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(54) Railroad hopper doors and positioning system

(57) A three door ballast gate is provided for selective discharge and distribution of ballast from a railroad hopper car (20) to positions to the left, to the right or between the rails (28). The doors (42) are aligned longitudinally in the ballast gate and are pivotably connected to the end plates (54) of the ballast gate. Hydraulic drive cylinders (60) are mounted on the end plates to move the door between an open and a closed position. The ballast gate includes two side openings (52) with extended outer discharge ramps (48) on each side to ensure that the ballast is discharged outside of the rails. A remote control positioning system is provided to control the opening and closing of the hopper gate doors.

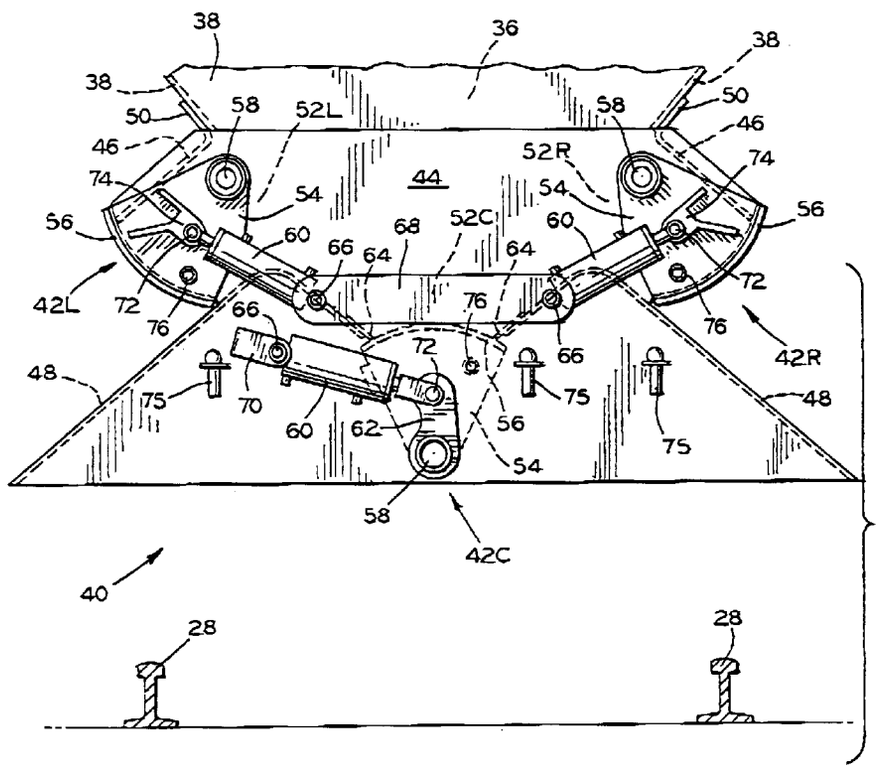

FIG. 2

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Description

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to a railroad car hopper door system, and more particularly, to ballast gates with hopper doors for mounting along the centerline of a railroad hopper car. Each hopper door in the ballast gates is provided with a drive system for opening and closing the hopper door. A remote control system is provided to selectively control the ballast discharge to the left, center or right of the rails.

In the preferred embodiment, the present invention utilizes the pneumatic power supply furnished by the locomotive to the railroad hopper cars. The pneumatic power is converted to hydraulic power to drive the hopper doors when opening and closing the doors to selectively discharge ballast material. However, other power sources and drive systems may be mounted on the hopper cars to provide power to open and close the hopper doors.

The remote control transmitter and receiver included as part of the system provide an accurate and economical means for achieving remote operating capabilities. Radio frequency, infrared, or other similar remote control systems may also be used to control the hopper doors.

The principal application for the present system is the remote control operation of ballast door mechanisms on railroad hopper cars, which facilitates selective discharge of stone ballast from the railroad hopper cars onto the road bed of a railway. The railroad hopper doors and control system of the present invention may also be used in railroad hopper cars with bottom discharge for other bulk material. In addition, the hopper door and control system may be used in similar bulk material handling applications.

DESCRIPTION OF THE PRIOR ART

The need for reballasting of railway road beds results from the loading and unloading of sections of track caused by the passage of wheels of railroad cars traveling on the track. The resultant flexing action of the track tends to force the ballast stone out from under the associated ties. The phenomenon is especially pronounced at the end of the ties, with the result that more ballast is pushed out from under the ties outside the rails than inside the rails. For safe railroad operation, it is necessary to replace the lost ballast. In the early days of the railroad, lost ballast was replenished manually.

When manual reballasting of the road bed was no longer economically feasible, specialized railway cars were developed. These specialized railway cars were provided with hopper doors capable of directing the flow of ballast to the various sections of road bed, including the area between the parallel spaced apart rails, and the area outside the rails. The first of these discharge arrangements were operated manually, such as disclosed in the U.S. Letters Patent No. 4,452,149 to LeMarbe, and U.S. Letters Patent No. 4,454,822 to Fischer. While these ballast cars satisfactorily directed the flow of ballast to the various sections of the road bed, the operator was required to walk along side the car as the ballast car moved along the rails. Safety problems arose because of the operator's close proximity, not only to the moving railway car, but to the heavy stone as it was discharged onto the road bed.

These safety problems led to the hydraulic operation of railway ballast cars. The car operator could operate a hydraulic actuated lever some distance away from the discharge area of the ballast gates, and thereby eliminate many of the aforementioned safety problems. An example of such hydraulically operated ballast gates is illustrated in U.S. Letters Patent No. 5,163,372 to Galvan et al.

An improved hydraulically operated railway ballast car is disclosed in commonly assigned U.S. Patent No. 5,261,333. The patent discloses the use of an air-operated hydraulic pump, which utilizes the available pneumatic power supply furnished by the locomotive to the hopper car, to power hydraulic cylinders to operate the ballast gate doors.

In the typical U.S. ballast railroad car, four hopper door gate assemblies are positioned such that two assemblies are positioned directly over the first rail and two assemblies are positioned over the second rail as shown in U.S Patent No. 5,261,333. Each assembly is provided with two doors to selectively distribute ballast inside the rail or outside the rail.

An alternative hopper door assembly is shown in commonly assigned U.S. Patent No. s,402,371. Door guides are provided in the ballast gate assemblies and a hydraulic system is used to move the doors.

