressed air through both the first and second air nozzles 22A and 22B simultaneously, the air pressure of the air tank 25 or the amount of air may be set at a necessary level. The ejection control device 20 acquires the value of the pressure of the air tank 25 from the pressure sensor 27, and when the pressure value becomes equal to or lower than a threshold value, allows the compressor 26 to become operational so that the compressor 26 supplies the compressed air to the air tank 25.

[0037] As shown in Fig. 1, from among the constituents of the ejection device 2, the first and second solenoid valves 24A and 24B, the air tank 25, the compressor 26, the pressure sensor 27 and the ejection control device 20 together form an air source unit 23. The air source unit 23 is a unit that can serve as the ejection device 2 by connecting the devices installed in the track switch unit 10 thereto. The devices installed in the track switch unit 10 include, for example, the first pipe 21A, the first air nozzle 22A, the second pipe 21B, the second air nozzle 22B, the point position sensor 41, the train detecting sensor 42 and the snowfall detecting sensor 43. When the heating control device 30, to which the first heater 31A, the second heater 31B, the first temperature sensor 32A and the second temperature sensor 32B of the heating device 3 are connected, is connected to the air source unit 23, the air source unit 23 can also serve as the heating device 3 in addition to as the ejection device 2. In this case, the ejection control device 20 of the air source unit 23 can control the ejection device 2 and the heating device 3. The air source unit 23 becomes capable of allowing the compressed air at the second pressure to be ejected through the first and second air nozzles 22A and 22B by adding thereto the low-pressure circuit 50 in such a manner that the first supply pipe 28 is connected to the first and second pipes 21A and 21B.

[0038] The ejection device 2 refers to the temperature of the rails and the snowfall information and, if necessary, cooperates with the heating device 3, so that snow and the like is no longer found in the track switch unit 10. The ejection control device 20 and the heating control device 30 are connected to each other communicatively via a connecting line 100. The ejection control device 20 acquires the temperature of the rails via the connecting line 100 from the heating control device 30. On the other hand, the heating control device 30 acquires the snowfall information and changeover failure information via the connecting line 100 from the ejection control device 20. Here, the connecting line 100 corresponds to a communicating unit and may be replaced with wireless communicating units provided in the ejection control device 20 and the heating control device 30.

[0039] The functions of the snow removal system 1 with the above-described configurations will now be described.

[0040] The ejection control device 20 controls the heating device 3. More specifically, the ejection control device

20 issues instructions to the heating control device 30 of the heating device 3, so that the ejection control device 20 controls the heating device 3 via the heating control device 30.

[0041] The ejection control device 20 controls the ejection device 2 and the heating device 3 based on the temperature of the rails and snowfall information in the track switch unit 10. If the temperature of the stock rails 12 is relatively high, snow may fall but melt immediately. On the other hand, if the temperature of the stock rails 12 is relatively low, falling snow may not melt but accumulate. Accordingly, if the ejection control device 20 controls the ejection device 2 and the heating device 3 based on the temperature of the stock rails 12, the track switch unit 10 can be prevented from experiencing changeover failure and, at the same time, the snow removal system 1 can be operated effectively.

[0042] The ejection control device 20 controls whether to operate the ejection device 2 based on the snowfall in the track switch unit 10. The ejection control device 20 determines whether the track switch unit 10 is in a disturbed state, namely, disturbed from operating by snow. The ejection control device 20 controls the ejection device 2 to perform follow-up ejection when determining that the track switch unit 10 is in the disturbed state. The ejection control device 20 controls the ejection device 2 to perform preventive ejection every time a train passes through the track switch unit 10. The ejection control device 20 controls the ejection device 2 to perform intermittent ejection when snow falls for the purposes of preventing the snow from accumulating.

[0043] As described above, including therein the low-pressure circuit 50, the ejection device 2 is capable of ejecting high-pressure compressed air and low-pressure compressed air. Accordingly, the ejection device 2 is controlled to eject the low-pressure compressed air for the preventive ejection and the intermittent ejection, so that the ejection sound can be lowered. When it is required to blow off foreign matter such as snow in the track switch unit 10, the ejection device 2 is controlled to eject the high-pressure compressed air as has been done in the conventional art. In this way, the ejection sound can be lowered without compromising the removal capability.

[0044] Advantageous effects of the embodiment will be now described.

(1) The pressure of the compressed air supplied to the air nozzles 22 can be varied between the first pressure of the compressed air supplied from the high-pressure circuit 29 and the second pressure of the compressed air supplied from the low-pressure circuit 50. In this manner, within the variable range of pressure, the ejection sound can be lowered from the level of the ejection sound produced when the pressure is relatively high down to the level of the ejection sound produced when the pressure is relatively low.

(2) Including the high-pressure circuit 29 and the low-pressure circuit 50, the ejection device 2 can change the pressure of the compressed air by combining together the different levels of the pressure from these circuits.

(3) As the pressure of the compressed air is lower for the preventive ejection than for the follow-up ejection, loud ejection sound can be produced a smaller number of times.

(4) If the ejection device 2 and the heating device 3 are individually operated, wasteful operations and controls can be carried out. If the ejection device 2 and the heating device 3 are combined for coordinated operation, such waste can be reduced and the ejection device 2 and the heating device 3 can be effectively operated.

<Second Embodiment

[0045] The following describes a snow removal device including an ejection device relating to a second embodiment with reference to Fig. 4. The ejection device relating to the second embodiment is different from that of the first embodiment in terms of the supply unit and the pressure control unit. The following description is made with focus on the differences between the first embodiment and the second embodiment.

