

March 21, 1961

C. E. STAPLES
AUTOMATIC CONTROL SYSTEM FOR RAILWAY
CAR CLASSIFICATION YARDS

2,976,406

Filed May 2, 1958

6 Sheets-Sheet 1

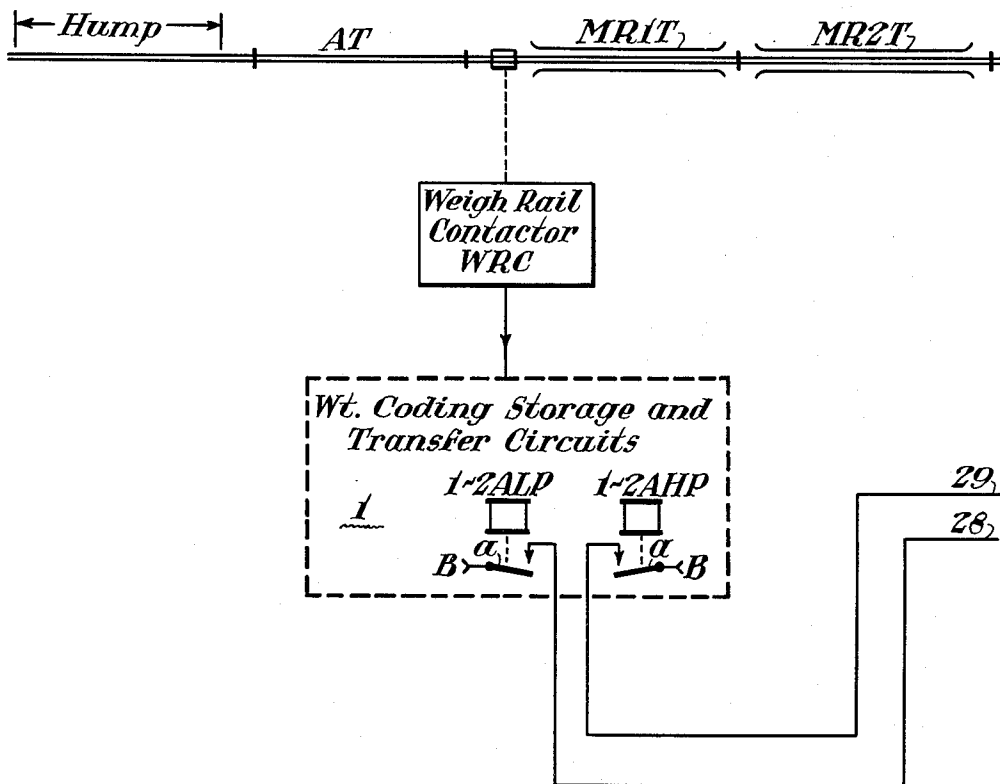


Fig. 1a.

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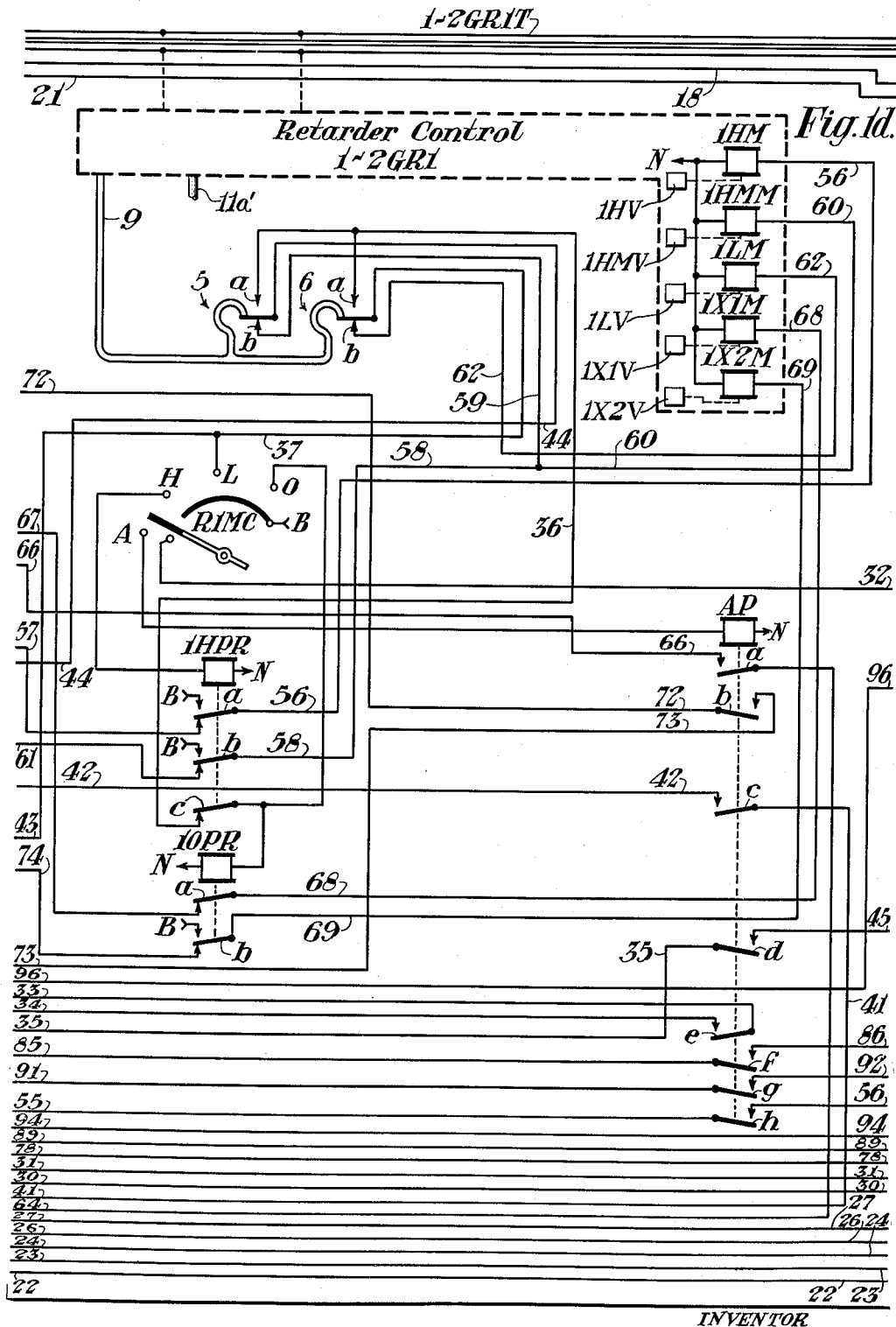
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6 Sheets-Sheet 2



