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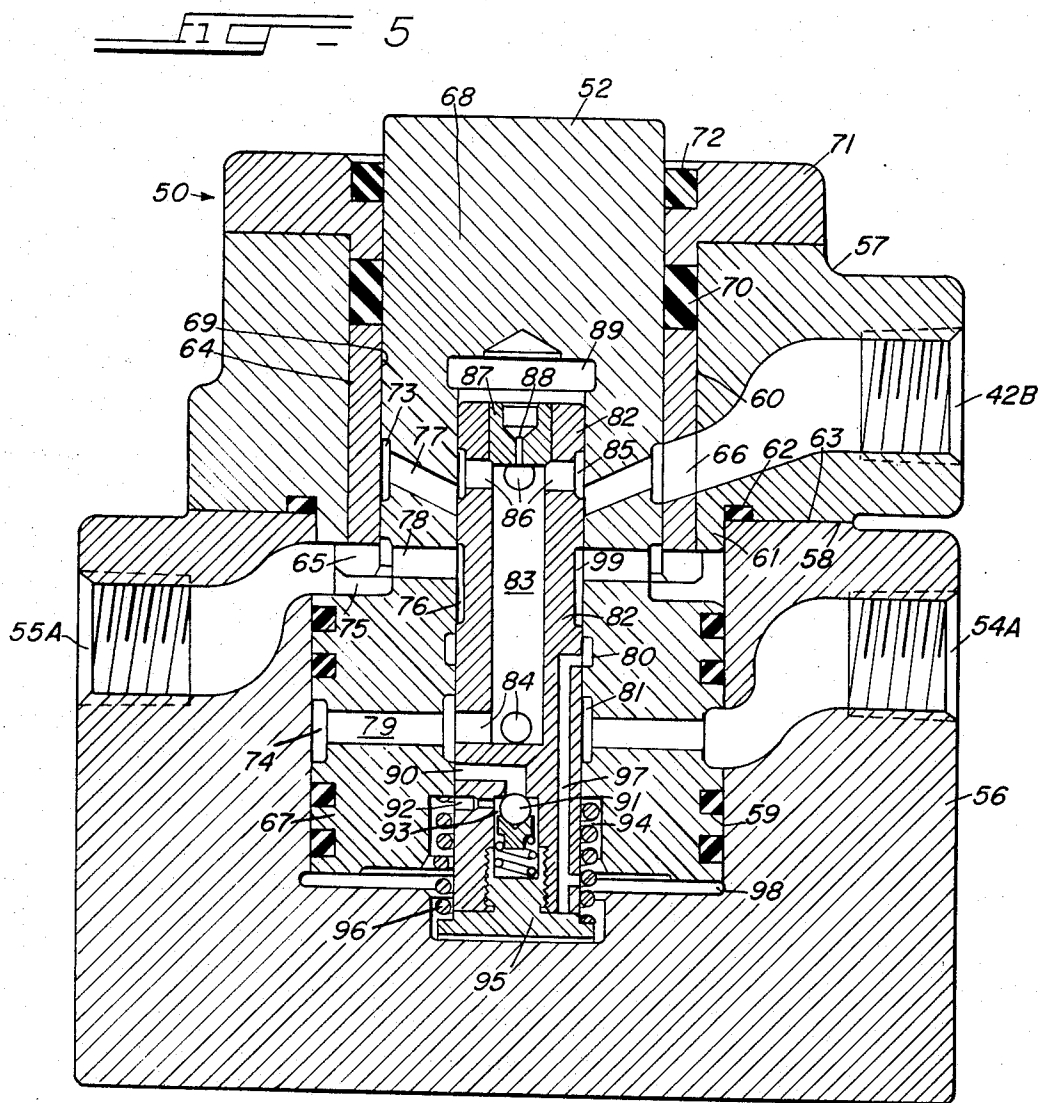
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3,360,304

RETARDER SYSTEMS

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5 Sheets-Sheet 2



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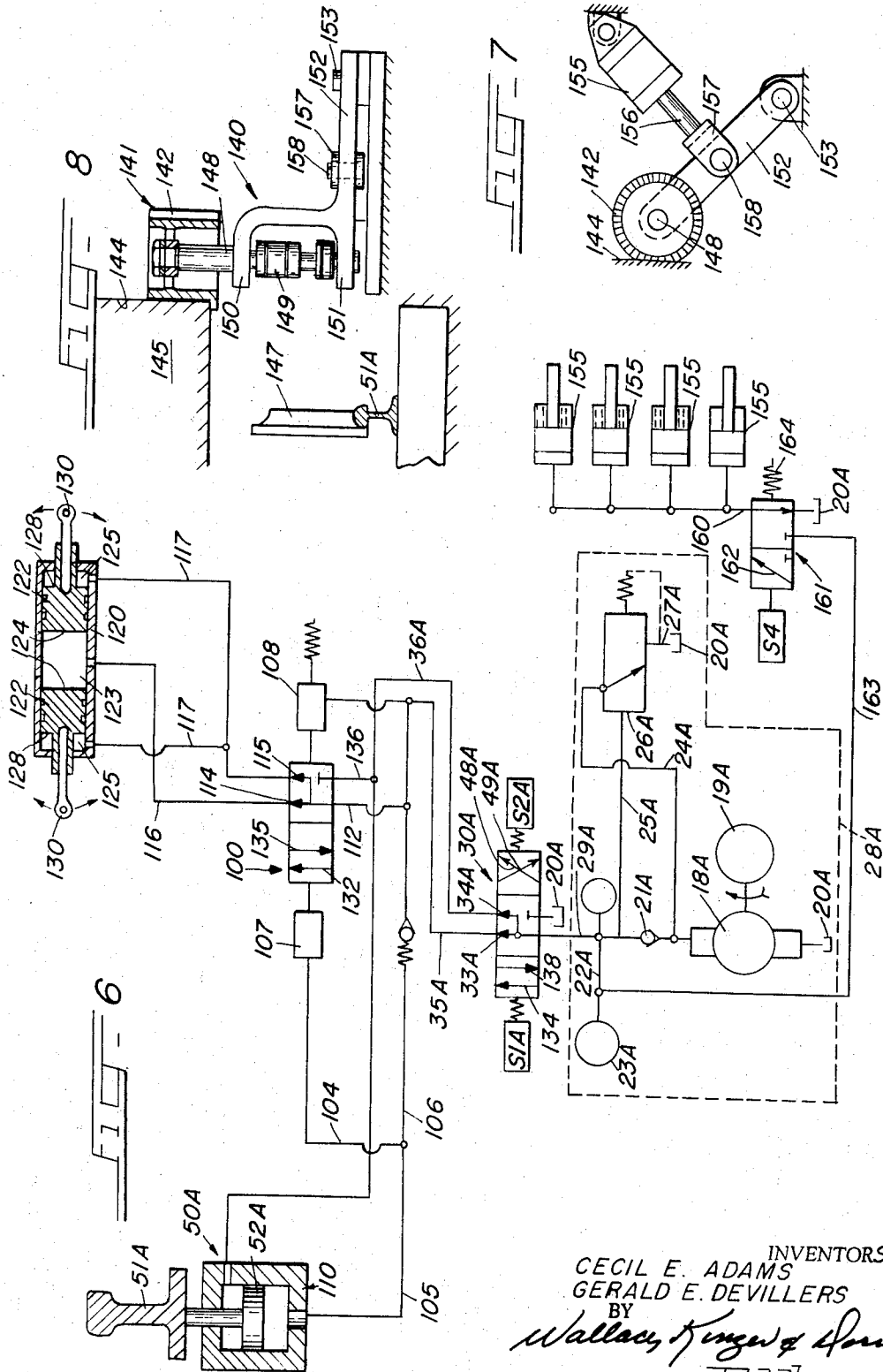
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5 Sheets-Sheet 3