[0046] As shown in Fig. 4, the ejection device 2 includes a high-pressure circuit 60 and a low-pressure circuit 70 that are arranged in parallel on the first supply pipe 28, which is configured to supply the compressed air to the first and second solenoid valves 24A and 24B. The high-pressure circuit 60 is configured to supply the compressed air at the first pressure in the air tank 25. On the other hand, the low-pressure circuit 70 is configured to supply the compressed air at the second pressure, which is lower than the first pressure supplied from the high-pressure circuit 60. The high- and low-pressure circuits 60 and 70 together serve as a supply unit.

[0047] The high-pressure circuit 60 includes a high-pressure pipe 61 for supplying the compressed air at the first pressure from the air tank 25 without a change in the pressure. The high-pressure pipe 61 is provided with a fifth solenoid valve 62 for opening and closing the high-pressure pipe 61. When the fifth solenoid valve 62 is opened, the compressed air at the first pressure, which is a high pressure, is supplied to the first and second solenoid valves 24A and 24B via the first supply pipe 28.

[0048] The low-pressure circuit 70 includes a low-pressure pipe 71 for supplying the compressed air at the second pressure, which is achieved by reducing the first pressure from the air tank 25. The low-pressure pipe 71 is provided with a pressure-reducing valve 72 for reducing the first pressure of the compressed air supplied from the air tank 25 to the predetermined second pressure and a sixth solenoid valve 73 for opening and closing the

low-pressure pipe 71. When the sixth solenoid valve 73 is opened, the compressed air at the second pressure, which is a low pressure, is supplied to the first and second solenoid valves 24A and 24B via the first supply pipe 28. The second pressure achieved by the pressure reducing valve 72 may be variable.

[0049] The ejection device 2 ejects the compressed air through the first and second air nozzles 22A and 22B by turning on and off the first and second solenoid valves 24A and 24B, which are connected to the first supply pipe 28. The ejection device 2 is capable of switching the pressure between the high pressure and the low pressure by turning on and off the fifth and sixth solenoid valves 62 and 73. When only the fifth solenoid valve 62 is opened, the compressed air at the first pressure, which is a high pressure, is supplied to the first supply pipe 28. When only the sixth solenoid valve 73 is opened, the compressed air at the second pressure, which is a low pressure, is supplied to the first supply pipe 28. In other words, the fifth and sixth solenoid valves 62 and 73 together serve as a pressure control unit.

[0050] The ejection control device 20 is connected to output devices such as the fifth and sixth solenoid valves 62 and 73. The ejection control device 20 turns on and off the first, second, fifth and sixth solenoid valves 24A, 24B, 62 and 73, so that the pressure, number and duration of the ejections of the compressed air are controlled.

[0051] For "follow-up ejection, retry ejection" and "manual ejection," the ejection control device 20 controls the high-pressure compressed air to be ejected through the first and second air nozzles 22A and 22B. More specifically, the ejection control device 20 opens the fifth solenoid valve 62 and closes the sixth solenoid valve 73, and opens the first and second solenoid valves 24A and 24B so that the high-pressure compressed air is ejected through the first and second air nozzles 22A and 22B. For "preventive ejection" and "intermittent ejection," the ejection control device 20 controls the low-pressure compressed air to be ejected through the first and second air nozzles 22A and 22B. More specifically, the ejection control device 20 opens the sixth solenoid valve 73 and closes the fifth solenoid valve 62, and opens the first and second solenoid valves 24A and 24B, so that the low-pressure compressed air is ejected through the first and second air nozzles 22A and 22B.

[0052] As described above, including therein the high- and low-pressure circuits 60 and 70, the ejection device 2 is capable of ejecting the high-pressure compressed air and the low-pressure compressed air. For the preventive ejection and the intermittent ejection, the ejection device 2 is controlled to eject the low-pressure compressed air, so that the ejection sound can be lowered. When it is required to blow off foreign matter such as snow in the track switch unit 10, the ejection device 2 is controlled to eject the high-pressure compressed air as has been done in the conventional art. In this way, the ejection sound can be lowered without compromising the removal capability.

[0053] Advantageous effects of the second embodiment will be now described. The second embodiment produces the following effects in addition to the effects (2) to (4) achieved by the first embodiment.

(1) As the first supply pipe 28 used to supply the compressed air to the air nozzles 22 includes the high- and low-pressure circuits 60 and 70, the compressed air at the first pressure from the high-pressure circuit 60 and the compressed air at the second pressure from the low-pressure circuit 70 can be supplied. In this manner, within the variable range of pressure, the ejection sound can be lowered from the level of the ejection sound produced when the pressure is relatively high to the level of the ejection sound produced when the pressure is relatively low.

(5) The pressure of the compressed air can be changed without the need of changing the controls performed by the first and second solenoid valves 24A and 24B on the compressed air to be ejected through the first and second air nozzles 22A and 22B.

<Third Embodiment

[0054] The following describes a snow removal device including an ejection device relating to a third embodiment with reference to Fig. 5. The ejection device relating to the third embodiment is different from that of the first embodiment in terms of the supply unit and the pressure control unit. The following description is made with a focus on the differences between the third embodiment and the first embodiment.

[0055] As shown in Fig. 5, the ejection device 2 includes a pressure adjusting valve 80 on the first supply pipe 28, which is configured to supply the compressed air to the first and second solenoid valves 24A and 24B. The pressure adjusting valve 80 adjusts the compressed air at the first pressure from the air tank 25 and supplies the resulting compressed air to the first and second solenoid valves 24A and 24B. The pressure adjusting valve 80 is controlled by the ejection control device 20 and configured to achieve the first or high pressure and the second or low pressure. In other words, the pressure adjusting valve 80 serves as a pressure control unit.