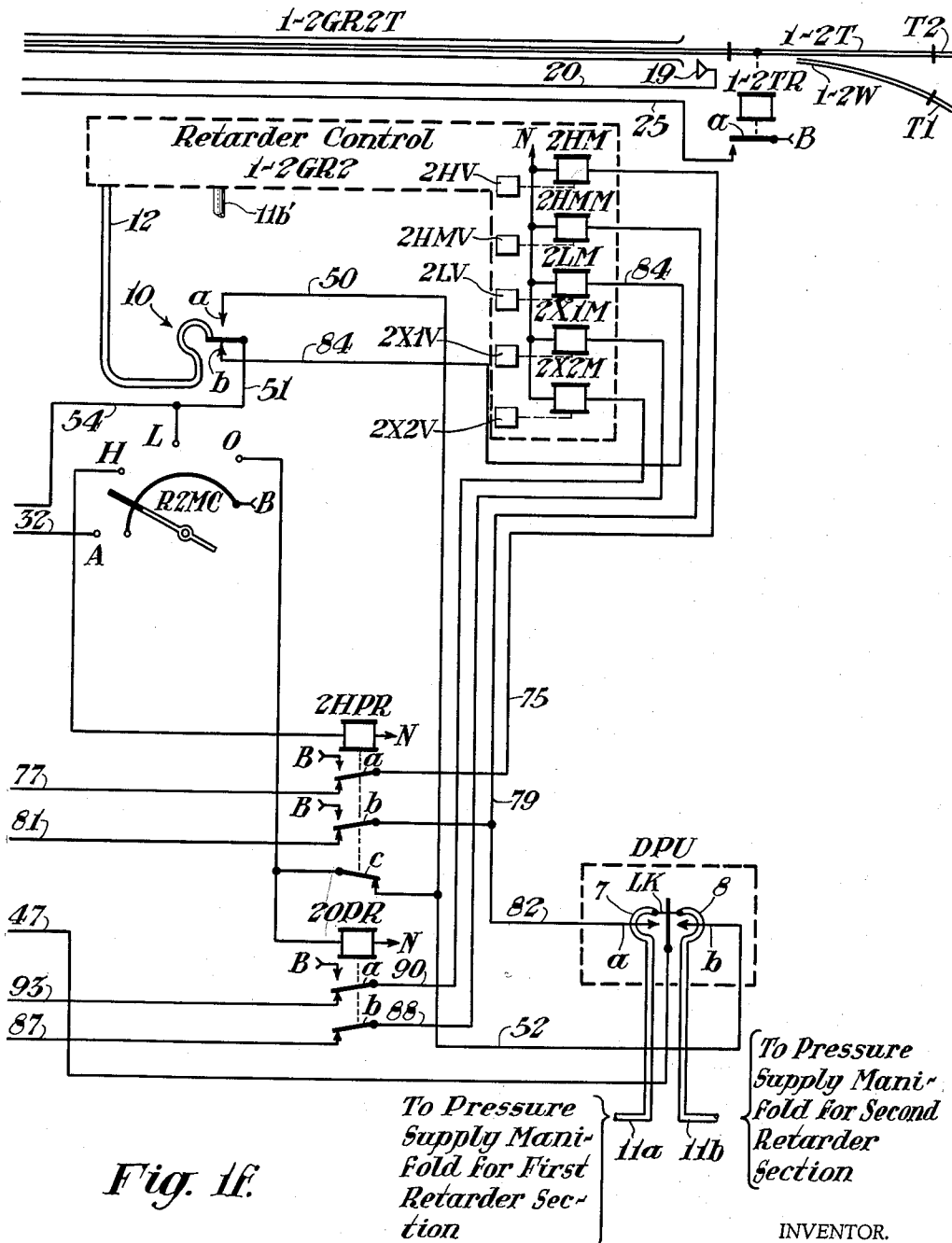
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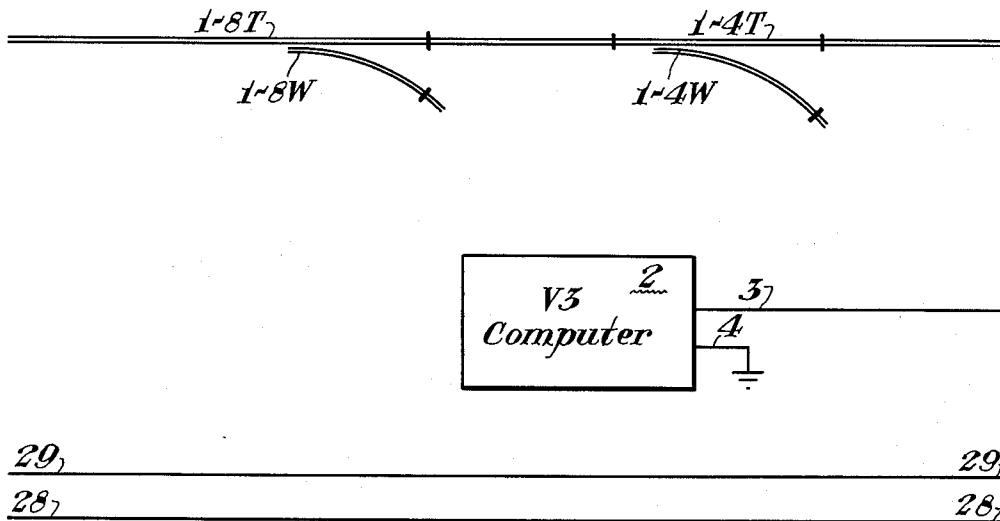


Fig. 1b.