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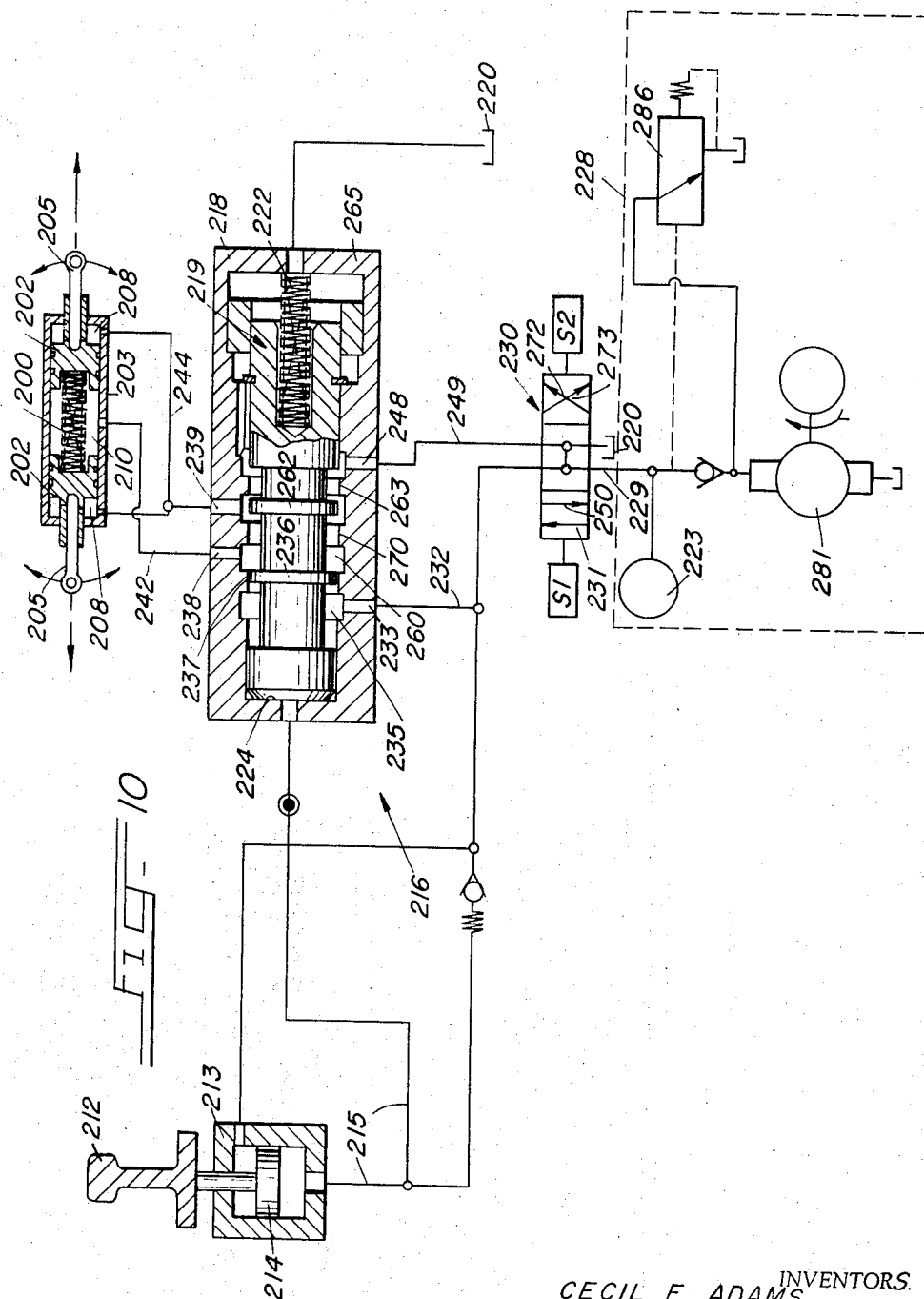
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RETARDER SYSTEMS

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5 Sheets-Sheet 5



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RETARDER SYSTEMS

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ABSTRACT OF THE DISCLOSURE

A fluid-pressure control system for a railroad car retarder. The car retarder mechanism is actuated by a plurality of fluid cylinder pistons; hydraulic pistons of the differential-area type are described. A multiposition control valve, or a combination of such valves, applies fluid under pressure to only one piston face for maximum braking force, to both piston faces for moderate braking force, and to the opposite piston face for release of the retarder. A weight-sensing load cell actuates the control valve or valves to vary braking force with car weight. A speed-sensing device actuates the control valve or valves to release the retarder when the car being braked is reduced to a predetermined release speed.

This invention relates to retarder systems for railroad cars and more particularly to a control system for retarder mechanisms capable of selectively applying different and distinct retarding forces to railroad cars.

Retarder systems for railroad cars are typically employed in railroad classification yards or the like to reduce the speed of railroad cars or, in some instances, to stop the railroad cars for later release from the retarder. The retarding force necessary to accomplish a reduction in speed or the stopping of which are the speed of the railroad car immediately prior to its entry into the retarder mechanism and the weight of the railroad car. Railroad cars with which the present invention is most particularly useful will have an approximate range of weights from 20 tons to 105 tons per car. Manifestly, such a difference in weights requires that light weight cars have a light braking force applied to their wheels to prevent the derailment of the cars as by their wheels climbing from between the braking rails of the retarder whereas heavy cars require greater braking forces to slow them to a desired low speed or to stop them within the length of a relatively short car retarder. Also, the cars are usually traveling at different velocities when entering the retarding system. For example, the retarding mechanism to which the present invention is most particularly applicable preferably has cars moving into it in the range of more than 4 but less than 14 miles per hour, and it is desirable to reduce the speed of the railroad cars by the retarder mechanism to approximately 4 miles per hour.

While it has been heretofore proposed to afford control systems for operating a retarding mechanism to apply selectively different retarding forces to railroad cars, these retarding systems have suffered from the objection of being relatively complicated and employing a number of operating pressures and being relatively expensive compared to the present invention. Accordingly an object of the present invention is to provide a novel control system for operating a retarder mechanism selectively to apply different retarding forces to railroad cars in accordance either with the weight of the car or the speed of the railroad car in the retarder, or both.

Another object of the invention is to provide a simple hydraulic control system which selectively provides different operating forces to the retarding mechanism by controlling the flow of hydraulic fluid in response to

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weight indicating signals from a hydraulic load cell or electric signals from an electrical speed sensing system, or both. More specifically, under this object of the invention, at least one of the traffic rails is supported on a number of transducers in the form of hydraulic load cells so that the weight of the railroad car generates a hydraulic weight-indicating signal to operate a hydraulic pilot valve which in turn controls the supply of hydraulic fluid to operating cylinders of the retarder actuating mechanism.

Another important object of the invention is the provision of a hydraulically operated railroad car retarder mechanism which operates from a single source of hydraulic fluid and at a single pressure to provide at least two separate and distinct retarding or brake operating forces and which does not include pressure reducing valves and the like.

More specifically, and in carrying out the foregoing object, it is another object of the invention to provide a retarder the hydraulic control system of which employs hydraulic fluid at a single operating pressure and which controls the application of the hydraulic fluid at the single operating pressure to either one or both sides of a piston in a fluid cylinder so that the operating forces are determined by the area of the piston face which is exposed to the hydraulic fluid or the difference in the areas between the faces when both of them are subjected to the same source of hydraulic fluid.