A remote control feature is desired in many drive system applications where no source of electrical power is readily available. A railway freight car has a source of compressed air available, i.e. the locomotive air supply, but no source of electrical power. Commonly assigned U.S. Patent No. 5,359,942 describes a remote control positioning system for a typical U.S. ballast hopper car application. The system includes radio frequency remote operation with means for converting the pneumatic power supply, which is supplied to the hopper car by the locomotive, to electrical power for control operations and to hydraulic power for ballast gate door positioning operations.

In Europe and other countries outside of the United States, the railroad hopper cars used for distributing ballast are provided with four ballast gates aligned in a row along the centerline of the car. The ballast gates each have a single door which is opened to distribute ballast along the center of the rails. Significant manual labor is still required to distribute the ballast along the outside

of the rail.

At this time, there is a need for a ballast gate system with hopper door compatible with the European style hopper car. Such system could be used to replace existing ballast gate systems in hopper cars as well as original equipment gates on new hopper cars. With a center line discharge design for the hopper cars, the ballast gates must be able to selectively distribute ballast on the left side, center, or right side of the tracks. A remote control system is required to permit the safe operation of the hopper doors on the ballast gates from a remote position.

SUMMARY OF THE INVENTION

A three door ballast gate is provided for discharge and distribution of the ballast from the hopper car to positions to the left, to the right or between the rails. The doors are aligned longitudinally in the ballast gate and are pivotably connected to the end plates of the ballast gate. Hydraulic drive cylinders are mounted on the end plates to move the door between an open and a closed position.

The ballast gate includes two side openings with extended outer discharge ramps on each side to ensure that the ballast is discharged outside of the rails. Two short center ramps are provided in the center opening for directing ballast between the rails.

An engine of a train typically provides a source of pneumatic power which is conveniently transferred to the other cars in the train. Electrical power may also be generated by a an engine generator. Electrical power is needed for the operation of the remote control system since electrical control circuits for controlling the position of the doors are preferred over both pneumatic and hydraulic controls. From a drive motor standpoint, hydraulic drives are the preferred drive for achieving the desired output performance to position the doors.

A remote control positioning system having a pneumatic power supply as the primary source of power is provided for operation of hopper gate doors on a hopper car. Within the positioning system, air motors are used to drive an alternator for charging a DC power supply and to drive a pump for producing hydraulic power. If an electrical generator is used for power, electrical motors can be used to supply power.

For the electrical system, a twelve volt battery is connected in parallel to an alternator. An air motor or an electric motor drives the alternator to continuously charge the battery. The battery provides a constant, low voltage power supply which is required by the receiver and electrical control circuits of the present invention. As signals are received from the remote transmitter, the receiver and control circuits of the present invention decode the signal and generate control voltage signals for operation of the control valves to the hydraulic cylinders.

For the hydraulic system, a pneumatic or electric motor connected to the pneumatic power source drives a hydraulic pump. The hydraulic pump circulates fluid to a manifold, and the flow of the fluid to and from the hydraulic cylinders is controlled by operation of the solenoid control valves in the manifold.

The hydraulic cylinders are coupled to the gates/doors of the hopper, and the movement of the hydraulic cylinder opens and closes the doors. Electrical signals from the control circuits are received at the control valves to direct the positioning of the hydraulic cylinders and the resultant positioning of the hopper doors.

The operator station for remote operation includes a battery powered transmitter and control switches to control the opening and closing of the gates/doors. The controller for each of the railway cars may be given a unique digital code (three digit) such that the specific railway car for operation may be selected by the operator using the operator station. Multiple cars may be controlled using a single operator station. The control switches permit the operator to selectively open and close the hopper gate doors on the railway hopper/ballast car.

An object of the present invention is to provide a ballast gate for mounting longitudinally along the centerline of a hopper car to distribute ballast left, right, and center of the rails. A three door system with independent control of each of the doors is used.

An additional object of the present invention to provide a remote control system for applications utilizing the pneumatic power or the electric power which can be generated on the train without connection to a stationary power source.

A further object of the present invention is to provide a control system which converts the pneumatic power into electrical power for control and radio frequency receiver use, and which also converts the pneumatic power to hydraulic power for drive cylinder use.

Another object of the present invention is to provide an improved radio frequency control system which permits the operator to control hopper doors of a railway ballast car from a remote location and to selectively operate hopper doors on multiple railway cars.

Further objects and advantages of this invention will be apparent from the following description and appended claims, reference being made to the accompanying drawings forming a part of the specification, wherein like reference characters designate corresponding parts in the several views.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a diagrammatic side elevational view showing a railroad hopper car embodying the construction of the present invention.

Figure 2 is an end view of one of the three door ballast gates shown in Figure 1.

Figure 3 is a diagrammatic view of a system embodying the present invention which includes four ballast gates with power systems for controlling the twelve

doors on the four ballast gates.

Figure 4 is an elevational view of a transmitter which may be used to operate the remote control receiver and controller shown in Figure 3.

Figure 5 is a schematic view of the control system shown in Figure 3.

It is to be understood that the present invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments, and of being practiced or carried out in various ways within the scope of the claims. Also, it is to be understood that the phraseology and terminology employed herein is for the purpose of description, and not of limitation.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The description of the preferred embodiment of the present invention shows a three door ballast gate with remote control positioning system embodying the present invention described in detail for use with railway hopper/ballast cars transporting and depositing road bed ballast. From the description, it will be easily understood that the present invention can be used for other types of railway cars, trailers and vehicles, hopper gate/door applications or any other advantageous applications for controlled discharge of a bulk substance.

Referring to Figure 1, there is shown a conventional hopper/ballast car 20 having a body 22 which is carried on a plurality of spaced apart trucks 24. Wheels 26 of the trucks 24, in turn, are positioned on a pair of rails 28.

The car body 22 is defined by spaced sidewalls 30 which join end walls 32. The bottom of the car body 22 includes a platform 34 for mounting the car body 22 on the trucks 24. The end walls 32 and sidewalls 30 define the load-carrying space in the car body 22. The internal walls of the car body 22 are sloped downwardly so as to direct the ballast material to the generally rectangular-shaped discharge opening 36 formed by discharge walls 38 at the bottom of the car body, as shown in Figures 1 and 2. It should be understood that each car 20 includes four discharge openings 36, and each discharge opening 36 includes a ballast gate 40 with doors 42L, 42C, and 42R. The discharge openings 36 and attached ballast gates 40 are aligned down the longitudinal center line of the car 20 such that the aperture for each of the discharge openings 36 is generally positioned between the two rails 28 of the car 20.