[0056] For "follow-up ejection, retry ejection" and "manual ejection," the ejection control device 20 controls the high-pressure compressed air to be ejected through the first and second air nozzles 22A and 22B. More specifically, the ejection control device 20 controls the pressure adjusting valve 80 such that the compressed air at the first pressure is supplied to the first supply pipe 28 and opens the first and second solenoid valves 24A and 24B. In this way, the high-pressure compressed air is ejected through the first and second air nozzles 22A and 22B. For "preventive ejection" and "intermittent ejection," the ejection control device 20 controls the low-pressure compressed air to be ejected through the first and second

air nozzles 22A and 22B. More specifically, the ejection control device 20 controls the pressure adjusting valve 80 such that the compressed air at the second pressure is supplied to the first supply pipe 28 and opens the first and second solenoid valves 24A and 24B. In this way, the low-pressure compressed air is ejected through the first and second air nozzles 22A and 22B.

[0057] As described above, including the pressure adjusting valve 80 on the first supply pipe 28, the ejection device 2 is capable of ejecting the high-pressure compressed air and low-pressure compressed air. For preventive ejection and intermittent ejection, the ejection device 2 is controlled to eject the low-pressure compressed air, so that the ejection sound can be lowered. When it is required to blow off foreign matter such as snow in the track switch unit 10, the ejection device 2 is controlled to eject high-pressure compressed air as has been done in the conventional art. In this way, the ejection sound can be lowered without compromising the removal capability.

[0058] Advantageous effects of the third embodiment will be now described. The third embodiment produces the following effects in addition to the effects (2) to (4) achieved by the first embodiment and the effect (5) achieved by the second embodiment.

(1) As the pressure adjusting valve 80 is added to the first supply pipe 28 used to supply the compressed air to the air nozzles 22, the compressed air at the first pressure and the compressed air at the second pressure can be supplied. In this way, the pressure of the fluid can be changed without the need of providing circuits configured to supply the compressed air at different levels of pressure. Accordingly, within the variable range of pressure, the ejection sound can be lowered from the level of the ejection sound produced when the pressure is relatively high to the level of the ejection sound produced when the pressure is relatively low.

<Fourth Embodiment

[0059] The following describes a snow removal device including an ejection device relating to a fourth embodiment with reference to Fig. 6. The ejection device relating to the fourth embodiment is different from that of the second embodiment in terms of the supply unit. The following description is made with a focus on the differences between the fourth embodiment and the second embodiment.

[0060] As shown in Fig. 6, the ejection device 2 includes a high-pressure circuit 160 and a low-pressure circuit 170 that are arranged in parallel on the first supply pipe 28, which is configured to supply the compressed air to the first and second solenoid valves 24A and 24B. The high-pressure circuit 160 is configured to supply the compressed air at the first pressure supplied from the compressor 26. On the other hand, the low-pressure circuit 170 is configured to supply the compressed air at

the second pressure, which is lower than the first pressure supplied from the high-pressure circuit 160. The high- and low-pressure circuits 160 and 170 thus together serve as a supply unit.

[0061] A high-pressure pipe 61 in the high-pressure circuit 160 is provided with a first tank 63 for storing therein the compressed air at the first pressure supplied from the compressor 26 and a fifth solenoid valve 62 for opening and closing the high-pressure pipe 61. When the fifth solenoid valve 62 is opened, the compressed air at the first pressure, which is a high pressure, is supplied from the first tank 63 to the first and second solenoid valves 24A and 24B via the first supply pipe 28.

[0062] A low-pressure pipe 71 in the low-pressure circuit 170 is provided with a pressure reducing valve 72 for reducing the first pressure supplied from the compressor 26 to the predetermined second pressure, a second tank 74 for storing therein the compressed air at the second pressure achieved by the pressure reduction, and a sixth solenoid valve 73 for opening and closing the low-pressure pipe 71. When the sixth solenoid valve 73 is opened, the compressed air at the second pressure, which is a low pressure, is supplied from the second tank 74 to the first and second solenoid valves 24A and 24B via the first supply pipe 28. The second pressure achieved by the pressure reducing valve 72 may be variable.

[0063] The ejection device 2 ejects the compressed air through the first and second air nozzles 22A and 22B by turning on and off the first and second solenoid valves 24A and 24B, which are connected to the first supply pipe 28. The ejection device 2 is capable of switching the pressure between the high pressure and the low pressure by turning on and off the fifth and sixth solenoid valves 62 and 73. When only the fifth solenoid valve 62 is opened, the compressed air at the first or high pressure is supplied to the first supply pipe 28 from the first tank 63. When only the sixth solenoid valve 73 is opened, the compressed air at the second or low pressure is supplied to the first supply pipe 28 from the second tank 74. The fifth and sixth solenoid valves 62 and 73 thus together serve as a pressure control unit.

[0064] The ejection control device 20 is connected to output devices such as the fifth and sixth solenoid valves 62 and 73, a pressure sensor (not shown) for detecting the pressure at the first tank 63, and a pressure sensor (not shown) for detecting the pressure at the second tank 74. The ejection control device 20 turns on and off the first, second, fifth and sixth solenoid valves 24A, 24B, 62 and 73, so that the pressure, number and duration of the ejections of the compressed air are controlled.