Another object of the invention is providing operating forces as a function of the difference in effective areas of the piston faces, and because of selective exposure of one of the piston faces to exhaust while applying pressurized fluid to the other piston face affords a second operating force. Also, under this object of the invention, the retarder mechanism is readily retracted to a released position, in which it applies no retarding force, by merely reversing the flow of fluid from one piston face while exhausting the other piston face so that the piston moves in a reverse direction to retract the retarding brake elements of the retarder mechanism.

Because the weight of the railroad cars to be retarded varies considerably in the range from 20 tons to 105 tons, it is desirable that the amount of retarding force be adjusted for each railroad car. In this invention, the weights of the cars are classified by the system into a plurality of ranges or levels within the broad weight range mentioned so that the same retarding force can be generated for each railroad car within its given level. For example, in a two-level system, all railroad cars from 20 to 52 tons in weight may receive a first or light retarding force, and all cars in the 52 to 105 ton level receive a second and larger retarding force. Also in accordance with this invention, the levels of weight of the railroad cars can be readily increased to three while still employing only a single operating pressure for the fluid by employing a spring-biased piston in the fluid cylinder to provide the third level of operating force.

The invention also readily affords a convenient manner of selectively providing different retarder operating forces for railroad cars traveling at different velocities by sensing the velocity of a railroad car and comparing that velocity to a predetermined standard prior to operating a valve to a position wherein the hydraulic fluid is selectively applied to either one or both of the piston faces.

Another object of the invention is to afford a combined speed and weight sensitive control system for a fluid cylinder to cause operation of the cylinder to afford two or more operating forces, and to direct fluid into the cylinder to cause the piston of the cylinder to retract the retarder mechanism to release a car therein whenever the speed sensing device determines that the speed has reached a predetermined released speed whereby a valve is operated

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to reverse the flow of fluid from that in which the retarding forces are being applied.

Another object of the invention is to provide a hydraulic load cell having the capability of operation in response to a railroad car thereon to control directly the flow of hydraulic fluid therethrough to afford hydraulic pressure at one or both of the faces of the piston within the retarder operating cylinder or motor.

Other and further objects of the invention will be apparent from the following description, claims and the accompanying drawings which, by way of illustration show the invention and the principles thereof and what is now considered to be the best mode for applying these principles. Other embodiments of the invention including the same or equivalent principles may be used and structural changes may be made as desired by those skilled in the art without departing from the spirit and scope of the invention.

In the drawings:

FIG. 1 is a diagrammatic showing of a hydraulic system for operating a railroad car retarder mechanism and which includes features of the invention;

FIG. 2 is a diagrammatic showing of a solenoid operated valve included in FIG. 1, but showing the valve in a different operating positions;

FIG. 3 is a view similar to FIG. 2 but showing the valve in still another operating position;

FIG. 4 shows diagrammatically how the hydraulic system of FIG. 1 may be made to include a hydraulic load cell;

FIG. 5 is a cross-sectional view of the hydraulic load cell seen in FIG. 4;

FIG. 6 is a diagrammatic showing of a hydraulic control system for a railroad car retarder mechanism which includes speed control apparatus;

FIG. 7 is a view in plan of an apparatus for mounting and causing a speed sensing tachometer device to engage a railroad car as the latter travels in the retarders;

FIG. 8 is a side view in elevation of the apparatus seen in FIG. 7, but showing the tachometer device engaging a side surface of a railroad car;

FIG. 9 is a schematic drawing of the electrical control system for the hydraulic apparatus; and,

FIG. 10 shows that embodiment of the invention which includes a three level or three force braking feature.

Referring now to the drawings, and more particularly to FIG. 1, there is illustrated a schematic form of the hydraulic system or circuit for operating each of a plurality of hydraulic cylinders or motors 10 which supply the operating force for the railroad car retarding mechanism (not shown). As will be readily understood by those familiar with the art, some retarder systems have retarder mechanisms operable to apply retarding forces to the wheels on both sides of a railroad car, and other retarder systems have mechanisms for applying retarding forces to the wheels located only on one side of the railroad car. In FIG. 1, two pairs of opposed hydraulic cylinders 10 are shown for operating retarder mechanisms and it is to be understood that this invention is not limited to any particular arrangement of retarder mechanisms for the wheels at either one or both sides of a railroad car.

The hydraulic cylinders or motors 10 each have a cylinder 11, piston 12 and a piston rod 13 extending outwardly of the cylinder 11, adapted to be connected to the retarder mechanism. When hydraulic fluid under pressure is applied to a piston face 14, the piston 12 and piston rod 13 move to force the piston rod 13 outwardly of the cylinder 11. Conversely, to retract the retarder mechanism, the hydraulic fluid under pressure is sent into the cylinder 11 against the other piston face 15 to move the piston rod 13 into the cylinder 11. The piston faces 14 and 15 have the same diameters, but the effective area of the piston face 15 is smaller than the effective face 14 because the area of the piston rod 13 is not available

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for fluid pressure. Thus, the piston face 15 is smaller, from an effective area standpoint, than the piston face 14.

The hydraulic system employed in the invention is a "single pressure system," i.e., only a single hydraulic pressure is employed to cause operation of the retarder mechanism to supply different retarding forces and to cause retraction or release of the retarder mechanism. This is in contrast to a hydraulic system of a type wherein various hydraulic pressures would be employed to obtain various force levels or to effect a release of the retarder.

The basic hydraulic system, shown in FIG. 1, includes a continuously operating pump 18 driven by an electric motor 19 to pump hydraulic fluid (preferably oil) from a tank 20 through a check valve 21 and a conduit 22 into an accumulator 23. The accumulator 23 serves to supply the peak demand for hydraulic fluid for the hydraulic cylinders 10 and permits the employment of a pump 18 which need not have the capacity to supply peak fluid demands by its own capacity. The accumulator 23 permits the use of a continuously operating pump and the operation of the pump is under substantially no pressure load so long as the system pressure is being maintained by the accumulator. System pressure is maintained when it, by being applied through conduit 25, opens an unloader valve 26, after which the pump 18 furnishes its output through conduit 24 to the unloader valve 26 and conduit 27 leading to the tank 20. That is, the unloader valve opens whenever the predetermined system pressure is reached and permits the pumping of fluid through the conduit 24, valve 26 and conduit 27 to the tank 20 until such time as the fluid pressure in the system drops below the pressure at which the unloader valve 26 closes to cause the pump 18 to furnish fluid to the system. The accumulator 23 supplies hydraulic fluid or oil very quickly to obtain the desired quick response and operation of the retarder mechanism. It may be mentioned here that all of the previously described elements which appear within the dotted rectangle 28 in FIG. 1 constitute a "pressure source" or "supply means" of hydraulic fluid under pressure for the hydraulic system now to be described.

Hydraulic fluid from the pressure source 28 flows through a conduit 29 to a four-way directional valve 30. The four-way valve 30 is spring urged to its central or first "braking" position shown in FIG. 1 wherein fluid from the input conduit 29 is directed through ports 33 and 34, which are open to output conduits 35 and 36. With control valve 30 in its center position, outlet port 32 to the tank 20 is blocked and the hydraulic fluid flows through the ports 33 and 34 and through the conduits 35 and 36 to a pair of supply lines 38 and 40 for branch lines 41 and 42, respectively, to apply system pressure against both the large and small faces 14 and 15, respectively, of the pistons 12.

When fluid under pressure is applied to both of the piston faces 14 and 15, the piston 12 applies an operating force to the retarder mechanism which is a function of the cross-sectional area of the piston faces 14 and 15. Stated differently, the net force at the piston rod 13, when fluid under pressure is applied to both piston faces 14 and 15, is the pressure force multiplied by the differential area of the piston faces 14 and 15 (which differential area equals the cross-sectional area of the piston rod 13). This force is available when the valve 30 is in its center position, and hydraulic pressure is being applied through the supply conduit 29 and through the ports 33 and 34, and into the respectively connected lines 35, 38 and 41 and lines 36, 40 and 42 to apply hydraulic pressure against both the large face 14 and the small face 15 of the piston 12.