The ballast gate 40, as shown in Fig. 2, is formed by two end plates 44, two top side plates 46, and two bottom discharge plates 48. The top side plates 46 extend longitudinally between the top corners of the end plates 44. The top side plates 46 have a flange 50 which is welded to the discharge walls 38 to help secure the ballast gate 40 to the discharge walls 38.

The two bottom discharge plates 48 extend longitudinally between the bottom portion of the end plates 44. Each bottom discharge plate 48 is positioned in parallel, spaced-apart relationship with a corresponding top side plate 46 to form side apertures 52L, 52R for discharging ballast on the outside of rails 28. The bottom discharge plates 48 have a curved configuration and are spaced-apart from each other to form bottom aperture 52C.

The doors 42L, 42R, 42C have the same general construction with door end plates 54 and curved plates 56. The narrow end of the door end plates 54 is pivotably connected to the end plate 44 at pivot point 58. The wide end of the door end plates 54 is used to secure the curved plates 56.

The two side doors 42L, 42R have the door end plates 54 mounted on the outside of the end plates 44. The doors 42L, 42R are pivoted such that the curved plates 56 barely clear the outer edges of the end plates 44 and the top side plates 46. The curved plates 56 are made of plate steel or other heavy material such the gravitational force and hydraulic force are sufficient to close the curved plates of doors 42L, 42R against the bottom discharge plate 48.

The center door 42C, in order to pivot open and close, is mounted on the inside of the end plates 44. The hydraulic cylinder 60 is connected to and drives an external cam 62 which correspondingly rotates the center door 42C. After the door 42C is mounted on the ballast gate 40, the gaskets 64 are mounted on the edge of the bottom discharge plates 48 to ensure the proper seal about curved plate 56 of the center door 42C.

The hydraulic cylinders 60 used to rotate the doors 42L, 42R, 42C have a fixed end 66 rotatably connected to the end plate 44 by brackets 68, 70. The piston rod 72 of the hydraulic cylinders 60 for the two side doors 42L, 42R are rotatably connected at bracket 74 to the door end plate 54 of a corresponding door such that the doors 42L, 42R can be selectively opened and closed to control the discharge of ballast. The extension and retraction of a piston rod 72 causes the corresponding door end plate 54 and curved plate 56 to rotate about pivot point 58.

Each ballast gate 40 is provided with locking pins 75 which may be inserted into aligned holes 76 in the end plate 44 and door end plate 54 to selectively lock the doors 42L, 42R, 42C in a known manner. The doors can be locked in the closed position to prevent an unintentional discharge of ballast from occurring. Door safety stops adapted to limit the swing or pivoting of the doors 42L, 42R, 42C are affixed to the end wall 44.

The hydraulic cylinders 60, shown schematically in Fig. 5, are double-acting hydraulic motors of a type well known in the art shaving an inner port 78, an outer port 80, a piston 82 slidingly received in a cylinder 84, and a piston rod 72 suitably attached at one end to the piston 82. The other end of the piston rod 72 extends out of the outer end of the cylinder 84 and is secured to a mounting bracket 74 welded to the door end plate 54.

As noted above, each hopper car 20 has four ballast gates 40, with each ballast gate having three doors, a

left door 42L, a right door 42R, and a center door 42C. The four center doors 42C are opened to direct ballast material between the rails 28. The left and right side doors 42L, 42R are opened to direct ballast material to the outside of the corresponding rail 28. When distributing ballast material from the hopper car 20 to the tracks 28, the operator can selectively distribute ballast material to either side of the pair of rails 28 or between the rails 28 by opening the desired doors 42L, 42R, 42C on the ballast gates 40.

The preferred method for positioning the doors 42 is a hydraulic system. However, electrical drive systems and pneumatic drive systems could also be used to open and close the doors 42 of the four ballast gates 40. Control systems and drive cylinders 60 or other motors are attached to the doors 42 on each of the hopper cars. The controls can be operated locally at a control station on each of the cars 20. The preferred system for controlling the ballast discharge is a remote control system 86 as shown in Figs. 3-5.

The remote control system described herein is a radio frequency system with a pneumatic power source and hydraulic drives. However, infrared or other remote systems could be used to generate control signals in a similar manner. Instead of pneumatic power, electric power may be generated on a train and transmitted to the ballast cars for operating the ballast gates 40.

The components of the control system 86 may be mounted on the platform 88 at either end of the hopper car 20. Pneumatic, electric, and hydraulic power may be transferred from car to car on the train in a conventional manner.

The major components of a remote control system 86 are illustrated with a radio frequency remote operation and a pneumatic power supply. The pneumatic power supply 88 readily available on the hopper car 20 is converted to electrical power by the air motor 90 and alternator 92 to charge battery 94, which supplies power to controller-receiver 96. Pneumatic power is also delivered to the hydraulic pump 98, which converts the pneumatic power to hydraulic power to drive the hydraulic cylinders 60 used to position the doors 42L, 42C, 42R.

The preferred embodiment of the positioning system 86 of the present invention is a twelve cylinder system using remote radio frequency control or other similar remote control system to independently operate the three door cylinders 60 on each of the ballast gates. For operational control purposes, the four ballast gates 40 have been numbered 1-4 and each of the three doors have been designated left "L", right "R", and center"C".

The door positioning system 86 of the present invention is powered by a pneumatic power supply 88, which in the railroad hopper car application is a locomotive compressed air supply. Pneumatic power systems for trains, which supply and distribute compressed air from the locomotive to the other cars in the train, are known in the industry.

Referring to Figures 3 and 5, the pneumatic power conduit 100 is connected to the pneumatic power supply 88 which extends from the locomotive in series to other cars in the train. Interposed in the pneumatic power conduit 100 is a normally open valve 102, which controls the entry of the compressed air into the positioning system 86. Valve 102 is maintained in the open position unless the operator desires to manually close the switch to disconnect the pneumatic power, such as to service the system 86.

The filter-regulator-lubricator 104 in conduit 100 removes moisture and contaminants from the air, maintains the minimum pressure required in the system, and adds oil to lubricate the air operated components.

Compressed air is then delivered through the conduit 106 to the air hydraulic pump 98 and through the conduit 108 to the air motor 90 for alternator 92. For the hydraulic system, the regulated compressed air operates the hydraulic pump 98 to pump hydraulic fluid through conduit 110 to the solenoid hydraulic valve manifold 112. The manifold 112 includes a solenoid valve 114 for each door 42 to control the flow of hydraulic fluid to and from the hydraulic cylinders 60.