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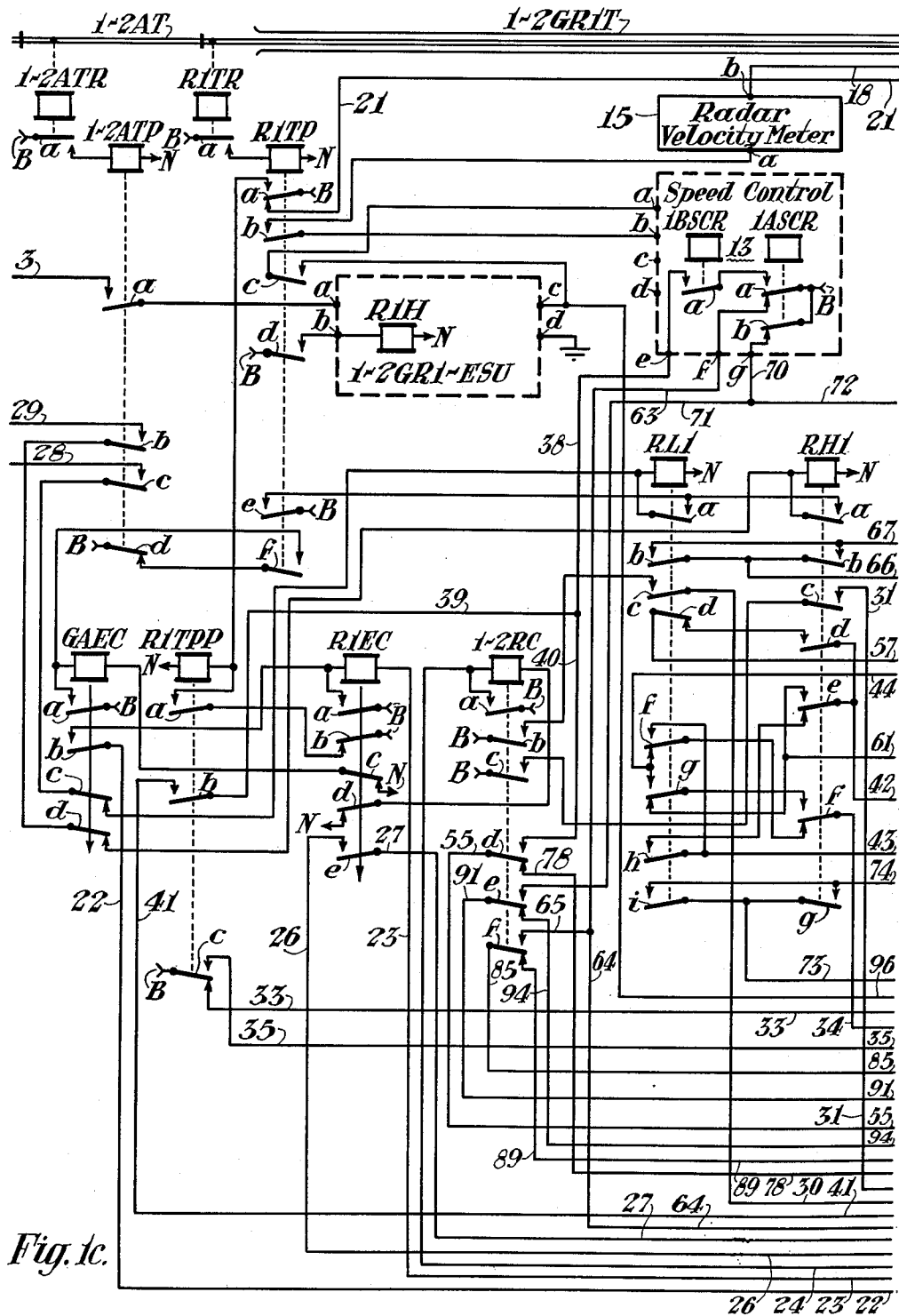
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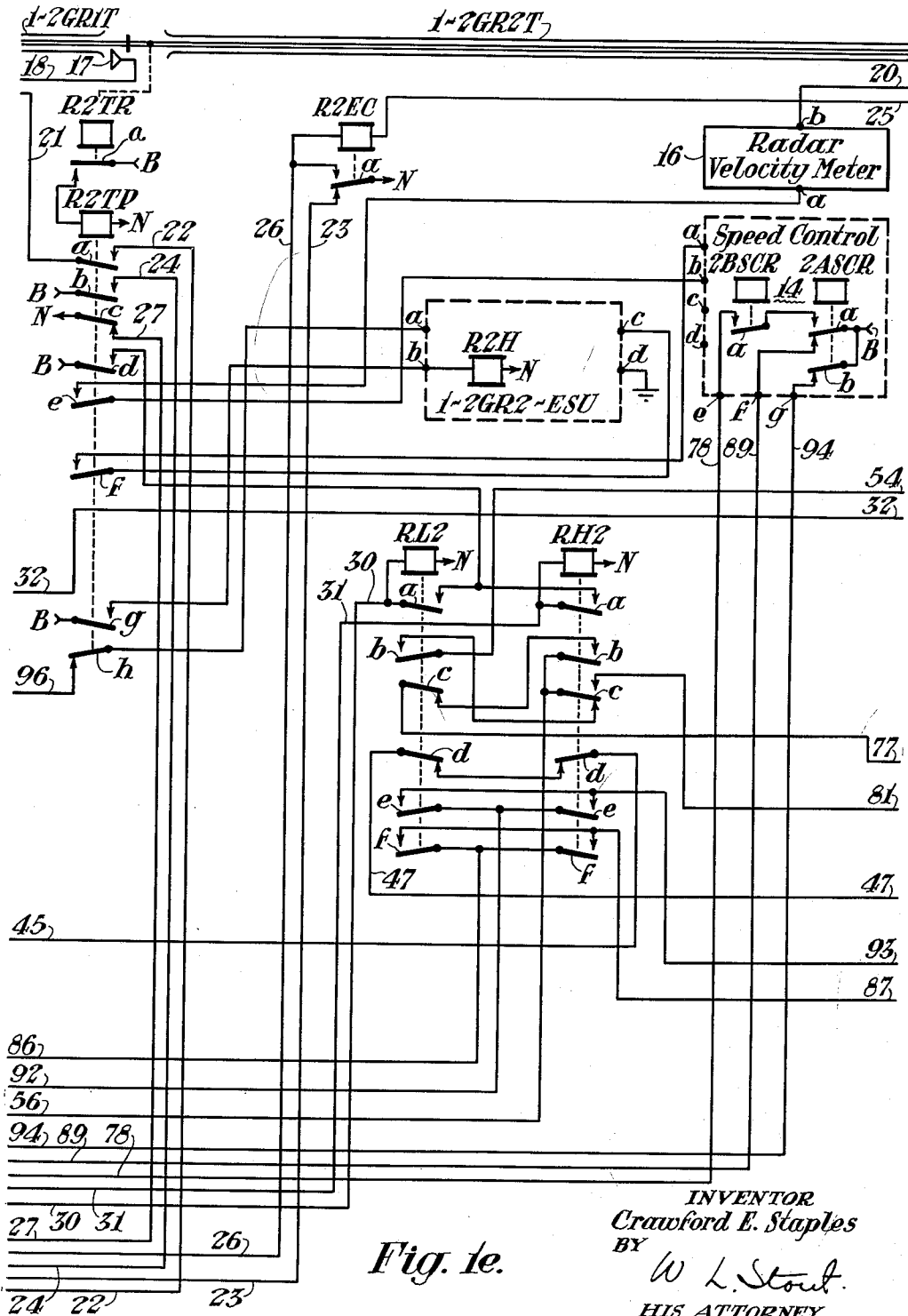
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CAR CLASSIFICATION YARDS

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2,976,406

**AUTOMATIC CONTROL SYSTEM FOR RAILWAY
CAR CLASSIFICATION YARDS**

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Filed May 2, 1958, Ser. No. 732,606

8 Claims. (Cl. 246—182)

My invention relates to an automatic control system for railway car classification yards, and in particular to an improved control system for multiple section car retarders.