The four-way valve 30 is operated to its second "braking" position shown in FIG. 2 upon energization of a solenoid S1, and it is moved to a "retract" or "release"

position (FIG. 3) upon energization of the solenoid S2, to connect the valve to reverse the fluid flow through crossed ports 48 and 49. The second "braking" position of the valve 30, as shown in FIG. 2, is for causing the pistons 11 to apply a heavy retarding force. Specifically, with valve 30 in its second "braking" position, the pressurized fluid flows through the conduit 29 and port 31 into the connected lines 35, 38 and 41 to apply hydraulic pressure against the large piston faces 14 and to drive the piston rods 13 outwardly of the cylinders 11. The conduits 42, 40 and 36 exhaust fluid from the cylinders 11 at the small faces 15 of the pistons through a port 37 in the valve 30 from which it flows into the tank 20. Thus, in the second "braking" position, the hydraulic fluid exerts a force on the large face 14 of the piston 12, and there is no counteracting fluid force operating on the smaller face 15 of the piston 12.

In order to cause the retarder mechanism to release a car, the piston rods 13 are moved inwardly of their respective cylinders 11. Such retraction is accomplished by energizing the solenoid S2 (FIG. 3) to route the pressurized fluid from conduit 29 through the port 49 to the conduit 36 and thence through the lines 40 and 42 to the small piston face 15. Driving of the pistons 12 inwardly of the cylinders 11 exhausts the fluid in the portion of the cylinders at the large piston faces 14 outwardly through lines 41 and 38, conduit 35, and port 48 and line 32 into the tank 20. Thus, during a retracting or release operation, the hydraulic fluid is diverted through port 49 and against the small piston face 15, while the large piston face 14 does not apply any counteracting force and is connected by port 48 to the tank 20.

The basic hydraulic system or circuit of FIG. 1 can be controlled by the energization of the solenoids S1 and S2 to provide various operating forces; or the system can include weight sensing load cells 50, one of which is shown diagrammatically in FIG. 4, disposed beneath at least one traffic rail 51 to cause changes of force levels. The traffic rail 51 is supported on the top of the ram element 52 of a series of spaced load cells 50 and these are depressed by the weight of a railroad car rolling over them on the traffic rail 51. The weight of the railroad car passing over the traffic rail determines whether the ram 52 of the load cell 50 is depressed sufficiently to cause a change in the amount of retarding force applied to a railroad car. That is, those railroad cars having a weight above a predetermined level, for example, fifty-two tons, cause the ram elements 52 to be depressed sufficiently to effect a change in the level of retarding force, whereas cars whose weights are under 52 tons do not depress the ram elements 52 sufficiently to generate a hydraulic load signal for a change in retarding forces. Preferably, the load cell 50 is of the kind shown in FIG. 5, and it is connected in the hydraulic circuit in the manner as shown in FIG. 4. More specifically, each of the load cells 50 is connected between the supply lines 38 and 40 by branch lines 54 and 55. The load cell 50 has an outlet line 42A leading to the small piston face 15 in the cylinder 11 and the conduit 41 directly interconnects the large piston face 14 with line 38.

One of the load cells 50 is shown in cross-section in FIG. 5 of the drawings. The load cell 50 has a two-piece body which includes a lower or base member 56 and an upper member 57. The lower or base member 56 has a flat top surface 58 from which a bore 59 extends downwardly into the base member. The base member 56 is also provided with a pair of ports or passageways 54a and 55a which are threaded as shown to receive the pipes 54 and 55, respectively, and these ports lead to the bore 59.

The upper member 57 includes a bore 60 which is concentric about the axis of bore 59 and it includes a downwardly extending annular boss or extension 61 which telescopes snugly into the bore 59 in the base 56 to retain

the bores 59 and 60 in concentric relation. The boss 61 is surrounded by a groove which receives an O-ring seal 62 and a flat surface 63 which mates with the surface 58. The bore 60 in upper member 57 receives a bushing 64 which is pressed into the bore 60 until a collar 65 on the bushing abuts the boss 61 and the bushing is installed in such a position that a port 66 in its side wall aligns with a port or passage 42b in the upper body member 57.

The ram 52 is actually a piston element having a large diameter bottom portion 67 which is received in the bore 59 in the base member 56 and a smaller diameter portion 68 which is received in the smaller diameter bore 69 formed by the bushing 64. The ram 52 projects upwardly out of the load cell 50 and it and the upper member 57 are sealed together by a packing 70 and a collar 71 both of which surround the upper portion 68 of the piston 52. Screws, not shown, extend through the collar 71, the upper member 57 and into the base member 56 to hold the cell 50 together. Collar 71 is provided with a dirt seal 72 which surrounds the piston 52 and prevents the entry of dirt to between the piston 52 and the collar 71.

The ram or piston 52 is provided with a pair of circumferential grooves 73 and 74 and its large and small diameter portions 67 and 68 have a circumferential groove 75 between them. These grooves 73, 74 and 75 are always in communication, respectively, with the ports 66, 55A and 54A. The piston 52 also includes a central bore 76 which is connected with the grooves 73, 75 and 74 by passageways 77, 78 and 79, respectively. The bore 76 is surrounded by two annular grooves 80 and 81, the latter of which connects with the passageway 79 and the functions of which will be explained hereinafter.

A valve spool 82 is contained within the valve bore 76 in piston 52 and this spool includes a central bore or passageway 83 the bottom of which is joined by bores 84 which are always in communication with the groove 81, passageways 79 and port 54A. The upper end of the bore 83 is connected with a circumferential groove 85 in the spool 82 by passageways 86 and the groove 85 cooperates with the readily innermost ends of the passageways 77 to form a valve means, the purpose of which will also be explained hereinafter. The upper end of the bore 83 is substantially closed by a plug 87 which is provided with an orifice 88 through which hydraulic fluid enters and leaves a chamber 89 which is formed within the piston 52 above the upper end of the valve spool 82. It will be seen that the fluid filled chamber 89, the upper end of the valve spool 82, the plug 87 and orifice cooperate to control and/or damp the speed of operation of the valve spool 82 within the bore 76.

The bottom portion of the valve spool 82 includes a small diameter bore 90 which is connected through a spring closed check valve 91 with a bore 92 which leads from the valve chamber 93 to the exterior of the spool and to a spring chamber 94 which is formed within the piston 52 and surrounds the lower end portion of the valve spool 82. The check valve chamber 93 is closed by a plug 95 which is threaded into the valve spool 82 and which provides a flange at the lower end of the valve spool 82 against which a spring 96 in the chamber 94 abuts to urge the valve spool 82 downwardly with respect to the piston 52.

The spool 82 is provided with a plurality of bores which cooperate to form a passageway 97 which interconnects the groove 80 in the piston 52 and the chamber 94 at the bottom of the spool 52. The load cell 50 is normally in its "light force" position in which its parts are in the positions shown in FIG. 5 when no car or a light car (less than 52 tons) is passing over the traffic rail 51.

Should the piston 52 descend below the position shown in FIG. 5, the passageway 90 will be placed in communication with the groove 81 which contains hydraulic fluid under pressure and fluid will flow from the groove 81 through passageway 90, check valve 91, chamber 93 and

bore 92 into chamber 98 to elevate the ram 52 until the valve 90-81 closes. Should the ram 52 be elevated above the position shown in FIG. 5, a groove 99 in spool 82 will be opened to groove 80 and fluid from chamber 98 will pass through the passageway 97, groove 80, the groove 99 in spool 82, passageway 78 and port 55A to tank whereupon the ram 52 will descend in the housing 56, 57 until the valve 80, 99 closes.