[0065] For "follow-up ejection, retry ejection" and "manual ejection," the ejection control device 20 controls the high-pressure compressed air to be ejected through the first and second air nozzles 22A and 22B. More specifically, the ejection control device 20 opens the fifth solenoid valve 62 and closes the sixth solenoid valve 73, and opens the first and second solenoid valves 24A and

24B so that the high-pressure compressed air supplied from the first tank 63 is ejected through the first and second air nozzles 22A and 22B. For "preventive ejection" and "intermittent ejection," the ejection control device 20 controls the low-pressure compressed air to be ejected through the first and second air nozzles 22A and 22B. More specifically, the ejection control device 20 opens the sixth solenoid valve 73 and closes the fifth solenoid valve 62, and opens the first and second solenoid valves 24A and 24B, so that the low-pressure compressed air supplied from the second tank 74 is ejected through the first and second air nozzles 22A and 22B.

[0066] As described above, including therein the high- and low-pressure circuits 160 and 170 respectively with the tanks, the ejection device 2 is capable of ejecting the high-pressure compressed air and low-pressure compressed air. For preventive ejection and intermittent ejection, the ejection device 2 is controlled to eject the low-pressure compressed air, so that the ejection sound can be lowered. When it is required to blow off foreign matter such as snow in the track switch unit 10, the ejection device 2 is controlled to eject the high-pressure compressed air as has been done in the conventional art. In this way, the ejection sound can be lowered without compromising the removal capability.

[0067] Advantageous effects of the fourth embodiment will be now described. The fourth embodiment produces the following effects in addition to the effects (2) to (4) achieved by the first embodiment and the effect (5) achieved by the second embodiment.

(1) As the first supply pipe 28 used to supply the compressed air to the air nozzles 22 is provided with the high- and low-pressure circuits 160 and 170, the compressed air at the first pressure and the compressed air at the second pressure can be supplied. In this manner, within the variable range of pressure, the ejection sound can be lowered from the level of the ejection sound produced when the pressure is relatively high to the level of the ejection sound produced when the pressure is relatively low.

<Other Embodiments>

[0068] The foregoing embodiments can be modified as described below. The above embodiments and the following modifications can be combined with each other to such an extent that they are technically consistent with each other.

[0069] In the first, second and fourth embodiments described above, the pressure supplied to the air nozzles 22 is changed by switching the fluid between the fluid supplied by the high-pressure circuits 29, 60 and 160 and the fluid supplied by the low-pressure circuits 50, 70 and 170. The pressure supplied to the air nozzles 22, however, may be changed by adjusting the flow rate of the fluid supplied by the high-pressure circuits 29, 60 and 160 and the flow rate of the fluid supplied by the low-

pressure circuits 50, 70 and 170.

[0070] In the above-described embodiments, the ejection control device 20 may control the pressure such that the pressure is lower in the nighttime than in the daytime. In other words, the ejection control device 20 sets the pressure, at which the compressed air is ejected through the first and second air nozzles 22A and 22B, lower in the nighttime than in the daytime. For example, while the compressed air at the high pressure may be ejected for all of the operations "follow-up ejection," "preventive ejection," "intermittent ejection" and "manual ejection" in the daytime, the compressed air at the low pressure may be ejected for all of the operations "follow-up ejection," "preventive ejection," "intermittent ejection" and "manual ejection" in the nighttime.

[0071] In the above-described embodiments, while the heating device 3 for heating the track switch unit 10 is in operation, the pressure supplied to the air nozzles 22 in the ejection device 2 may be changed to the low pressure and the ejection device 2 and the heating device 3 may cooperate with each other. In this way, the ejection device 2 and the heating device 3 can be effectively operated since wasteful operations and controls that may be carried out if the ejection device 2 and the heating device 3 are individually operated can be reduced.

[0072] In the above-described embodiments, when there is snow in the track switch unit 10, at least one of the ejection control device 20 and the heating control device 30 may put the ejection device 2 and the heating device 3 into operation.

[0073] In the above-described embodiments, the ejection device 2 and the heating device 3 are put into operation based on the information on the snowfall and the temperature of the rails. The ejection device 2 and the heating device 3, however, may be put into operation based on only one of the snowfall information and the temperature of the rails.

[0074] In the above-described embodiments, the controls are performed based on the temperature of the stock rails 12, but the controls may be alternatively performed based on the temperature of the tongue rails 13. As a further alternative, the controls may be performed based on both the temperature of the stock rails 12 and the temperature of the tongue rails 13. For example, the temperature of the stock rails 12 and the temperature of the tongue rails 13 may be compared against each other, and the controls may be performed based on a lower one of the temperature of the stock rails 12 and the temperature of the tongue rails 13.

[0075] As for the above-described configurations, as shown in Figs. 1 and 4, the snow removal system 1 may include a temperature sensor 44 for detecting the temperature around the track switch unit 10 and outputting a temperature signal including the temperature information. The ejection control device 20 and the heating control device 30 may perform the on/off controls based on the ambient temperature, not on the temperature of the rails.

[0076] In the above-described embodiments, the ejection control device 20 and the heating control device 30 are formed by a PLC but not limited to such. The ejection control device 20 and the heating control device 30 may be a device for controlling a to-be-controlled device using something other than a ladder program.

[0077] In the above-described embodiments, the ejection control device 20 is configured to control the heating device 3, but the ejection control device 20 may not need to control the heating device 3. In other words, the heating control device 30 itself is configured to control the heating device 3 based on the temperature of the rails. Furthermore, the heating device 3 may be omitted.