In copending application Serial No. 676,730, filed August 7, 1957, by David P. Fitzsimmons and William A. Robison, Jr., for Automatic Control System for Railway Classification Yards, which is assigned to the assignee of my present application, a system is disclosed for automatically routing cuts of one or more railway cars to selected storage track destinations, while at the same time controlling the speed at which they couple with preceding cars on the storage tracks to prevent damage to lading.

In a yard of the class described in said copending application, each storage track is approached from a common hump track over a series of sections comprising an approach track section, a fluid pressure actuated master retarder located in one or more detector track sections, one or more switch detector track sections following the master retarder, a group retarder approach track section, a fluid pressure actuated group retarder located in a plurality of track sections and one or more switch detector track sections following the group retarder.

The group retarders in the yard shown in said application consists of at least two retarder sections comprising a first section and a second section. Under automatic operation, and with the exception of the times when the second retarder section is occupied by a cut of cars, the cylinder pressure of the second section is continuously controlled in accordance with the cylinder pressure in the first retarder section. When the second retarder section is occupied, the cylinder pressure in that section is controlled by the speed control apparatus disclosed in said application.

In order to conserve power and fluid pressure, it is desirable to make changes in the pressure settings of a retarder as infrequently as possible. At the same time, to provide close control of the leaving speed of cuts from the retarders and prevent "nose-diving" of light cars and "runaway" of heavy cars entering the second sections of the retarders, control of the retarder pressure should be as precise as possible. Accordingly, the object of my present invention is to provide an arrangement, operating when the retarders are under automatic control, with which the cylinder pressure of the second section of a group retarder is closely preset in accordance with the cylinder pressure in the first retarder section, but only after a cut of cars enters the first retarder section. Prior to a cut of cars entering the first retarder section, the cylinder pressure in the second retarder section remains at the last pressure to which it has been controlled.

Other objects and characteristic features of my invention will become apparent as the description proceeds.

In accomplishing the foregoing object of my invention, I employ a unit termed a differential pressure unit which consists of two pressure sensitive devices opposing each

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other. One of the said devices is provided for each section of the group retarder. An electrical contact is provided for these devices and is so controlled by said devices that one point of the contact is closed if the pressure of the first retarder section is somewhat greater than the pressure of the second retarder section and the other contact is closed if the pressure of said second section is somewhat greater than the pressure of said first section.

I shall describe one form of apparatus embodying my invention, and shall then point out the novel features thereof in claims.

I have illustrated an embodiment of my invention which is adapted to be employed for the control of a group retarder in a classification yard of the type disclosed in the above copending application. Only those components of the system disclosed in the above copending application which are necessary to the understanding of my invention have been illustrated, and in general these components have been illustrated in block diagram form. However, the correspondence between schematically illustrated components and those shown in detail in the above-mentioned copending application will be readily apparent to those skilled in the art as the description proceeds.

In order to simplify the illustration of the circuits employed in my invention, I have not shown the necessary power supplies in detail. One of these power supplies is a conventional source of D.C. voltage having positive and negative terminals, connections to which are schematically indicated on the drawings by the reference characters B and N, respectively, associated with arrow symbols indicating connections to the battery terminals. The additional power supplies required are shown schematically by a control lead carried from component to component and a ground lead which is returned to a common ground as conventionally indicated. The circuits so shown will be readily identified with those shown in detail in the copending application.

In the drawings, Figs. 1a through 1f, when arranged side by side, comprise a schematic diagram of one embodiment of my invention.

Referring now to the drawings, I have illustrated a pair of routes in a classification yard. These routes terminate in two storage tracks T1 and T2, as shown in Fig. 1f. These storage tracks are approached over a common route. As shown in Fig. 1a, the entrance of this common route comprises a hump followed by an approach track section AT. Following approach track section AT is a master retarder comprising two track sections MR1T and MR2T. Following the master retarder are two switches, designated respectively 1-8W and 1-4W, which are provided with detector track sections 1-8T and 1-4T. These switches control the routes to storage tracks 1-8 and 1-4, respectively, as described in detail in the above copending application.

As pointed out in the above copending application, a number of track sections will normally be provided between each group retarder and the preceding switch. However, for the sake of simplicity I have shown only a single approach track section 1-2AT in this portion of the route. Approach track section 1-2AT is followed by a group retarder comprising two adjacent track sections 1-2GR1T and 1-2GR2T.

The group retarder is followed by at least one switch, here shown as switch 1-2W which controls the routes to tracks T1 and T2, and having a detector track section 1-2T.

Each of the track sections just described is, in practice, provided with track circuits in the manner fully disclosed in the above copending application. Since the majority of these track circuits are not involved in the

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operation of this embodiment of my invention, only the track relays in the track circuits associated with approach track section 1-2AT, group retarder track sections 1-2GR1T and 1-2GR2T, and switch detector track section 1-2T are shown. These track relays, respectively designated as 1-2ATR, R1TR (Fig. 1c), R2TR (Fig. 1e), and 1-2TR (Fig. 1f) are controlled by conventional D.C. track circuits including the rails of their respective track sections in a manner well-known in the art, such that they are energized when their respective sections are unoccupied and released when their respective sections are occupied. The circuits controlled by these track relays will be discussed in detail below.

Referring now to Fig. 1a, in accordance with this embodiment of my invention, a weigh-rail contactor WRC is located just inside the entrance end of master retarder track section MR1T as shown, to be actuated by the wheels of the cars entering section MR1T in accordance with the load on each wheel. In a manner explained more fully in the above-mentioned copending application, the response of contactor WRC is transmitted to weight coding storage and transfer circuits 1, wherein means are provided to advance the weight information for each cut in step with the progress of the cut in its selected route, and finally, when the cut occupies detector track section 1-2AT, for energizing one or both of weight repeater relays 1-2ALP and 1-2AHP in accordance with the registered axle loading of the cut. In particular, for light cars weighing between 16 and 32 tons, relay 1-2ALP is energized and relay 1-2AHP is released. For medium cars weighing between 32 and 50 tons, both of relays 1-2ALP and 1-2AHP are energized. For heavy cars weighing over 50 tons, relay 1-2AHP is energized and relay 1-2ALP is released. Since the circuits for performing this function do not form a part of my present invention, they are not shown in detail. However, they are fully described in the above-mentioned copending application, in which weigh-rail contactor WRC is shown in Fig. 18 and relays 1-2ALP and 1-2AHP are shown as ALP and AHP in Fig. 43.