In the "light force" position (FIG. 5), hydraulic fluid from the pressure source 28 enters the port or passageway 54A through which it flows to groove 74, passageways 79, groove 81, bores 84, the central bore 83, and passageways 86 to the valve groove 85 which valve groove 85 is now open to the valve ports or passageways 77 from which the hydraulic fluid flows to groove 73 and to the port or passageway 42B. Thus, with reference to FIGS. 2 and 4, when the load cell 50 is in its "light force" position shown in FIG. 5, hydraulic fluid from the valve port 31 is conducted to the large area side 14 of piston 12 through conduits 35, 38 and 41 and hydraulic fluid from the load cell, as described above, to the small area 15 of the piston 12 whereby the piston 12 urges the retarder to close at a light retarding force.

The bottom portion of the bore 59 and the bottom of the piston or ram 52 cooperate in providing a chamber 98 in which a predetermined volume of hydraulic fluid is trapped and this trapped fluid supports the piston or ram 52 in the position shown. When a heavily loaded wheel of a railroad car (car weight of 52 tons or more) moves over the traffic rail 51 and across the piston or ram 52, the latter is urged downwardly with sufficient force to cause the pressure on the hydraulic fluid in the chamber 98 to overcome the force of spring 96 and the hydraulic force of the fluid at system pressure in the chamber 89 acting downwardly on the valve spool 82 to move the valve spool 82 upwardly whereby communication between the ports 54A and 42B is broken by the movement of the groove 85 upwardly out of alignment with the passageways 77. Movement of the valve spool 82 upwardly establishes a flow path for hydraulic fluid between the port 42B and the port 55A which is connected with branch line 55 (FIG. 4) through the port 37 of valve 30 (FIG. 2) to tank 20. When the port 42B is connected to port 55A and the tank as described, hydraulic fluid under pressure is conducted only to the large piston face 14 and the hydraulic fluid at the piston face 15 is vented to tank whereby the hydraulic cylinder 10 delivers its large force to the retarder mechanism.

For the purpose of retracting the retarder mechanism it is necessary to reverse the flow of pressurized hydraulic fluid so that the pressurized fluid is acting against the smaller piston face 15, while the fluid in the opposite side of the cylinder 10 is being directed to tank 20. For this purpose solenoid S2 is energized to place the valve 30 in the position shown in FIG. 3 whereby hydraulic fluid from the pressure source 28 flows through conduit 29 and the port 49 to supply fluid under pressure (FIG. 4) through the conduits 36, 40, and 55 bypassing the load cell 50 through a conduit 53 including a check valve to the line 42A and into the cylinder 11 to act upon the small area 15 of the piston 12 to retract the piston and force hydraulic fluid from the cylinder 11 at the large area side 15 of the piston through the conduits 41, 38 and 35, cross port 48 of valve 30 and into the tank 20.

As has been observed, the load cell 50 operates to shift and route the flow of hydraulic fluid to obtain the different levels of retarding forces. However, in lieu of the load cell 50, shown in FIG. 5, the hydraulic system can employ a simplified load cell 110, such as that shown diagrammatically in FIG. 6, if there is also provided another control valve such as the 4-way, directional valve 100. The load cell 110 of FIG. 6 generates hydraulic pressure signals indicative of weight of the railroad cars passing over a traffic rail 51A to operate the hydraulic pilot-operated valve 100 which functions in much the

same manner as the load cell 50 of FIG. 5. Those portions of the hydraulic system shown in FIG. 6 are designated by reference characters having a subscript "A" in the following description. For example, a traffic rail 51A is disposed on a ram 52A to exert pressure in a conduit 105 leading to a hydraulic pilot line 104 to operate the hydraulic pilot 107 to cause the application of either a light or heavy retarding force. A conduit 106 including a check valve is provided through which fluid is supplied to the bottom of cell 110 to maintain the latter filled and the ram in an elevated position. It will be recognized that the load cell 110 could be an electrical load cell to generate operating signals for controlling solenoids to operate a solenoid controlled pilot valve, rather than the hydraulically operated pilot valve 100.

The system shown in FIG. 6 is similar to that shown in FIG. 1 in that it has a pressure source 28A having an output conduit 29A and a four-way valve 30A which is normally spring biased to a position to direct pressurized fluid through a pair of ports 33A and 34A to conduit lines 35A and 36A, respectively. The four-way valve 30A is controlled by the solenoids S1A and S2A. The system is such that the solenoids S1A and S2A are normally unenergized to position it to cause application of braking forces (FIG. 6). When the solenoid S1A is energized, the pressurized fluid from output 29A is routed through port 134 and through line 35A, and line 36A is connected through port 138 to the tank 20A. The system also is such that the solenoid S2A is energized to cause a retraction or "release" operation of the retarder. When the solenoid S2A is energized, a cross port 49A connects the conduit 35A to the tank 20A, and a cross port 48A connects the pressurized fluid in conduit 29A to the conduit 36A.

With the control valve 100 in its "light force" position and with the solenoids of valve 30A unenergized, as shown in FIG. 6, fluid under pressure from line 29A is routed through the valve 30A, and through both the conduit lines 35A and 36A. Conduit line 35A is connected to line 112 leading to valve 30A and supplies pressurized fluid to line 112 and valve 100 and pressurized fluid flows through the ports 114 and 115 to conduit lines 116 and 117, respectively, to both sides of pistons 122. That is, the conduit line 116 supplies the pressurized fluid to the central portion 123 of a cylinder 120 and thereby to each of the large piston faces 124 of the opposed pistons 122. Counteracting the pressure applied to the large piston faces 124, pressurized fluid is also going through the conduits 117 into the end portions 125 of the cylinder 120 and against the small piston faces 128, so that each piston rod 130 is forced outwardly of the cylinder 120 by a force proportional to the difference in areas of its large piston face 124 and small piston face 128. Thus, with the valves 100 and 30A in the positions shown, a light retarding or braking force is being supplied by the retarder mechanism to the railroad car.

When a wheel of a heavy railroad car moves over the traffic rail 51A which is supported by the ram 52A of the load cell 110, the ram 52A is forced downwardly whereby the cell 110 generates an increased pressure in the pilot lines 105 and 104 in the form of a hydraulic force or weight-indicating signal operable through the pilot lines 104 and 105 to actuate the pilot 107 and shift the valve 100 to the right, as seen in FIG. 6. In this position of valve 100, port 132 thereof connects the conduit 112 and the conduit 16 which leads to the central portion 123 of the cylinder 120. The solenoid S1A is also operated, for reasons described later in connection with FIG. 9, and the line 29A supplies pressurized fluid through a port 134 to the large piston faces over a path including line 35A, conduit 112, port 132 of valve 100, and conduit 116 to the piston faces 124. The pistons 122 are forced apart and the fluid in the ends 125 of the cylinder 120 is exhausted from the cylinders through the conduits 117 and a port 135 of valve 100 to a conduit line 136 and through

the conduit 36A and a port 138 in the valve 30A to the tank 20A. Thus, with pressurized fluid present only at the piston faces 124 the larger operating force for the retarder is applied for the heavy railroad car on the traffic rail 51A.

To move the retarder mechanism to a "retract" or "release" position, solenoid S2A is energized and solenoid S1A is deenergized. The valve 30A shifts to its "third" position wherein ports 48A and 49A reverse the fluid connections so that pressurized fluid flows from supply line 29A through the port 48A, line 36A, through line 136, port 135, and conduits 117, to exert force on the small-area piston faces 128. Since the central area 123 of the cylinder is connected to the tank 20A, as will be explained, the opposed pistons 122 move toward each other to retract the retarder mechanism. The fluid in the central cavity 123 between the pistons 122 exhausts through conduit 116, port 132, conduit 112, line 35A, and port 49A to the tank 20A. Thus, the piston rods 130 move inwardly. Upon deenergization of solenoid S2A, the solenoid S1A is again energized to apply fluid under pressure again to both sides of the opposed pistons 122, over the paths hereinbefore described, for the valve 30A when the solenoid S1A is energized to place the valve ports 134 and 138 in the hydraulic circuit.