[0078] As for the above-described configurations, based on the temperature of the rails in the track switch unit 10, the pressure at which, number of times and duration during which a fluid is ejected by the ejection device 2 may be changed while the ejection device 2 is in operation. If the pressure at which the fluid is ejected is raised, a larger amount of snow can be blown off or the snow can be blown off farther. If the number of times the fluid is ejected is increased, a larger amount of snow can be blown off or the snow can be blown off farther. If the duration during which the fluid is ejected is extended, a larger amount of snow can be blown off or the snow can be blown off farther.

[0079] In the above-described embodiments, in the case of "manual ejection," a field worker, who is in the track switch unit 10, may manually operate the ejection device 2 to eject the compressed air. However, the ejection device 2 does not need to be operated to perform ejection by the field worker in the track switch unit 10 but may be operated remotely using a monitoring board, a PC, a tablet terminal and the like.

[0080] In the above-described embodiments, snow is removed by simply blowing off snow, but a heating unit for heating air to be ejected may be provided for ejecting hot air. As another alternative, a pipe unit including the above-described nozzles may be used as a heating device, so that heating may be performed between the stock rails 12 and the tongue rails 13 when changeover failure occurs in the track switch unit 10.

[0081] As for the above-described configurations, the air source unit 23 alone, excluding the air nozzles 22 and the ejection control device 20, may be configured to serve as an ejection device that may be capable of lowering the ejection sound.

[0082] The fluid to be ejected by the ejection device 2 may not be limited to air but can be water or hot water.

Claims

1. An ejection device (2) comprising:

a supply unit (29, 50, 60, 70, 160, 170) for supplying a fluid to an ejecting unit (22) for ejecting the fluid to a track switch unit (10); and

a pressure control unit (24A, 24B, 53, 54, 20, 62, 73, 80) for controlling a pressure of the fluid supplied to the ejecting unit (22).

2. The ejection device (2) of claim 1, wherein the pressure control unit (24A, 24B, 53, 54, 20, 62, 73, 80) includes:

a valve (24A, 24B, 53, 54, 62, 73, 80) for reducing the pressure of the fluid supplied to the ejecting unit (22); and
a control unit (20) for driving the valve (24A, 24B, 53, 54, 62, 73, 80).

3. The ejection device (2) of one of claims 1 and 2, wherein the pressure control unit (24A, 24B, 53, 54, 20, 62, 73, 80) controls the pressure such that the pressure is lower in the nighttime than in the daytime.

4. The ejection device (2) of one of claims 1 and 2, wherein the pressure control unit (24A, 24B, 53, 54, 20, 62, 73, 80) controls the pressure such that the pressure is lower for preventive ejection than for follow-up ejection, and the preventive ejection involves ejecting the fluid every time a train passes through the track switch unit (10) and the follow-up ejection involves ejecting the fluid when the track switch unit (10) experiences changeover failure.

5. The ejection device (2) of one of claims 1 to 4, wherein the supply unit (29, 50, 60, 70, 160, 170) includes:

a high-pressure circuit (29, 60, 160) for supplying a fluid at a first pressure;
a low-pressure circuit (50, 70, 170) for supplying a fluid at a second pressure, the second pressure being lower than the first pressure, and
wherein the pressure control unit (24A, 24B, 53, 54, 20, 62, 73, 80) changes the pressure by adjusting a flow rate of the fluid supplied by the high-pressure circuit (29, 60, 160) and a flow rate of the fluid supplied by the low-pressure circuit (50, 70, 170).

6. The ejection device (2) of one of claims 1 to 4, wherein the pressure control unit (24A, 24B, 53, 54, 20, 62, 73, 80) includes a pressure adjusting valve (80) for adjusting the pressure supplied to the ejecting unit (22).

7. The ejection device (2) of one of claims 1 to 6, wherein, when a heating device (3) for heating the track switch unit (10) is in operation, the pressure control unit (24A, 24B, 53, 54, 20, 62, 73, 80) changes the pressure supplied to the ejecting unit (22) to a low pressure, and the ejection device (2) cooperates with the heating device (3).