Referring now to Fig. 1b, a V3 computer 2 is shown which corresponds to V3 computer 22 in Fig. 13 of the above-mentioned copending application. Insofar as my present invention is concerned, it is sufficient to note that this device supplies a D.C. voltage proportional to the desired group retarder leaving speed V3 for each cut between its output lead 3 and grounded lead 4 which is available while the cut occupies detector track section 1-2AT, which may correspond to track section CL4T as shown in Fig. 12 of the above-mentioned copending application. This voltage is supplied to input terminal *a* of storage unit 1-2GR1-ESU, to be described, over lead 3 and front contact *a* of relay 1-2ATP.

Referring now to Fig. 1d, the first section of the group retarder is provided with a retarder control or pressure control unit 1-2GR1 which will be more fully described below. It is sufficient to note for the present that this apparatus controls the braking pressure exerted by the first section of the group retarder in response to the actuation of the intake control magnets 1HM, 1HMM and 1LM or exhaust magnets 1X1M and 1X2M. As fully explained in the aforementioned copending application, magnets 1HM and 1HMM control fast acting valves designated 1HV and 1HMMV, respectively, which in turn control the supply of fluid under pressure to actuating cylinders for the retarders. Magnet 1LM controls a similar but smaller and faster valve 1LV, which also controls the admission of fluid under pressure to the actuating cylinders. Magnet 1X1M controls a valve 1X1V similar to that controlled by magnets 1HM and 1HMM, which valve controls the exhaust of fluid under pressure from the actuating cylinders. Magnet 1X2M controls a large capacity exhaust valve 1X2V which is relatively slower to respond and which also controls the exhaust of fluid under pressure from the cylinders. In operation, exhaust

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magnet 1X2M may be energized alone, or in combination with magnet 1X1M, and one or more of intake magnets 1HM, 1HMM, and 1LM are energized in combination in accordance with the desired rate of response of the retarder as indicated by the weight of the cut. Magnet 1LM alone is used in the control of light cuts, magnet 1HMM alone is used in the control of medium weight cuts, and magnets 1HM and 1HMM are used for heavy cuts in order to get appropriate rates of response for these various weight classification.

The pressure in the actuating cylinders of retarder control 1-2GR1 is indicated by the response of Bourdon tubes 5 and 6, connected by a conduit 9 to the supply manifold for the actuating cylinders, not shown. Bourdon tube 5 is adapted to close its front contact *a* when the pressure in the first section exceeds 64 p.s.i. and to close its back contact *b* when the pressure is less than 59 p.s.i. This Bourdon tube is used to preset the first section of the retarder for medium weight cars, and to establish a standby pressure in the first section. Bourdon tube 6 closes its front contact *a* when the pressure exceeds 39 p.s.i. and its back contact *b* when the pressure goes below 32 p.s.i. This tube is used to establish a pressure ceiling for light weight cars and to preset the first section of the retarder for light weight cars.

Referring now to Fig. 1f, the second section of the group retarder is provided with a retarder control or pressure control unit 1-2GR2 which may be identical with the first pressure control unit, just described, with certain exceptions shown in the drawings which will hereinafter be more fully described. This pressure control unit is provided with intake control magnets 2HM, 2HMM and 2LM, and with exhaust magnets 2X1M and 2X2M. Exhaust magnet 2X2M is used alone, or in parallel with magnet 2X1M, for automatic control, magnet 2X1M controlling a fast acting valve 2X1V of relatively small capacity, and magnet 2X2M controlling a slower acting valve 2X2V of large capacity. For light cuts, magnet 2LM is used alone to control a high speed relatively low capacity intake valve 2LV. For medium weight cuts, intake magnet 2HMM is used alone to control a fast acting valve 2HMMV of the same size of that controlled by magnet 2X1M and of approximately twice the capacity of the valve controlled by magnet 2LM. Magnet 2HM controls a valve 2HVV similar to that controlled by magnet 2HMM, and is used in parallel with magnet 2HMM to provide a rapid rate of response for the control of heavy cars.

Retarder control 1-2GR2 is provided with a Bourdon tube 10 which is connected to the fluid supply manifold in retarder control 1-2GR2 by a conduit 12. Bourdon tube 10 is set to close its front contact *a* when the pressure in the second section exceeds 39 p.s.i. and to close its back contact *b* when the pressure is less than 32 p.s.i. This tube is used to establish a pressure ceiling for light cars in the second section of the group retarder.

There is also shown in Fig. 1f the previously mentioned differential pressure unit designated DPU and here shown as two Bourdon tubes designated 7 and 8. Bourdon tube 7 is connected by a conduit 11a-11a' to the supply manifold for the actuating cylinders of the first section of the retarder, and Bourdon tube 8 is connected by a conduit 11b-11b' to the supply manifold for the actuating cylinders of the second section of the retarder. For purposes of simplicity these supply manifolds are not shown in the drawings. Bourdon tubes 7 and 8 are mechanically linked to each other by a connecting strip LK in such a manner as to be mechanically opposed. This arrangement of Bourdon tubes is so constructed and the tubes so proportioned that the front point *a* of a movable electrical contact operated by the Bourdon tubes is closed when the pressure in the cylinders of the first section of the retarder exceeds that in the cylinders of the second section of the retarder by a pressure of a predetermined value such as 4 p.s.i. The back point *b* of the contact

is closed when the pressure in the cylinders of the second section of the retarder exceeds that in the cylinders of the first section by the same amount of pressure. The operation and utility of this differential pressure unit including the electrical contact will become apparent as this description proceeds.

A speed control unit 13 (Fig. 1c) is provided for the first section of the group retarder, and at times also controls the second section, as will be described. A second speed control unit 14 (Fig. 1e) is provided for the second section of the group retarder. These speed control units are identical with those described in the above copending application, and will, therefore, not be described in detail. Each of these speed control units includes a pair of control relays which are energized in accordance with the measured speed of the cut as compared with its desired speed.

In speed control unit 13, relay 1ASCR is energized and relay 1BSCR is released when the speed of the cut is as desired. When the speed of the cut falls below the desired speed, relay 1ASCR is released and exhaust terminals *f* and *g* of the speed control unit are energized from terminal B of the battery over the back point of contact *a* and back contact *b*, respectively, of relay 1ASCR. If the speed of the cut is above the desired speed, both relays 1ASCR and 1BSCR are energized, and intake terminal *e* of the speed control unit is energized from terminal B of the battery over the front point of contact *a* of relay 1ASCR and front contact *a* of relay 1BSCR.