The hydraulic pump 98 is provided with an integral air motor and pump. The hydraulic system typically includes a hydraulic reservoir 116 and hydraulic manifold 112. The hydraulic reservoir 116 stores the hydraulic fluid when the pump 98 is not in operation. Hydraulic pressure is supplied from the hydraulic pump 98 through the conduit 110 and the solenoid valves 90 in manifold 112 to cylinders 60. The hydraulic cylinders 60 are connected to doors 42 of the ballast gates 40.

The hydraulic system includes pilot check valves 118 connected in series between the solenoid valves 90 and the cylinders 60. The check valve 118 is a differential pilot open check valve. When a pressure difference exists between port 78 and port 80, the valve is open. When the pressure is equal at both ports, the valve 118 is closed.

When the hydraulic pump 98 loses power and the pressure drops in power conduit 110, such as when the pneumatic power supply is disconnected, the pilot check valve 118 will be opened to permit hydraulic fluid to leave port 80, which retracts the piston rod 72 and closes the door 42L, 42R, 42C. When the solenoid valve 114 is in the center position 120, the pressure is equal and check valve 118 is closed, which retains piston rod 72 of the cylinder 60, and doors 42 in the designated position.

The solenoid valve 114 is a spring centered, three position, four port valve. The center position 120 is a closed position, during which there is no hydraulic powered movement of the piston 82 or piston rod 72 in the cylinder 60. The conduit 110 is the power line delivering hydraulic power through the valve 114 to the cylinder 60. The center position 120 does have an open return line 122 which is connected to both port 78 and port 80. This equalizes the pressure at both ports 78, 80 when the valve 114 is in the center position 120 and permits any open doors 42L, 42C, 42R to return to the closed

position if the hydraulic system loses power for any reason.

When the coil 124 of solenoid valve 114 is actuated to the right, the valve 114 shifts to the left or door opening position 126. In position 126, valve 114 causes hydraulic fluid to flow into port 80 and out of port 78 to move the piston 82 and extend the piston rod 72 until the coil 124 is de-actuated, at which time the spring return 130 causes valve 114 to return to the middle position 120.

When the coil 124 of solenoid valve 114 is actuated to the left, the valve 114 shifts to the right or door closing position 132. In position 132, valve 114 causes hydraulic fluid to flow into port 78 and out of port 80 to move the piston 82 in the opposite direction and retract the piston rod 72, which closes the door 42. A return line 122 returns the hydraulic fluid to a filter reservoir 116 which is connected to the air-operated hydraulic pump 98.

For the electrical power system and controller 96, conduit 108 is connected to an air motor 90 which drives an alternator 92. The air motor 90 is typically rated 1 horsepower or less with a 0.50 horsepower motor providing sufficient power in most cases. The air motor 90 may utilize a belt drive system or a direct coupling arrangement (not shown) to drive the alternator 92.

Radio frequency controllers for remote operation require an electrical power supply, and will operate on either an alternating current (AC) or direct current (DC) system. Because of the remote location of the hopper cars and the unavailability of a conventional AC power supply, the battery powered DC power supply is the preferred power source. A 12 volt DC system, similar to an automobile system, is utilized in the present invention. A standard 12 volt DC battery 94 provides an electrical source of power. Commercial generators and regulators are one means of providing power to charge the battery 94. It was discovered that an automobile type alternator 92 was a more space efficient and cost effective means of providing power to charge the battery 94.

The alternator 92 is connected in parallel to battery 94. The alternator 92 charges the battery 94 until limited by the regulator (not shown) in the alternator 92 to prevent overload. The battery 94 provides the 12 volt DC power supply needed for operation of the controller 96 and for transmittal of the various control signals.

The battery 94 is connected to controller 96 in series with a pressure switch 134. The controller 96 includes a receiver, decoder, timer and programmable control circuitry for receiving radio frequency signals, for decoding the radio frequency signals, for receiving other input signals (such as the pressure switch), and for transmitting control signals to control the operation of both the electrical system and the hydraulic drive system. The controller 96 will be described in more detail hereinafter. In addition, a signal means other than radio frequency can be used to for remote signalling purposes.

The pressure switch 134 is interposed in the air supply conduit 108 to monitor the supply of compressed air being supplied to the electrical and hydraulic systems in the overall positioning system 86. When the desired compressed air supply is present, the pressure switch is closed electrically to connect the battery 94 and alternator 92 to the controller 96. When the compressed air supply is not present, the pressure switch 134 disconnects the controller 96 from the battery 94 and alternator 92. This prevents the undesirable drain on the battery and limits operation to when the alternator 92 is operable to charge the battery 94.

Once the pressure switch 134 is closed to connect the battery 94 to the controller 96, the controller 96 is maintained in a stand by mode until a radio frequency signal is received for operational purposes. In the standby mode, a very low current drain occurs until a signal is received from the operator station 136, which is used for remote operation. The battery 94 is able to supply the necessary stand by power for an extended period of time without draining the battery 94.

Interposed between the pressure switch 134 and the alternator 92 is a solenoid actuated air valve 138 which is controlled by the controller 96. When a radio frequency signal is received from the operator station 136, the controller 96 transmits a signal to the solenoid air valve 138 to open the valve and permit the transmission of compressed air to operate the air motor 90 and alternator 92, which charges the battery 94.

The operation of the air motor 90 and alternator 92 continues until the controller 96 transmits a signal to the air valve 138 to open the valve. The controller 96 includes a timing circuit to determine the period of time for which the air valve 138 is opened to operate the air motor 90 and alternator 92. Once the time period specified for operation has been completed, the air valve 138 closes and the controller 96 returns to the standby mode until the next radio frequency signal is received to operate the hydraulic cylinders 60. Every signal received by the controller 96 re-initializes the timing circuit and continues to operate the alternator 92 to charge the battery 94. The timing circuit reduces the operational wear on the air motor 90 and alternator 92, and reduces the overall pneumatic power consumption of the positioning system 86.

The controller 96 shown in Fig 5 consists of a radio receiver and decoder, plus various control circuits and timing circuits for receiving input signals and decoded radio frequency transmissions and for transmitting signals to the hydraulic valves 114 which control the operation of the hydraulic cylinders 60. The control circuits may include a programmable controller to permit the operator to input performance variables for controller 96 operation, such as the timing or sequence of operation and an access-identification code for each individual hopper car 20.