The retarder applies the heavier braking force to faster moving cars than to slower moving cars and, as herein-after described, apparatus including the present invention may be provided with speed sensing devices to cause the appropriate amount of braking force to be applied. More specifically, FIG. 8 shows a speed ascertaining device including a tachometer mounting device 140, which has a car engaging wheel 141 with a frictional surface such, for example, as a bristle brush 142, FIG. 7, disposed to engage a side 144 of a railroad car 145 so that the wheel 141 rotates with a peripheral velocity equal to the linear velocity of the railroad car 145. In FIG. 8, the railroad car 145 is shown with a wheel 147 in engagement with traffic rail 51A, which is supported on hydraulic load cells, not shown in FIG. 7.

The device 140 includes a shaft 148 rotatable with the wheel 141, and a tachometer in the form of an electrical generator 149 on the shaft 148 for generating an electrical signal indicative of the revolutions per minute of the shaft 148. The shaft 148 is journaled for rotation in forked arms 150 and 151 of a bracket 152 pivotally mounted by a pin 153 to a suitable foundation. As best seen in FIG. 7, the bracket 152 is adapted to be pivoted by actuation of a hydraulic cylinder 155 to bring the wheel 141 into and out of operative engagement with a railroad car 145. The hydraulic cylinder 155 has an actuator rod 156, the outer end of which is attached by a clevis 157 and pin 158 to cause the pivoting of the bracket 152 about the pivot pin 153.

As seen in FIG. 6, four cylinders 155 are preferably provided at spaced locations to engage the railroad car, and a common hydraulic conduit or line 160 is connected to a control valve 161 for controlling operation of the hydraulic cylinders 155. Control valve 161 is adapted to connect the common line 160 either to the tank 20A or to a port 162 leading to a hydraulic line 163 connected to the accumulator 23A. The control valve 161 is actuated upon energization of its solenoid S4 to shift from the normal position, wherein the common line 160 is vented to the tank 20A, to a position wherein the line 160 is connected to the supply line 163 for conducting pressurized fluid to the cylinders 155.

The operation of the tachometers and the utilization of the speed control information to control the level of retarding force applied to a railroad car will be more readily apparent from a consideration of the electrical circuit shown schematically in FIG. 9. The four tachometer generators 149 are shown connected in parallel across common lines 165 and 166. Each generator 149 has an individual isolation diode 167, and an adjustable trimming

potentiometer 168, whereby the generators 149 can be individually calibrated. The amplitude of the voltage generated by the generators 149 appears on a DC volt meter 170 disposed across the lines 165 and 166. Also disposed across the lines 165 and 166 are a pair of variable potentiometer resistors 169 for adjusting the points at which energization and deenergization of two relays R1 and R2 occur. A third relay TDR, constituting a time delay relay, is also provided. The TDR relay is energized when very slow moving cars, as well as fast moving cars, are moving through the retarder system and requires only a very small output by the tachometer generators 149 to become energized. The relay R2 is adjusted to close whenever the car speed is in excess of a predetermined speed, which in the preferred example, is approximately seven m.p.h. The relay R1 is the comparison or release relay which is energized until the car speed is reduced to the desired release speed, which is nominally at four or five m.p.h. in the preferred example, at which time the output of the generators 149 will be insufficient to maintain the relay R1 energized.

Closing of an on-off switch 175, FIG. 9, completes the circuit between the opposed lines 176 and 177 to connect an electric power supply 178 thereacross. With the switch 175 closed, power is provided to energize the electric motor 19A, FIGS. 6 and 9. An indicator lamp 174 is connected between the lines 176 and 177 by a pressure switch PS which is closed by pressure in the output conduit 29 or 29A when the pressure in the accumulator 28 or 28A is sufficient to operate the retarder. A manually operable, rotary position control switch 180 can be turned to any one of a number of indicated positions designated in FIG. 9 to cause weight control only, speed and weight control, or the disabling of the electrical system of the retarder.

When speed control is being effected, the upper wiper 179 of the manual control switch 180 is connected to the "speed control" tap, and its lower wiper 181 is in engagement with the tap 182 to complete a circuit for the tachometer solenoid S4 to cause the operation of valve 161, FIG. 6, and thereby the actuation of hydraulic cylinders 155 to move the tachometer mounting devices 140 into car-engaging positions. Thus, when a car is moving through the retarder, the tachometer generators 149 generate a voltage having an amplitude representative of the speed of the railroad car. For example, if the railroad car is moving through the retarder at a velocity in excess of seven m.p.h. sufficient voltage is present to close relays R1, R2 and TDR. Operation of these three relays R1, R2 and TDR completes an energizing circuit for the valve controlling solenoid S1A, FIG. 9, over a path extending from the wiper 179 of switch 180, lead 184, now closed, contacts R1-1, now closed, contacts R2-2, lead 185, coil of solenoid S1A to common return 177. At this time an indicator lamp 183 connected in parallel with solenoid S1 will be lighted. It will be remembered that when valve control solenoid S1A is energized the valve 30A is positioned to direct pressurized fluid to the large piston faces, and to port the fluid at the small piston faces to the tank so that a large braking force is imparted to the railroad car passing through the retarder.

As the velocity of the car decreases under the retarding forces being exerted thereon by the retarder, the voltage across lines 165 and 166 decreases. When the car speed decreases to the normal range of 4-5 m.p.h., the voltage is reduced sufficiently so that both the relays R1 and R2 open or drop out. The solenoid S2A, FIG. 9, now becomes energized to cause the release or retracting of the retarder mechanism. The energizing circuit for solenoid S2A is from line 176, wiper 179, lead 184, contact R1-2, lead 187, now closed, contacts TDR-1, speed control on-off switch 188, lead 189, coil of valve solenoid S2A to line 177. Also, lamp 190 lights to signify that valve solenoid S2A is energized.

After the car is completely stopped or leaves the retarder mechanism, depending on the application, the

tachometer generators 149 stop. Relay TDR opens its contact TDR-1 to break the energized circuit for valve solenoid S2A. A circuit for energizing solenoid S1A is completed by release of relay TDR over a path from common return 176, wiper 179, lead 184, normally closed contact TDR-2, lead 192, lead 185, coil of valve solenoid S1A to common return 177.

When the manual control switch 180 is turned to the "open" position, the lower wiper 181 opens the circuit for the tachometer solenoid S4, which deenergizes valve 161, FIG. 6, to vent the hydraulic cylinders 155 and return the tachometer mounting devices 140 to their non-engaging, or spaced position relative to a railroad car. The upper wiper 179 completes a circuit to energize the valve solenoid S2A across a circuit including common return 176, wiper 179, lead 194, coil of valve solenoid S2A and common return 177. Thus, in the "open" position the valve solenoid S2A is operated to cause the application of the pressurized fluid to be routed through valve 30A to drive the pistons inwardly in their cylinders and to route the fluid from the large piston faces to the tank. Thus, the retarder mechanism is in its "open" or "retracted" position.