Speed control unit 14 in Fig. 1e operates in the same manner as described for speed control unit 13 in Fig. 1c. That is, relay 2BSCR corresponds to relay 1BSCR in unit 13 and relay 2ASCR corresponds to relay 1ASCR in unit 13. Accordingly, when the speed of the cut is correct, none of the terminals *e*, *f* and *g* of unit 14 are energized. If the speed of the cut is too high, intake terminal *e* is energized over front contacts *a* of relays 2BSCR and 2ASCR. If the speed of the cut is too low, exhaust terminals *f* and *g* are energized over back contacts *a* and *b*, respectively, of relay 2ASCR.

Speed control units 13 and 14 further include input terminals *a* and *b*, to which the selected speed and measured speed, respectively, for each cut are supplied in terms of voltages proportional to their values, as will appear.

Input terminal *a* of speed control unit 13 (Fig. 1c) has an energizing circuit extending from output terminal *c* of storage unit 1-2GR1-ESU, to be described, over front contact *c* of relay R1TP. Input terminal *b* of speed control unit 13 has an energizing circuit extending from output terminal *a* of radar velocity meter 15, to be described, over front contact *b* of relay R1TP. Accordingly, terminals *a* and *b* are energized with voltages proportional to the desired speed and the measured speed, respectively, of cuts occupying track section 1-2GR1T.

Input terminal *a* of speed control unit 14 (Fig. 1e) has an energizing circuit extending from output terminal *c* of storage unit 1-2GR2-ESU, to be described, over front contact *f* of relay R2TP. Input terminal *b* of speed control unit 14 has an energizing circuit extending from output terminal *a* of radar velocity meter 16, to be described, over front contact *e* of relay R2TP. Accordingly, terminals *a* and *b* are energized with voltages proportional to the desired speed and the measured speed, respectively, of cuts occupying track section 1-2GR2T.

Each section of the group retarder is provided with a radar velocity meter, radar velocity meter 15 being provided for the first section of the group retarder (Fig. 1c) and radar velocity meter 16 being provided for the second section (Fig. 1e). Terminals *b* of these radar velocity meters are connected to suitable antennas 17 and 19, respectively, through conventional wave guides 18 and 20, respectively, as schematically illustrated, and the output terminals *a* of these meters are at times connected to

the input terminals *b* of their corresponding speed control units, as has been described.

As shown in Fig. 1e, antenna 17 for radar velocity meter 15 is located adjacent the exit end of track section 1-2GR1T in the first section of the group retarder and is connected to input terminal *b* of velocity meter 15 over wave guide 18. Antenna 19 for radar velocity meter 16 is located adjacent the exit end of track section 1-2GR2T and is connected to input terminal *b* of meter 16 over wave guide 20. Velocity meters 15 and 16 accordingly respond to measure the speeds of cuts occupying their respective sections.

The leaving speed for each cut from the group retarder is established by V3 computer 2, described above. The leaving speed computed by computer 2 is made available to speed control unit 13 in the first section of the group retarder from a first electronic storage unit 1-2GR1-ESU (Fig. 1c). The computed leaving speed is made available to the second section of the group retarder from a second electronic storage unit 1-2GR2-ESU (Fig. 1e).

These storage units have been described in detail in the above copending application and will accordingly not be described here. It is sufficient for the purposes of describing my invention to note that, when required by the group retarder, these storage units provide output voltages between their output terminals *c* and ground terminals *d* which are a measure of the stored computed leaving speed. These output voltages are at times connected to terminals *a* of speed control units 13 and 14 of the group retarder by the circuits described above.

A voltage to be stored in one of these units is supplied between input terminal *a* of the unit and ground, and the storage is made final and maintained when a storage relay R1H in unit 1-2GR1-ESU and R2H in unit 1-2GR2-ESU is energized by a voltage applied from terminal B of the battery to input terminal *b* of the storage unit.

Terminal *a* of storage unit 1-2GR1-ESU is energized from output lead 3 of V3 computer 2 over front contact *a* of relay 1-2ATP as previously described. Terminal *b* of storage unit 1-2GR1-ESU has an energizing circuit which extends from terminal B of the battery over front contact *d* of relay R1TP. Accordingly, relay R1H is picked up and the storage in this unit is made final when track section 1-2GR1T is occupied.

Terminal *a* of storage unit 1-2GR2-ESU is energized from output terminal *c* of storage unit 1-2GR1-ESU over lead 96 and back contact *h* of relay R2TP. The stored desired speed voltage in unit 1-2GR1-ESU is accordingly supplied to unit 1-2GR2-ESU prior to the occupancy of track section 1-2GR2T. Terminal *b* of storage unit 1-2GR2-ESU is energized from terminal B of the battery over front contact *g* of relay R2TP to make the stored voltage final when track section 1-2GR2T is occupied.

The first section of the group retarder has a lever R1MC (Fig. 1d), and the second section has a corresponding lever R2MC (Fig. 1f). Each of these levers has a series of control contacts, comprising a first set of contacts A which are closed in the automatic condition of the apparatus, a second set of contacts H, closed when it is desired to control a heavy or a medium cut manually, a third set of contacts L, closed when it is desired to control a light cut manually, and a fourth set of contacts Q, closed when it is desired to open the retarder.

A group of control relays are provided for marking the progress of cuts through the group retarder, and for controlling the sequence of operation of the group retarder during its occupancy by a cut. As shown in Fig. 1c, these relays comprise track repeater relays 1-2ATP, R1TP and R1TPP, end-of-cut relays GAEC and R1EC, and relay 1-2RC, which is picked up when the cut occupies both sections 1-2GR1T and 1-2GR2T. In Fig. 1e, there are shown track repeater relay R2TP and end-

of-cut relay R2EC. The control circuits for these relays will now be described.

Track repeater relay 1-2ATP (Fig. 1c) is energized over an obvious circuit which extends from terminal B of the battery over back contact *a* of track relay 1-2ATR, and through the winding of the relay to terminal N of the battery. This relay is accordingly energized when approach track section 1-2AT is occupied.

Repeater relay R1TP (Fig. 1c) has an obvious energizing circuit which extends from terminal B of the battery over back contact *a* of relay R1TR and through the winding of the relay to terminal N of the battery. This relay is accordingly picked up when track section 1-2GR1T is occupied.