The radio receiver and decoder in the controller 96 is a standard model, such as Cattron model. Infrared and other remote transmitters and receivers could be used in place of radio frequency. When the pressure switch 134 is open, the electrical power is disconnected

and the controller 96 is not operable. When switch 134 is closed, power is supplied to the controller 96 and the controller 96 remains in a stand by mode until a operational signal is received from the operator station 136.

The controller 96 includes an antenna 140 for receiving the radio frequency signals. When the remote radio frequency transmitter in the operator station 136 transmits a signal to the controller 96 through the antenna 140, or when a signal is received from the local push button control station 142, the controller 96 is changed into an operational mode. Control signals are transmitted from the controller 96 over output terminals SAV to open the solenoid air valve 138 to charge the battery 94, as discussed above, which ensures the availability that the necessary 12 volt DC power is available for operational purposes. The operator station 136 then transmits additional signals to instruct the controller 96 as to which cylinder 60 is to be actuated and in which direction the specified cylinder 60 is to be actuated. The controller 96 processes the signals received from the transmitter in operator staticn 136 and transmits control signals over the appropriate output terminals (S1-S12, one pair for each hydraulic cylinder) to the solenoid valve 114 of the specified cylinder 60.

The operator station 136 is a battery powered unit and includes a standard radio frequency transmitter, such as the Cattron Model 824E-01. The operator station 136 also includes various battery powered control switches for generating signals to be transmitted by the transmitter to the receiver in controller 96. Fig. 4 shows three position, center-throw toggle switches 144 for operating the twelve gates, but other similar control switches would be acceptable for operation of the system.

To prepare the positioning system 86 for operation, the car 20 must be connected to the pneumatic power source 88. The pressure switch 134 is closed, which facilitates the connection of the battery 94 to the controller 96. The controller 96 is in the stand by mode. The compressed air operates the air motor-hydraulic pump 98 to build up the necessary pressure in the hydraulic system.

If multiple hopper cars 20 are used, then an identification number must be set or programmed in the controller 96 for each of the cars 20 to be operated by the remote operator station 136. Each controller 96 includes an access circuit having an access identification number which may be set manually or programmed into the circuit. The identification number, which is a digital code, must be received and processed by the controller 96 before any further positioning operations will occur.

When one or more cars 20 are in position on the tracks 28 for depositing ballast from car 20 through doors 42, the operator will use the operator station 136 to send a signal from a remote location to the controller 96 on the desired car 20. First, the operator station 136 must be activated using the on/off switch 146 to connect the battery (not shown) in station 136 to the transmitter and the control switches. The operator station 136 is then manually programmed to match the proper digital code to signal the desired car 20. The first selector switch 148 is rotated to set the first digit of the code, the second selector switch 150 is rotated to set the second digit of the code, and the third selector switch 152 is rotated to set the third digit. In this example, the code "093" is shown as being selected.

The next step requires the selection of one of the twelve doors on the four gate assemblies for operation. The operator station 136 is provided with twelve switches 144. For convenience, the four gates 40 of the hopper car 20 have been designated gate 1, gate 2, gate 3, and gate 4 and the three doors on such gates as 1L, 1C, 1R, 2L etc. To operate door 1L on gate 1, the toggle switch 144 designated for gate 1L is moved to the open position. A signal is generated and transmitted from the operator station 136 to the receiver in controller 96. Since the radio receiver/decoder 96 is now receiving its first signal, the controller 96 is placed in an operational mode. A signal is sent from the output terminals designated "SAV" to open the solenoid air valve 138 for the timed operation of the air motor 90 and alternator 92 to charge the battery 94.

A control signal is transmitted from the appropriate output terminals (S1 for door 1L, S2 for door 1C, S3 for door 1R etc.) to the coil 124 of solenoid valve 114 to control operation of the solenoid 114 at the specified door. Each of the twelve hydraulic cylinder 60 has a corresponding solenoid operated valve 114 to individually control the operation of the cylinders 60. Identical valves 114 are used in the illustrated embodiment. However, it is noted that twelve separate sets of lines are shown leaving the controller 96 with only one pair of leads going to any one solenoid valve 114. The control signal will actuate the coil 124 of solenoid valve 114 of the appropriate cylinder 60 to solenoid position 126 to allow hydraulic fluid to enter outer port 80 and move the piston 82 and its associated piston rod 72 and cause the desired door 42 to open. Since the solenoid valve 114 is a spring return, the switch 144 must be held to the "open" position until the door 42 reaches the desired open position. When the door 42 reaches the desired position or the door 42 is in the fully opened position (hitting the door safety stops), the switch 144 is returned to its middle or neutral position and the solenoid valve 114, with springs 130, returns to the middle position 120.

When it is desired to close the door 42, the switch 144 is moved to the "close" position which causes a signal to be transmitted from the operator station 136 through the controller 96 to the coil 124 of solenoid valve 114, which shifts the valve 114 to the position 132. Hydraulic fluid enters port 78, actuating the piston 82 and piston rod 72 to move the door 42 to the closed position.

It can easily be understood that the rest of the hydraulic cylinders or motors 60 operate in an identical fashion. The use of three position valves 114 insures that the doors cannot be moved accidentally when the switch 144 is in its neutral position. The check valves 118 insure that the door 42 stays in the desired position

until further signals are received or until the door 42 closes due to loss of hydraulic power.

The operator station 136 may use a variety of switch arrangements. For example, the operator station 136 may control twelve cylinders by utilizing a four position selector switch to select one of the four gates 40, a three position selector switch to select left side door 42L, center door 42C, or right side door 42R of the gate 40, and a single center throw switch 144 to open and close the selected door.

In addition to remote operation, a local push button control station 142 electrically connected to the controller 96 and mounted on the car 20 could also be included to control the operation of the doors 42 to gate 40. The station 142 uses a similar switching system to selectively operate the cylinders 60 to position the doors 42.

In accordance with the provisions of the patent statutes, the present invention has been described in what is considered to represent its preferred embodiment. However, it should be noted that the invention can be practiced otherwise than as specifically illustrated and described.

Claims

1. A hopper gate for mounting on a hopper outlet of a railway car (20) having a hopper body (22), said hopper gate (40) comprising:

   a) a frame member (30, 32) having end walls (32) and side walls (30) forming an inlet portion and an outlet portion (36), said frame member connected to a hopper body such that the inlet portion is aligned with the hopper outlet;
   b) a first discharge plate (48) and a second discharge plate (48) secured to said frame member in spaced-apart relationship at the outlet portion to form a first side outlet between a first side wall and the first discharge plate, a center outlet between the first and second discharge plate, and a second side outlet between a second side wall and the second discharge plate;
   c) a set of three doors (42) pivotally mounted on the end walls of said frame member to selectively open and close the first side outlet, the center outlet, and the second side outlet;
   d) a drive system (60-84) connected to the doors for selectively driving said doors between an open and close position; and
   e) a control system (86) connected to said drive system for controlling the drive system and the positioning of said doors.