When the manual switch 180 is turned to the "weight control" position, the tachometer controlling solenoid S4 is still deenergized. However, a circuit is completed from common lead 176, wiper 179, lead 195 through valve solenoid S1A to line 177 to energize the latter and the lamp 183. With valve solenoid S1A energized, for example, the valve 30A is in the position shown in FIG. 6, directing pressurized fluid to both sides of the pistons and thereby causing application of a light retarding force. However, when a heavy car enters the retarder, the load cell 110 causes the hydraulic pilot 107 to shift the valve 100 to the left-hand position of FIG. 6, whereupon the fluid from the small piston chambers 125 is routed through conduit 117, port 135, conduit 36A, and port 138 to the tank 20A. To release the car, it is necessary to manually operate the switch 180 to the "open" position, whereupon the control solenoid S2A for valve 30A is again operated to cause a retraction operation.

For the purpose of completely disconnecting the electrical system from the hydraulic system, the manual control switch 180 is turned to the "over-ride" position, at which the solenoids S1A, S2A and S4 are not, and cannot be, energized. The solenoid operated valves such as 30, 30A (or 231, FIG. 10, hereinafter described) are then in their respective center positions.

In the embodiments of the invention described hereinbefore, the retarder control systems operate to produce two separate and distinct levels of force application to the car wheels. In the embodiment of the invention shown in FIG. 10, a spring 200 is provided between the opposed pistons 202 in hydraulic cylinder 203 to urge the piston rods 205 outwardly of the cylinder 203 with a first or "light" force. The second or "medium" range of force is provided by the applying of pressurized fluid in the cavities 208 at the end of the cylinders, and simultaneously applying pressurized fluid in a central cavity 210 between the opposed pistons 202. The third or "heavy" level of force is generated by applying the pressurized fluid to the central cavity 210, and connecting the cylinder cavities 208 to a tank 220. By provision of the spring 200, the control system of the present invention is readily capable of adaptation to a three-force-level system selectively applying these distinct levels of retarding forces for three distinct categories of car weights. For example, the retarder mechanism may apply 39,000 lbs. for railroad cars in the 61-105 ton range, 22,500 lbs. for railroad cars in the 35-61 ton range, and 13,000 lbs. for railroad cars in the 20-35 ton range.

When a railroad car having a weight within the lightest weight category is disposed on the traffic rail 212, the weight of the car depresses rams 214 in their respective load cells 213 and causes hydraulic weight signals to be

impressed in the respective pilot lines 215 to actuate the associated valves 216.

The valve 216 has a housing 218 with a spool 219 biased by a spring 222 to the position shown in FIG. 10. The amount of pressure generated by the ram 214 in the pilot line 215 by a lightweight car, acts against an end face 224 of the spool 219 but is not of sufficient force to move the spool rightwardly against the bias of spring 222. Thus, the pilot valve remains in the position illustrated.

With the valve 216 in the "light force" position shown in FIG. 10, pressurized fluid coming from pressure source 228 (identical with the pressure source 28 of FIG. 1) through a supply line 229 is routed through a port 231 in a valve 230 to line 232, and into a port 233 in the valve 216. The pressurized fluid enters the valve 216 through the port 233 into a chamber 235, but is blocked from exiting the valve by a land 236 on the spool 219 that is aligned with an annular shoulder 237 of the valve 216. Thus, the pressurized fluid entering valve 216 through the line 232 and port 233 is blocked from reaching valve outlet ports 238 and 239. The hydraulic cylinder 203 is vented to exhaust by the valves 216 and 230 over paths including lines 242 and 244 leading to the ports 238 of valve 216, lower port 248 of valve 216, line 249, port 250 of valve 230 to tank 220. Thus, one function of the valve 216 is to block the pressurized fluid from entering the hydraulic cylinder 203 and to connect the lines 242 and 244 of the hydraulic cylinder to a line 249 leading to exhaust, whereby only the spring 200 urges the opposed pistons 202 apart to cause the retarder to apply its first or "light" force.

When a car of medium weight is disposed on the traffic rail 212, each ram 214 exerts pressure through its pilot line 215 to shift the spool 219 in the valve 216 to a middle position to admit pressurized fluid from the line 229 to both sides of the pistons 202. More specifically, line 229 supplies pressurized fluid through port 230 to conduit 232 and valve port 233. Pressurized fluid entering the port 233 flows through the chamber 235 and across the shoulder 237 and outport 238 to line 242 leading to the central cavity 210. The spool 219 is shifted to place its land 236 midway in the chamber 260 and pressurized fluid flows around the land 236 and out through port 239 and through conduits 244 to the small sides of the piston faces. Land 262 on spool 219 is in sealing alignment with an annular collar 263 to block the pressurized fluid flowing into the chambers 235 and 260 from reaching the port 248 and conduit 249 leading to the tank 220. Thus, when the valve 216 is in its middle position and pressurized fluid is applied to both ports 238 and 239 and the port 248 is blocked, the pistons 202 cause the retarder to exert its second, intermediate or middle braking force.

When a railroad car in the heavy weight category is disposed on traffic rail 212, the hydraulic load cell 213 generates sufficient pressure in the pilot line 215 to move the spool 219 of valve 216 to engage the right end wall 265 against the bias of the spring 222. In this position, the valve 216 functions to permit pressurized fluid to flow through the valve 216 and to the central cavity 210 while the end chambers 208 of the hydraulic cylinder 203 are connected to the tank 220. Thus, the pressure exerted on the pistons 202 is the maximum, that is, the largest of the three retarding forces. When the valve 216 is shifted to this third position, pressurized fluid flows through port 231 of control valve 230, through line 232 and port 233 into the chambers 235 and 260, and out of the port 238 and through conduit 242 to the central cavity 210. The pistons 202 move apart and the fluid in chambers 208 exhausts over conduits 244, port 239, across annular shoulder 263 and through port 248 and coincident 249 into control valve 230 and through valve port 250 into the tank 220. When the valve 216 is in this third position, the land 236 on spool 219 is in sealing engagement with annular collar 270 to isolate the ports 238 and 239 so that the

pressurized fluid is confined to the left of land 236 and the exhaust fluid is confined to the right of the land 236.

In order to release or retract the retarder mechanism, it is necessary to energize valve solenoid S2 and to reverse the flow of pressurized fluid through control valve ports 272 and 273 in control valve 230. Thus, pressurized fluid from supply line 229 flows through port 272, conduit 249, port 248, port 239 and conduits 244 to drive the opposed pistons 202 towards each other against the bias of the spring 200. The pistons 202 force fluid to exhaust from chamber 210 through line 242, port 238, port 233, line 232, to port 273 of valve 231, and then to the tank 220. After the car has been released, the solenoid S1 is then energized and the control valve 230 is moved to the left position and the load cell permits the spring 222 to move the spool 219 leftwardly to the position of FIG. 10, wherein the fluid from both the chambers 208 and 210 are connected to the tank 220, as described in conjunction with the light retarding force due to the spring 200 only.

The three-force system is also capable of being controlled in the manner described hereinbefore in conjunction with the electrical control circuit of FIG. 9. Upon "over-ride" or shutdown of the electrical controls, both the solenoids S1 and S2 of the control valve 230 de-energize so that the valve 231 returns to its center position where both the pressurized line 229 and pilot valve conduits 232 and 249 are vented to the tank 220 to insure that the retarder system is rendered inoperative except for the retarding force due to the spring 200.

From the foregoing it will be seen that the present invention affords a control system for a retarder mechanism to cause the generation of selectively different operating forces and thereby railroad car retarding forces depending upon the weight or speed or both of the railroad car. Also, the present invention employs a unique load cell which itself has the capability of directing the flow of fluid therethrough to either one or both sides of the fluid operated cylinder for the retarding mechanism.

The present invention also has the advantage of employing relatively few and simple parts, and a single operating pressure which is selectively applied to a large piston face, a small piston face, or both piston faces. The load cell controls selective application to either one or both of the piston faces, and the speed detection device controls the direction of flow so as to move the piston within the cylinder to cause a release or retraction of the retarder mechanism when the speed sensing device ascertains that the railroad car has reached a predetermined release speed.