Repeater relay R1TPP (Fig. 1c) has a pickup circuit which extends from terminal B of the battery over the front point of contact *a* of relay R1TP and through the winding of the relay to terminal N of the battery. Relay R1TPP has a stick circuit which extends from terminal B of the battery over back contact *b* of relay R1EC, to be described, its own front contact *a*, and through the winding of the relay to terminal N of the battery. This relay is accordingly picked up when track section 1-2GR1T is occupied, and, as will appear, it is then held up until track section 1-2GR1T is cleared.

Repeater relay R2TP (Fig. 1e) has an obvious energizing circuit which extends from terminal B of the battery over back contact *a* of track relay R2TR and through the winding of the relay to terminal N of the battery. This relay is accordingly picked up when track section 1-2GR2T is occupied.

End-of-cut relay GAEC (Fig. 1c) has a pickup circuit which extends from terminal B of the battery over back contact *d* of relay 1-2ATP, front contact *f* of relay R1TP, and through the winding of the relay, and over back contact *c* of relay R1EC to terminal N of the battery. Relay GAEC has a stick circuit which extends from terminal B of the battery over its own front contact *a*, through its winding, and over back contact *c* of relay R1EC to terminal N of the battery. This relay is accordingly picked up with track section 1-2GR1T occupied when track section 1-2AT has been vacated, and once picked up, is held up until track section 1-2GR1T is cleared. Relay GAEC is made somewhat slow to release, as indicated, for reasons to appear.

End of cut relay R1EC (Fig. 1c) has a pickup circuit which extends from terminal B of the battery over the back point of contact *a* of relay R1TP, lead 21, front contact *a* of relay R2TP (Fig. 1e), lead 22, front contact *b* of relay GAEC, through the winding of relay R1EC, lead 23, and over the back point of contact *a* of relay R2EC (Fig. 1e) to terminal N of the battery. Relay R1EC has a stick circuit which extends from terminal B of the battery over its own front contact *a*, through its winding, over lead 23, and over the back point of contact *a* of relay R2EC to terminal N of the battery. This relay is accordingly picked up when track section 1-2GR1T is cleared and is held up until track section 1-2GR2T is cleared. Relay R1EC is made somewhat slow to release, as indicated, for reasons which will appear.

Relay 1-2RC (Fig. 1c) has a pickup circuit which extends from terminal B of the battery over front contact *b* of relay R2TP (Fig. 1e), lead 24, through the winding of relay 1-2RC, and over back contact *d* of relay R1EC to terminal N of the battery. Relay 1-2RC has a stick circuit which extends from terminal B of the battery over its own front contact *a*, through the winding of the relay, and over back contact *d* of relay R1EC to terminal N of the battery. This relay is accordingly picked up when track section 1-2GR2T is occupied, as indicated by the energized condition of relay R2TP, and while the cut is still shunting section 1-2GR1T, as indicated by the released condition of end-of-cut relay R1EC.

Relay R2EC (Fig. 1e) has a pickup circuit which extends from terminal B of the battery over back contact *a*

of track relay 1-2TR (Fig. 1f), lead 25, through the winding of relay R2EC, lead 26, over front contact *e* of relay R1EC (Fig. 1c), lead 27, and over back contact *c* of relay R2TP to terminal N of the battery. Relay R2EC has a stick circuit which extends from terminal B of the battery over back contact *a* of relay 1-2TR, lead 25, through the winding of relay R2EC, and over the front point of contact *a* of relay R2EC to terminal N of the battery. Relay R2EC is accordingly picked up when track section 1-2GR2T is cleared, and is held up as long as track section 1-2T is occupied.

The first section of the group retarder is provided with two weight storage relays RL1 and RH1 (Fig. 1c) and the second section is provided with two weight storage relays RL2 and RH2 (Fig. 1e). The control circuits for these storage relays will now be described.

Relay RL1 (Fig. 1c) has a pickup circuit which extends from terminal B of the battery over front contact *a* of relay 1-2ALP (Fig. 1a), lead 28, front contact *c* of relay 1-2ATP, back contact *c* of relay GAEC, and through the winding of relay RL1 to terminal N of the battery. Relay RL1 has a stick circuit which extends from terminal B of the battery over front contact *e* of relay R1TP, its own front contact *a*, and through the winding of the relay to terminal N of the battery. This relay is accordingly picked up if relay 1-2ALP is picked up when a cut occupies approach track section 1-2AT, and is held up thereafter as long as track section 1-2GR1T is occupied.

Relay RH1 (Fig. 1c) has a pickup circuit which extends from terminal B of the battery over front contact *a* of relay 1-2AHP (Fig. 1a), lead 29, front contact *b* of relay 1-2ATP, back contact *d* of relay GAEC, and through the winding of relay RH1 to terminal N of the battery. Relay RH1 has a stick circuit which extends from terminal B of the battery over front contact *e* of relay R1TP, its own front contact *a*, and through its winding to terminal N of the battery. This relay is accordingly picked up if relay 1-2AHP is picked up when track section 1-2AT is occupied, and is held up thereafter as long as track section 1-2GR1T is occupied.

Relay RL2 (Fig. 1e) has a pickup circuit which extends from terminal B of the battery over front contact *b* of relay 1-2RC, front contact *c* of relay RL1, lead 30, and through the winding of relay RL2 to terminal N of the battery. Relay RL2 has a stick circuit which extends from terminal B of the battery over front contact *d* of relay R2TP, its own front contact *a*, and through the winding of the relay to terminal N of the battery. Relay RL2 is accordingly picked up if relay RL1 is picked up when relay 1-2RC is energized, and once picked up, is held up as long as section 1-2GR2T is occupied.

Relay RH2 (Fig. 1e) has a pickup circuit which extends from terminal B of the battery over front contact *c* of relay 1-2RC (Fig. 1c), front contact *c* of relay RH1, lead 31, and through the winding of relay RH2 to terminal N of the battery. Relay RH2 has a stick circuit which extends from terminal B of the battery over front contact *d* of relay R2TP, its own front contact *a*, and through the winding of the relay to terminal N of the battery. Relay RH2 is accordingly picked up if relay RH1 is picked up when relay 1-2RC is picked up, and once picked up, is held up as long as track section 1-2GR2T is occupied.

Relay AP (Fig. 1d) is picked up when the retarder is under automatic control. This relay has an energizing circuit which extends from terminal B of the battery over the contacts of lever R2MC (Fig. 1f) in its A position, lead 32, the contacts of lever R1MC in its A position, and through the winding of relay AP to terminal N of the battery.

Two additional control relays are associated with the first section of the group retarder. These are relays 1HPR and 10PR, shown in Fig. 1d, the control circuits for which will now be described.

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Relay 1HPR (Fig. 1d) has an obvious pickup circuit extending from terminal B of the battery over the contacts of lever R1MC in its H position and through the winding of the relay to terminal N of the battery. The lever is moved to its H position to energize this relay whenever it is desired to apply manually a heavy braking pressure suitable for cuts of heavy or medium weight.