2. The hopper gate defined in claim 1, wherein said discharge plates (48) are generally inverted L-shaped plates positioned such that, when the railway car (20) loaded with ballast is mounted on rails (28), the first and second outlets are formed to discharge ballast outside the rails, and the center outlet is formed to discharge ballast between the rails.

3. The hopper gate defined in claim 1, wherein said doors (42) are formed by an arcuate plate (56) mounted between two door end plates (54), the end plates being pivotably connected to the end walls (44) of said frame member.

4. The hopper gate defined in claim 3, wherein said drive system includes a hydraulic drive (60-84) pivotably connected to each of the doors (42), said hydraulic drive having a first end (66) pivotably connected to the end walls (44) of said frame member and a second (72) end pivotably connected to one of the door end plates (54).

5. The hopper gate defined in claim 1, wherein said control system includes a remote control system (86).

6. The hopper gate defined in claim 1, including a locking means for locking the doors in a closed position.

7. A plurality of remote control hopper gates for mounting on corresponding hopper outlets of a railway car (20) having a hopper body, said remote control hopper gates comprising:

   a) a frame member (30, 32) for each hopper gate having end walls (32) and side walls (30) forming an inlet portion and an outlet portion, said frame member connected to a hopper body (22) such that the inlet portion is aligned with a hopper outlet;
   b) a first discharge plate (48) and a second discharge plate (48) secured to said frame member in each hopper gate, said discharge plates positioned in spaced-apart relationship at the outlet portion to form a first side outlet between a first side wall and the first discharge plate, a center outlet between the first and second discharge plate, and a second side outlet between a second side wall and the second discharge plate;
   c) a set of three doors (42) pivotally mounted on the end walls of said frame member for each hopper gate to selectively open and close the first side outlet, the center outlet, and the second side outlet;
   d) a power supply (60-84) connected to the hopper body of the railway car;
   e) a drive system (86) connected to said power supply, said drive system including a motor means coupled to each door of the hopper gates for selectively effecting the motion of the door between an open and a closed position,

whereby the actuation of the motor means determines the position of the door;
f) a controller (96) connected to said power supply and in electrical communication with said drive system, said controller including a receiver for receiving remote signals, and a processor for processing the remote signals and transmitting control signals to said drive system to control the movement of the motor means; and
g) a remote operator station, said operator station including a transmitter and control switches for transmitting remote signals from said operator station to the receiver in said controller, whereby the positioning of the doors is controlled by said remote operator station.

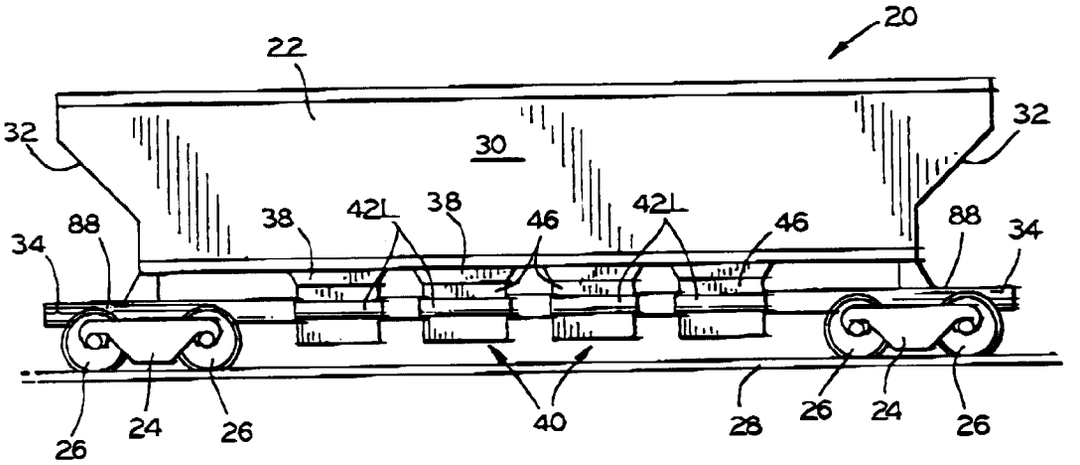
8. The remote control hopper gates defined in claim 7, herein said power supply includes a battery (94) connected to said controller (96).

9. The remote control hopper gates defined in claim 8, wherein said power supply includes a pneumatic power source (88), pneumatic drive (90), and an alternator (92) coupled to said pneumatic drive for charging the battery (94).

10. The remote control hopper gates defined in claim 7, wherein said drive system includes a hydraulic drive (90) pivotably connected to each of the doors (42), said hydraulic drive having a first end (66) pivotably connected to the end walls (44) of said frame member and a second end (72) pivotably connected to one of the door end plates (54).