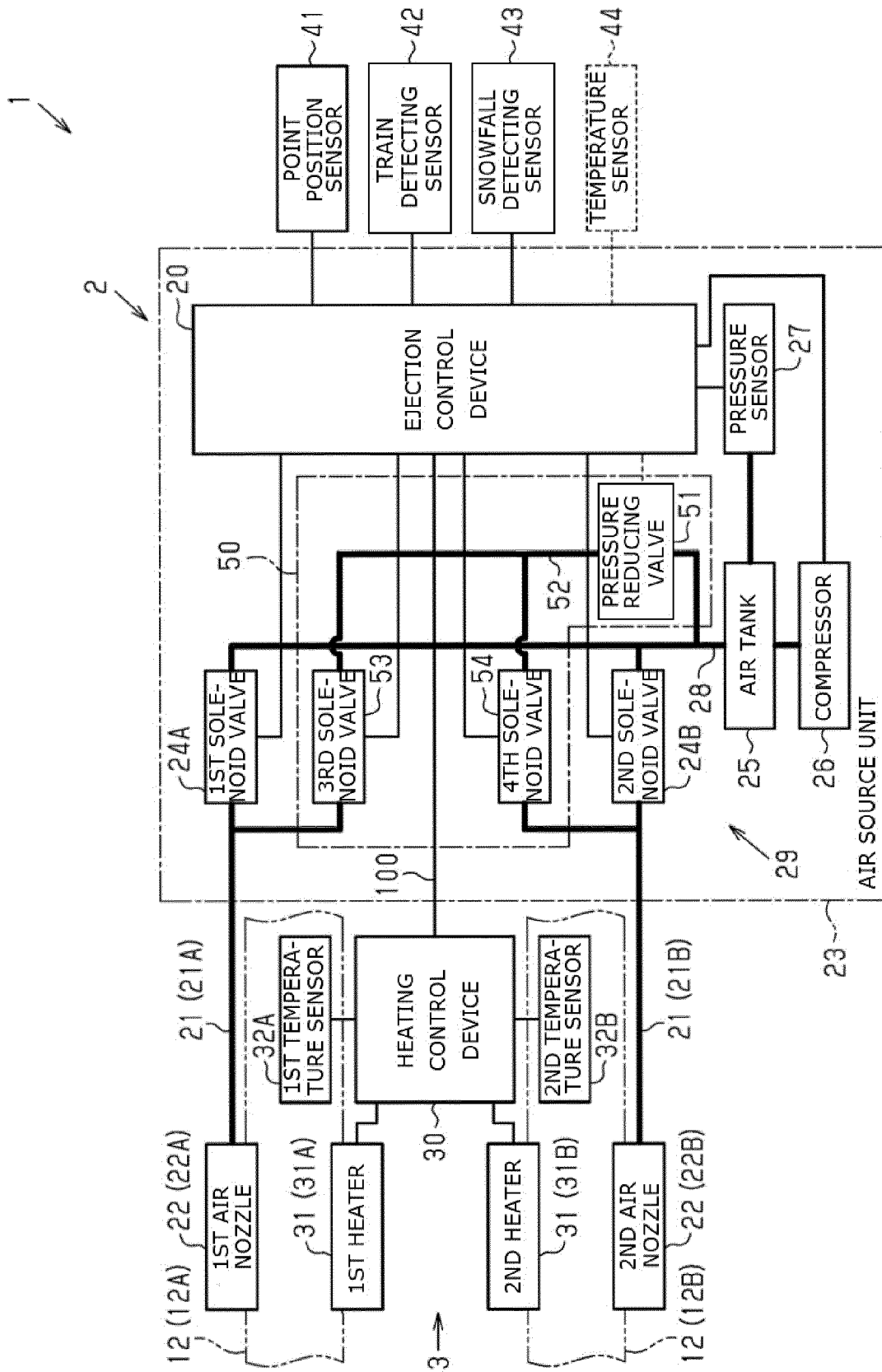


FIG. 1

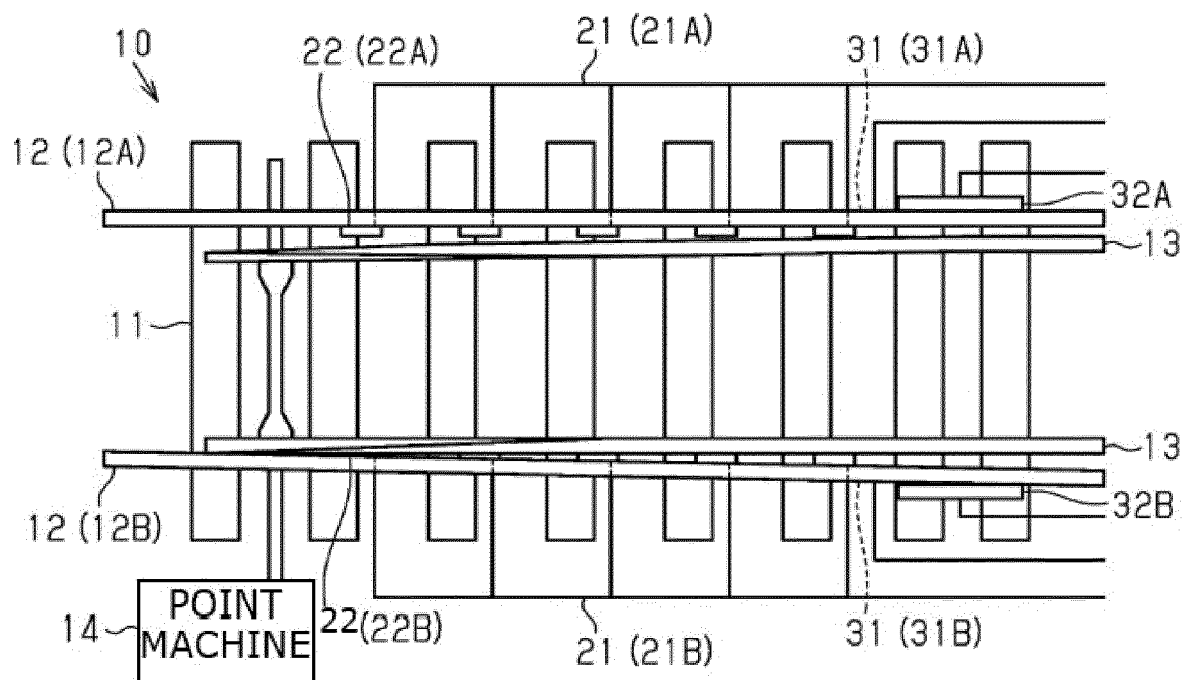


FIG. 2

	FOLLOW-UP/ RETRY EJECTION	PREVENTIVE EJECTION	INTERMITTENT EJECTION	MANUAL EJECTION
HIGH PRESSURE	ON	OFF	OFF	ON
LOW PRESSURE	OFF	ON	ON	OFF