Hence, while we have illustrated and described preferred embodiments of our invention, it is to be understood that these are capable of variation and modification.

We claim:

1. A control system for a retarder mechanism for selectively applying at least two distinct levels of retarding forces to car wheels of a railroad car in said retarder mechanism, said control system comprising:
 - a load cell means operable to generate at least two distinct weight indicating signals indicative of at least two different weight classifications of railroad cars;
 - fluid cylinder means having piston means adapted to operate said retarder mechanism, said piston means having first and second faces with different effective areas;
 - a source of pressurized fluid of a single pressure for exerting of force on either said first or said second piston face or to both said piston faces simultaneously;
 - valve means connected to said load cell means and operable in response to said weight-indicating signals, for applying said pressurized fluid to said first side of said piston means when said valve is in one position, and to apply said pressurized fluid to both faces of said piston when said valve means is in another position to produce a second retarding force;

a controlling valve means operable to return said piston means to one of said force applying positions by directing fluid only against said second face of said piston means;

and speed sensing means for sensing the speed of a railroad car, said speed sensing means having a comparing circuit for comparing the speed of the car against predetermined standards, said speed sensing means being connected to said controlling valve means to operate said controlling valve means and return said piston means when the railroad car is retarded to a predetermined release speed.

2. A control system for a retarder mechanism for selectively applying at least two distinct operating forces to a retarder mechanism which applies at least two distinct levels of retarding forces to car wheels of a railroad car in said retarder mechanism, a supply means of hydraulic fluid at a single pressure;

an exhaust means for receiving fluid under pressure; a hydraulic cylinder means having at least one piston therein with a large and a small piston face, each piston face to receive fluid under pressure from said supply means;

a hydraulic load cell means operable to generate hydraulic pilot pressure signals indicative of the weight of the railroad car passing over said load cell means; a pilot valve means operable by said hydraulic pressure signals between first and second positions, said pilot valve means having a pair of ports connected to said cylinder means and a pair of ports adapted to be connected to either said supply means or to said exhaust means; and

a remotely controlled valve means operable between a first and second position, said remotely controlled valve means having a pair of ports connected to the ports of said pilot valve means through which pressurized fluid may be supplied and exhausted, said remotely controlled valve having another set of ports adapted to be selectively connected to said source and said exhaust means, operation of said remotely controlled valve means reversing the flow of pressurized fluid to cause flow of fluid through said pilot valve means to cause said piston means to reverse its path of movement.

3. A hydraulic system for selectively affording at least two separate levels of operating forces for a retarding mechanism to control the application of retarding forces to car wheels of railroad cars;

said control system comprising a hydraulic cylinder having a piston and piston rod disposed within said cylinder, said piston having opposed faces with said piston rod making its associated face smaller than the opposite piston face cylinder;

supply means for supplying pressurized fluid for operating said piston within said cylinder means;

a tank adapted to be connected to said cylinder means to receive fluid from a portion of the cylinder at said large piston face or at said piston rod side of the cylinder;

conduit means extending between said supply means and said cylinder means and between said cylinder means and said tank means;

a remotely controlled valve adapted to apply pressurized fluid to said large piston face and to permit flow of fluid from said small piston face when a heavier car is being retarded, said valve means movable to a second position to apply pressurized fluid to small piston face and to permit fluid to flow from said large piston face to said tank when retracting said retarder mechanism; and

a load cell means movable by the weight of a heavy railroad car to permit flow of fluid from small piston face to said tank, said load cell positioned, when a light rail car is thereon, to direct flow of pressur-

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ized fluid to the small piston face while said valve directs fluid to said large piston face to provide a lighter retarding force.

4. The hydraulic system of claim 3, wherein is provided a control means having a speed sensing device for determining the speed of a railroad car, said control means operating said remotely controlled valve to said second position when said railroad car is at or under a predetermined speed.

5. A control system for a retarder mechanism for selectively applying a plurality of distinct levels of retarding forces to car wheels of a railroad car in said retarder mechanism, said control system comprising:

load cell means for determining the weight of a railroad car;

fluid cylinder means having a piston means adapted to operate said retarder mechanism, said piston means having first and second piston faces with different effective areas;

a source of pressurized fluid at a single pressure for exerting force on either said first or second piston faces or to both said first and second piston faces simultaneously;

biasing means for biasing said piston means to a first position for exerting a first level of force for said retarder mechanism; and

valve means connected to said load cell means and operable to direct said pressurized fluid to said first side of first said piston means to produce a second retarding force when said valve means is in said one position, said valve means being operable by said load cell means to a second position to apply said pressurized fluid to both faces of said piston means to produce a third retarding force.

6. A control system for selectively actuating a railroad car retarder to apply retarding forces of at least two distinct levels to the wheels of railroad cars, said control system comprising:

a cylinder having a piston mounted therein and adapted to be moved within said cylinder by the introduction of fluid, under pressure, into said cylinder, said piston having one face of a larger effective area than an opposite face on said piston;

supply means to supply fluid at a predetermined pressure;

control means, connecting said supply means to said cylinder, said control means comprising a weight-responsive load cell operable by the railroad cars and a supply valve actuatable between first and second operating conditions, said supply valve in its first condition connecting said supply means to said load cell and to said larger piston face;

said load cell including a ram and a spool in said ram, the weight of railroad cars up to a predetermined weight moving said ram and spool to direct fluid from said supply valve to the smaller piston face;

the weight of railroad cars above said predetermined weight further moving said ram to exhaust fluid from said small piston face; and

said control means further including means to actuate said supply valve to its second condition wherein said supply valve directs fluid from said supply means to said small piston face and exhausts fluid from said large piston face to return the car retarder to a released position.

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7. A control system according to claim 6 in which said load cell comprises a single multi-position valve interposed between said supply means and said cylinder.

8. A control system according to claim 6 and further including a speed determining device for determining the speed of a railroad car, said speed determining device being connected to said supply valve to actuate said supply valve to its second condition whenever the railroad car reaches a predetermined speed.

9. A control system for selectively actuating a railroad car retarder to apply retarding forces of at least two distinct levels to the wheels of railroad cars comprising:

a supply means of hydraulic fluid under pressure;

an unpressurized reserve tank for hydraulic fluid;

a hydraulic cylinder including a piston having first and second faces of different areas and connected to said car retarder;

a hydraulically actuated control valve, actuatable between first and second operating positions, said control valve having first and second inlet ports and having first and second outlet ports connected to said hydraulic cylinder, for directing fluid under pressure to both piston faces of said hydraulic cylinder when said control valve is in said first position and for directing fluid under pressure against only one of said piston faces when said control valve is in its second condition;

a hydraulic load cell for generating hydraulic pressures corresponding to the weights of railroad cars passing over said load cell, said load cell being connected to said control valve to actuate said control valve between its first and second operating positions; and

a supply valve connecting said supply means to said control valve, said supply valve being actuatable between a first position in which said supply valve connects both inlet ports of said control valve to said supply means, a second position in which said supply valve connects the first inlet port of said control valve to said supply means and connects the second inlet port of said control valve to said reserve tank, thereby directing fluid under pressure against only one of said piston faces for maximum drive in a first direction, and a third position in which said supply valve reverses the fluid pressure connections to said piston faces, relative to said second position, for maximum drive in the opposite direction, maximum drive of said piston in said opposite direction affording a release of said car retarder.

10. A control system according to claim 9 and further comprising speed sensing means for sensing the speed of a railroad car, said speed sensing means being connected to said supply valve to actuate said supply valve to its third position whenever said railroad car is moving at less than a predetermined speed.

11. A control system according to claim 8 in which said speed determining device comprises a plurality of electrical tachometer generators connected in an electrical control circuit for said control means.

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