11. The remote control hopper gates defined in claim 7, wherein said control system is a radio frequency control system.

12. The remote control hopper gates defined in claim 7, wherein said control system is an infrared system control system.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32
32
30
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42L
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42L
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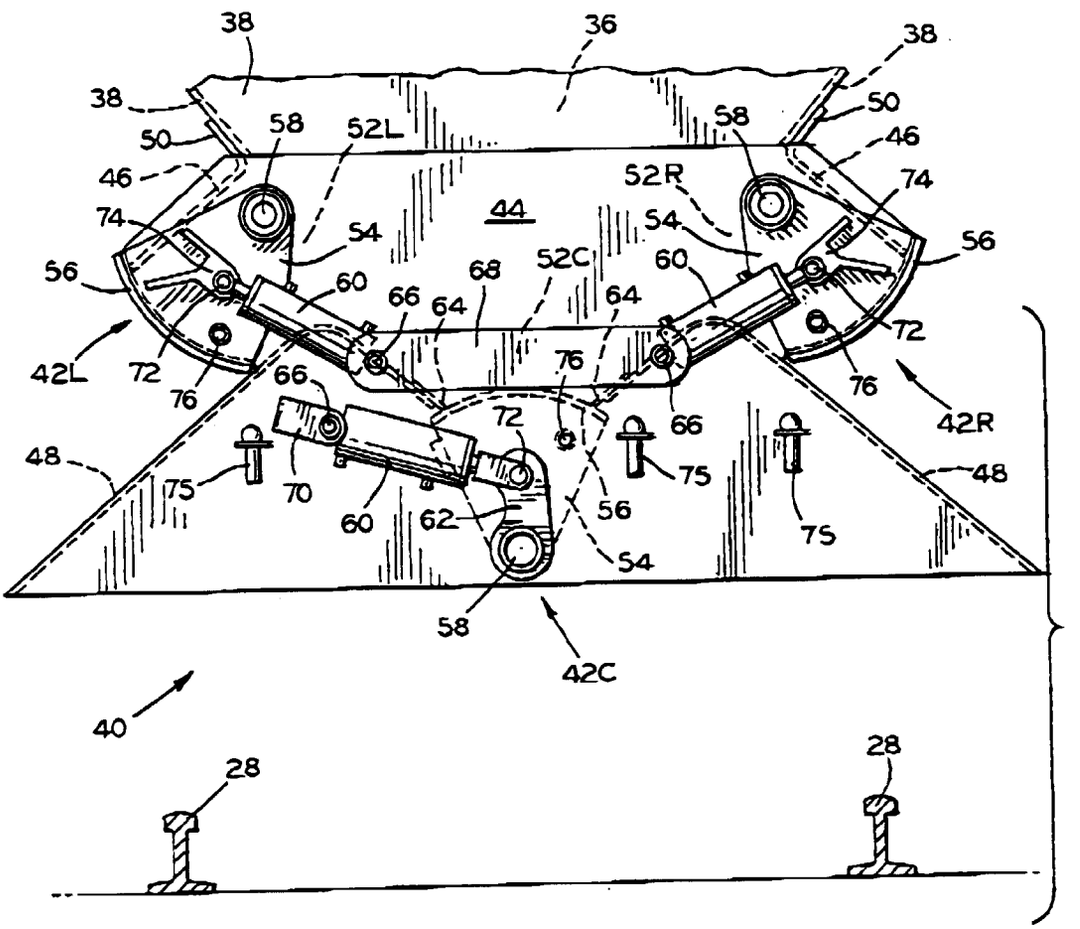
26

FIG. 1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52C
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66
64
64
72
42L
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76
76
66
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42R
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56
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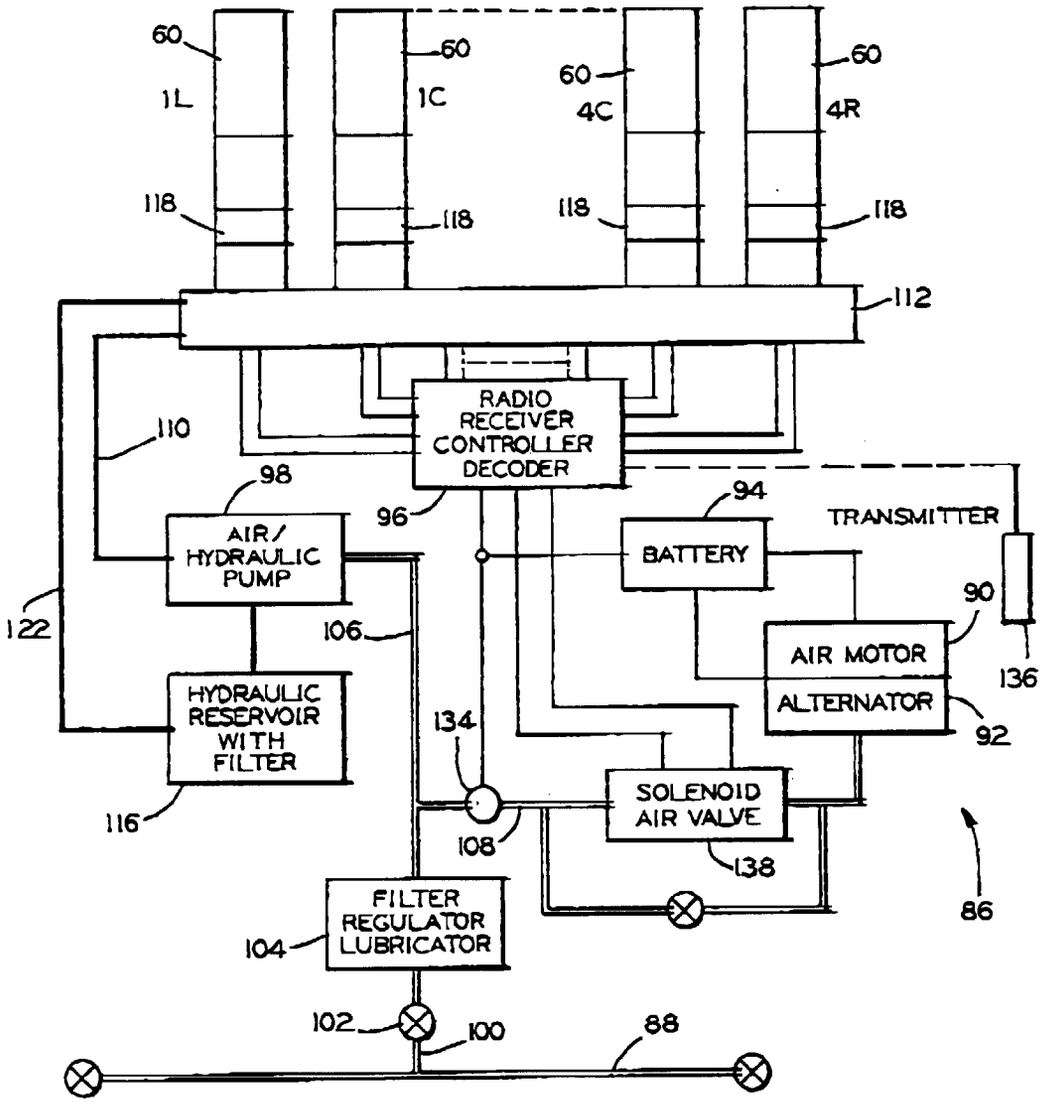
42C
40
28
28