FIG. 3

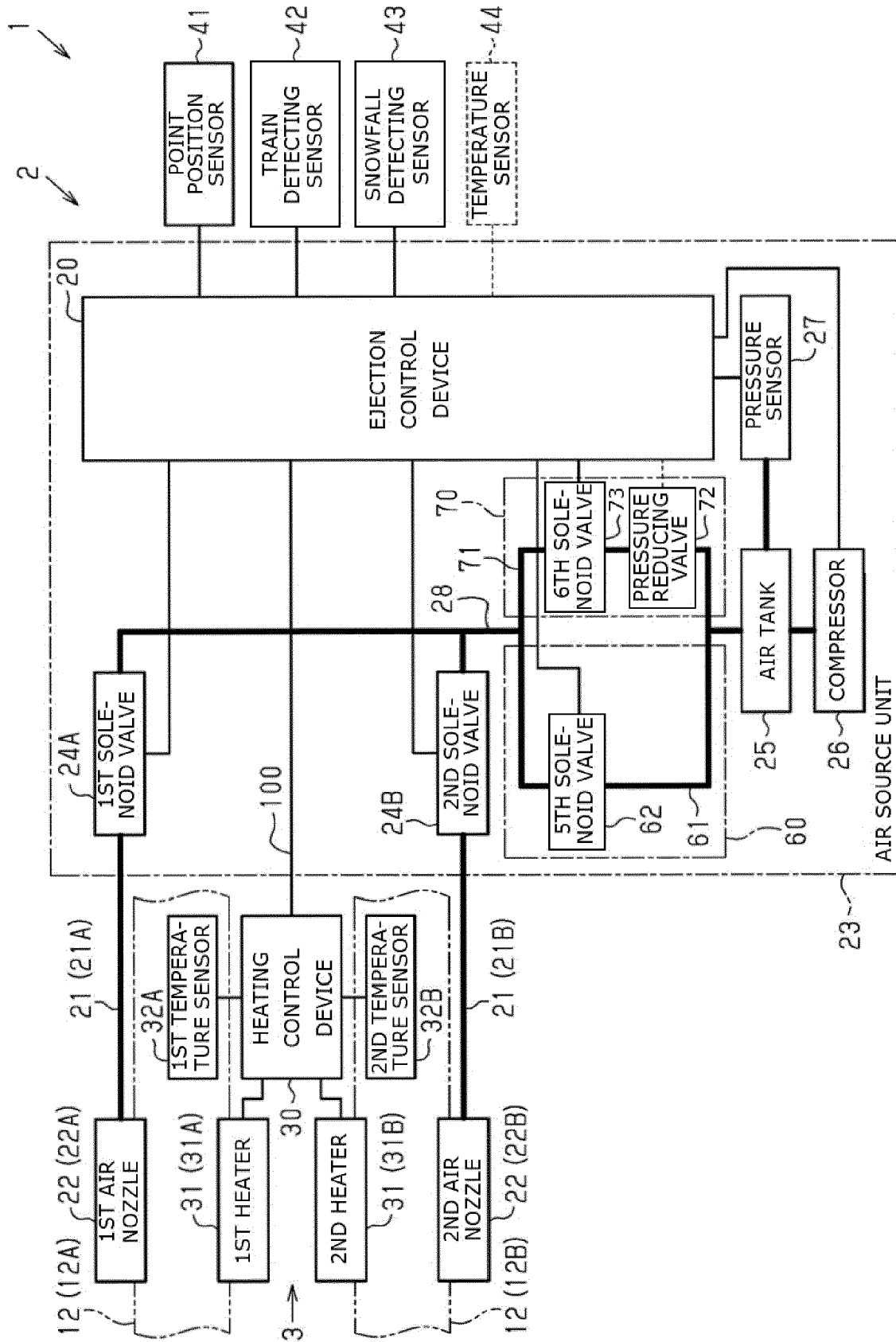


FIG. 4

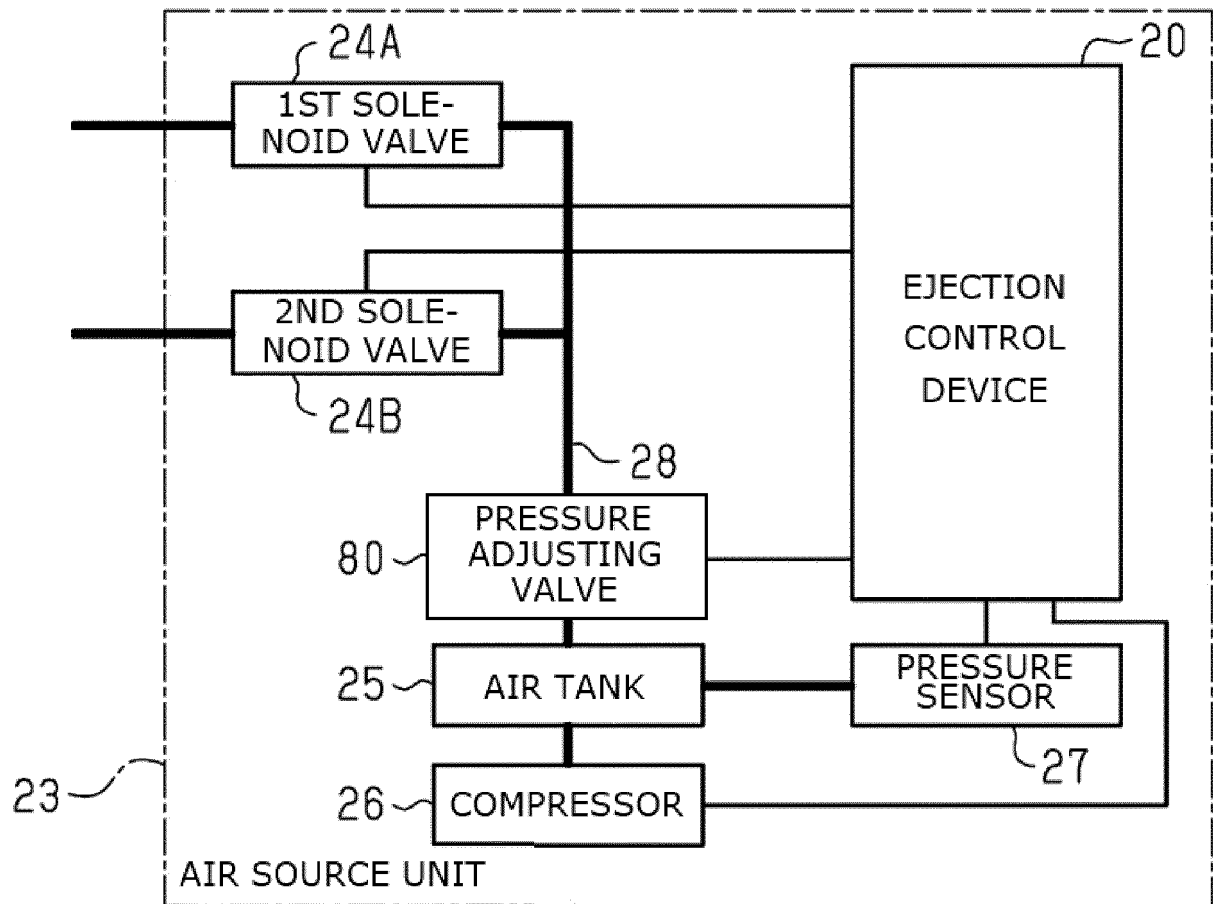


FIG. 5

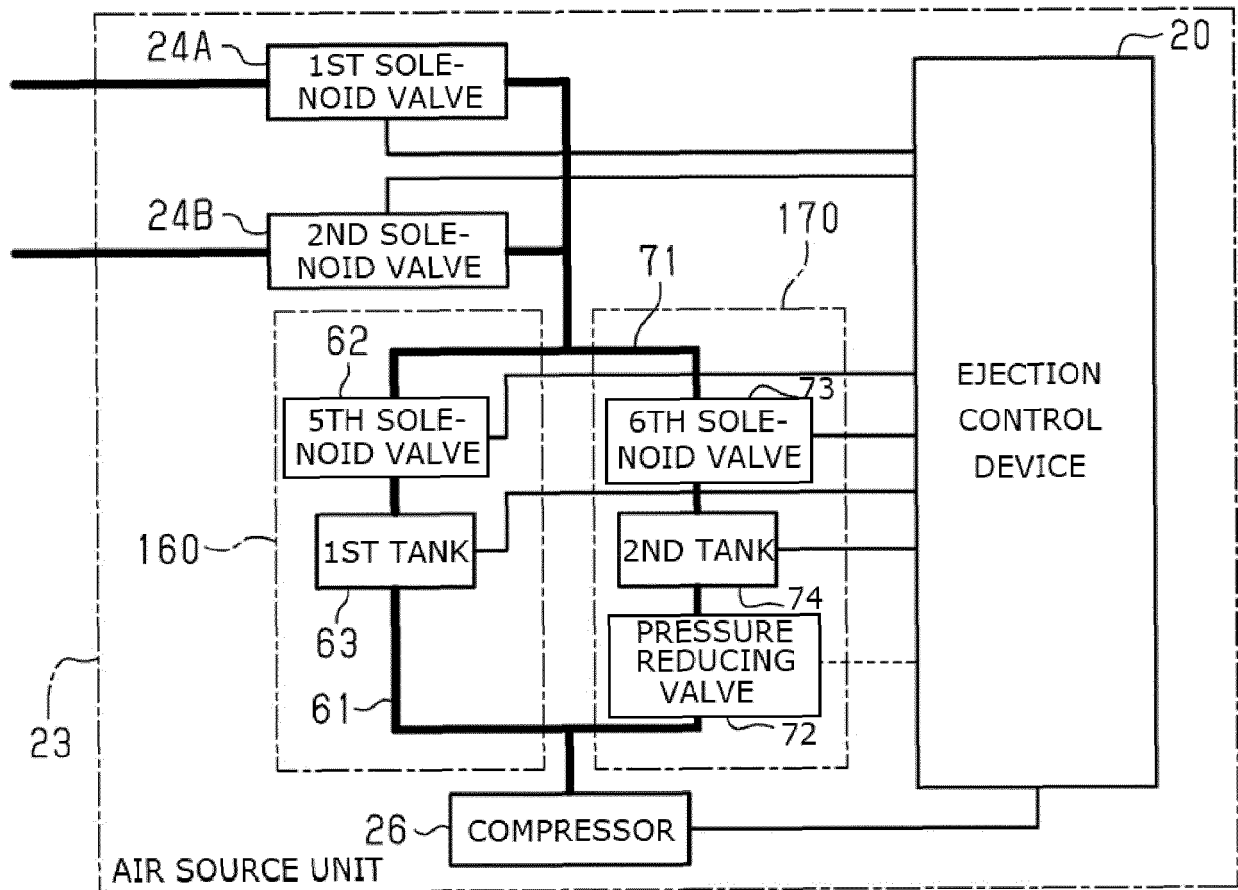


FIG. 6



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