FIG. 2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1C
60
4C
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4R
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118
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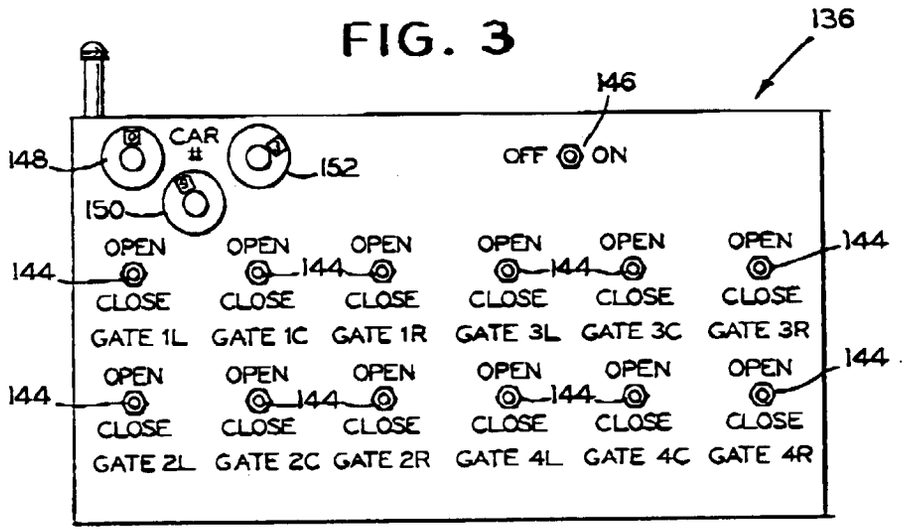
96
94
TRANSMITTER
AIR/ HYDRAULIC PUMP
BATTERY
122
106
90
AIR MOTOR
136
HYDRAULIC RESERVOIR WITH FILTER
ALTERNATOR
92
134
SOLENOID AIR VALVE
116
108
138
86
FILTER REGULATOR LUBRICATOR
104
102
100
88

FIG. 3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GATE 3R
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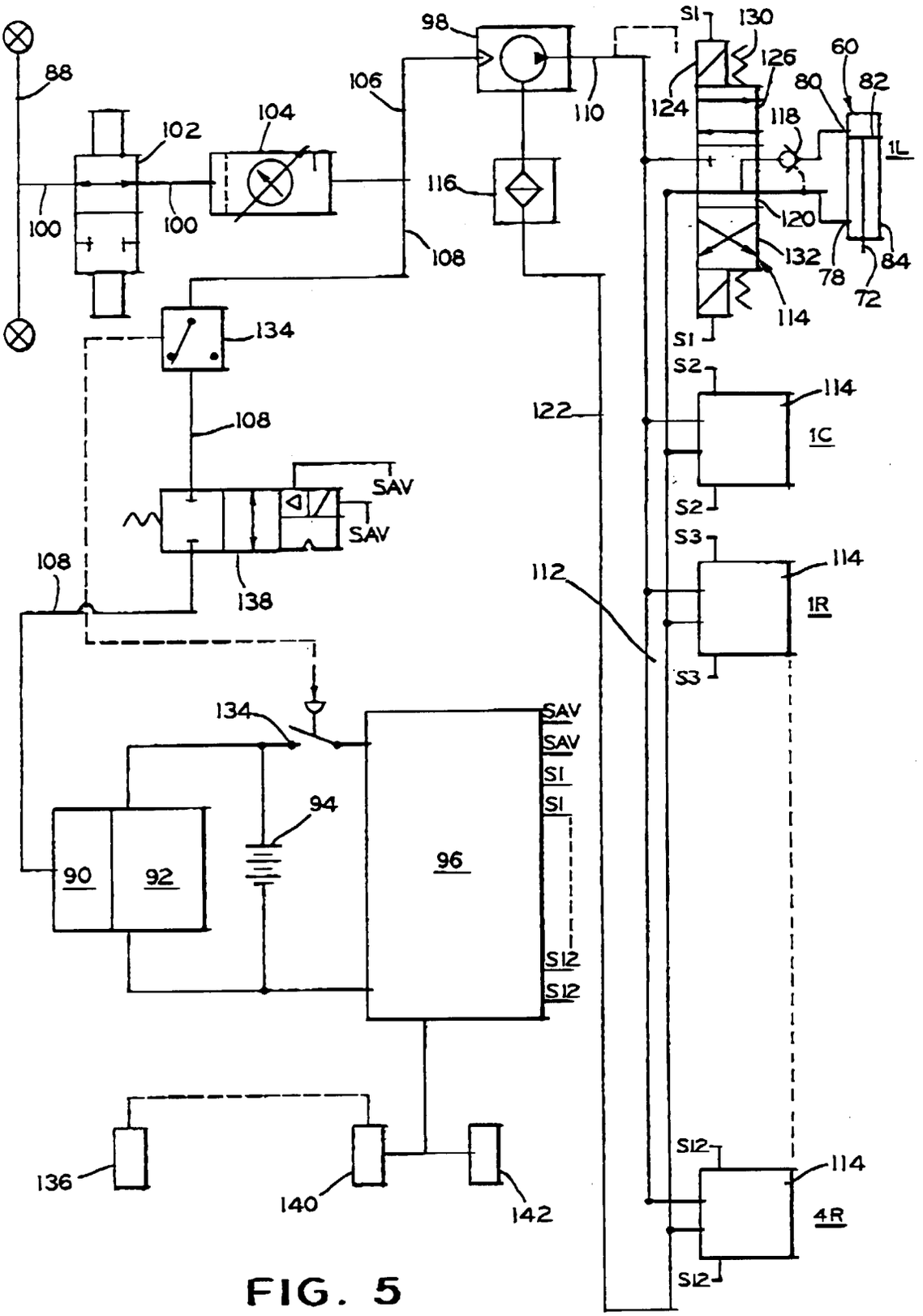
GATE 4C
GATE 4R

FIG. 4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SAV
S2
S3
114
108
112
1R
138
S3
134
SAV
SAV
S1
S1
94
90
92
96
S12
S12
136
140
142
S12
114
4R
S12

FIG. 5

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 96 40 1329

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
Y,D	US-A-5 359 942 (WARD ROBERT J) 1 November 1994 * column 4, line 7 - column 10, line 66; figures 1-5 *	1,7	B61D7/30 B61D7/06
Y	FR-A-426 121 (THE LEEDS FORGE COMPANY LTD AND G. SHARP) * the whole document *	1,7	
A	DE-A-21 15 588 (SIEMENS AG) 5 October 1972 * page 3, line 1 - page 6, line 7; figures 1-5 *	1,7	
A	DE-B-11 61 578 (RHEINSTAHL SIEGENER EISENBAHNBEDARF GMBH) 23 January 1964 * column 3, line 13 - column 7, line 57; figures 1-4 *	1,7	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6) B61D B60P

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	26 September 1996	Chlosta, P

CATEGORY OF CITED DOCUMENTS

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L : document cited for other reasons

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