Relay 10PR (Fig. 1d) has a first pickup circuit extending from terminal B of the battery over the contacts of lever R1MC in its O position and through the winding of the relay to terminal N of the battery. The lever is moved to position O when it is desired to open the retarder, and relay 10PR will be continuously energized while the lever is in this position. Relay 10PR has a second pickup circuit which extends from terminal B of the battery over the back point of contact c of relay R1TPP (Fig. 1c), lead 33, front contact e of relay AP (Fig. 1d), lead 34, the back point of contact f of relay RH1, the front point of contact f of relay RL1, lead 43, lead 37, front contact a of Bourdon tube 6, closed when the pressure in the first section exceeds 39 p.s.i., lead 36, back contact c of relay 1HPR, and through the winding of relay 10PR to terminal N of the battery. This circuit is employed to pick up relay 10PR before section 1-2GRIT is occupied, but after it has been established that the weight of the next cut is light, to maintain the preset pressure of the first section below 39 p.s.i. Relay 10PR has a third pickup circuit which extends from terminal B of the battery over the contacts of lever R1MC in its L position, lead 37, front contact a of Bourdon tube 6, closed when the pressure in the first section exceeds 39 p.s.i., lead 36, back contact c of relay 1HPR, and through the winding of relay 10PR to terminal N of the battery. This circuit is used to establish a pressure ceiling of 39 p.s.i. for light cuts under manual control. Relay 10PR has a fourth pickup circuit extending from terminal e of speed control unit 13 (Fig. 1c), energized when the speed of the cut is above the desired value to request more air pressure in the retarder, lead 38, lead 39, front contact b of relay R1TPP, lead 41, front contact c of relay AP, lead 42, the back point of contact e of relay RH1, front contact h of relay RL1, lead 43, lead 37, front contact a of Bourdon tube 6, lead 36, back contact c of relay 1HPR, and through the winding of relay 10PR to terminal N of the battery. This circuit is employed to enforce a pressure ceiling of 39 p.s.i. on light cars under automatic control. Relay 10PR has a fifth pickup circuit extending from terminal B of the battery over the back point of contact c of relay R1TPP, lead 33, front contact e of relay AP, lead 34, the front point of contact f of relay RH1, the front point of contact g of relay RL1, lead 44, front contact a of Bourdon tube 5, lead 36, back contact c of relay 1HPR, and through the winding of relay 10PR to terminal N of the battery. This circuit is used in presetting the first section of the retarder for medium weight cars to prevent the pressure from exceeding 64 p.s.i. Relay 10PR has a sixth pickup circuit extending from terminal B of the battery over the back point of contact c of relay R1TPP, lead 33, front contact e of relay AP, lead 34, the back point of contact f of relay RH1, the back point of contact f of relay RL1, lead 44, front contact a of Bourdon tube 5, lead 36, back contact c of relay 1HPR, and through the winding of relay 10PR to terminal N of the battery. This circuit is used to establish standby pressure in the group retarder at a maximum of 64 p.s.i.

Two additional control relays are provided for the second section of the retarder. These are relays 2HPR, and 20PR, as shown in Fig. 1f. The control circuits for these relays will now be described.

Relay 2HPR (Fig. 1f) has an obvious pickup circuit extending from terminal B of the battery over the contacts of lever R2MC in its H position and through

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the winding of the relay to terminal N of the battery. Accordingly, relay 2HPR is energized when the lever is set manually to its H position, and, as will appear, it then controls circuits which energize intake magnets 2HM and 2HMM in parallel to provide a rapid increase in pressure, and to maintain a relatively high pressure, in the second section during the manual control of heavy or medium weight cuts.

Relay 20PR (Fig. 1f) has a first pickup circuit extending from terminal B of the battery over the contacts of lever R2MC in its O position and through the winding of the relay to terminal N of the battery. This relay is thus energized when it is desired to open the second section of the retarder, and, as will appear, completes circuits to maintain exhaust magnet 2X2M energized at such times. Relay 20PR has a second pickup circuit extending from terminal B of the battery over the front point of contact c of relay R1TPP (Fig. 1c), lead 35, front contact d of relay AP (Fig. 1d), lead 45, back contacts d of relays RH2 and RL2 in series, lead 47, back contact b of differential pressure unit DPU, closed when the pressure in the second section is approximately 4 p.s.i. or more, greater than the pressure in the first section, lead 52, back contact c of relay 2HPR, and through the winding of relay 20PR to terminal N of the battery. This circuit is used in conjunction with a circuit (to be traced later on in this description) over front contact a of the differential pressure unit to establish a preset pressure in the second section of the retarder within 4 p.s.i. of the pressure in the first section of the retarder when a cut of cars enters the track section associated with the first section of the retarder and before the cut enters the track section associated with the second section of the retarder. Relay 20PR has a third pickup circuit which extends from terminal B of the battery over the contacts of lever R2MC in its L position, lead 51, front contact a of Bourdon tube 10, closed when the pressure in the second section exceeds 39 p.s.i., lead 50, back contact c of relay 2HPR and through the winding of relay 20PR to terminal N of the battery. This circuit is used during the manual control of light cuts to maintain the pressure in the second section below 39 p.s.i. Relay 20PR has a fourth pickup circuit extending from terminal e of the first section speed control unit 13 (Fig. 1c) over leads 38 and 40, the front point of contact d of relay 1-2RC, lead 55, front contact h of relay AP, lead 56, the back point of contact c of relay RH2, front contact b of relay RL2, lead 54, lead 51, front contact a of Bourdon tube 10, lead 50, back contact c of relay 2HPR, and through the winding of relay 20PR to terminal N of the battery. This circuit is employed during the time that the cut occupies both sections of the group retarder to maintain a ceiling of 39 p.s.i. for light cuts, even though increased braking may then be requested by the first section speed control unit. Relay 20PR has a fifth pickup circuit which extends from terminal e of the second section speed control unit 14 (Fig. 1c) over lead 73, back point of contact d of relay 1-2RC, lead 55, front contact h of relay AP, lead 56, the back point of contact c of relay RH2, front contact b of relay RL2, lead 54, lead 51, front contact a of Bourdon tube 10, lead 50, back contact c of relay 2HPR and through the winding of relay 20PR to terminal N of the battery. This circuit is employed when the cut occupies the second section only of the group retarder to maintain a ceiling of 39 p.s.i. for light cuts.

The energizing circuits for the control relays having been described, the circuits controlled thereby for actuating the intake and exhaust magnets in the pressure control units for the first and second sections of the retarder will now be described.

Intake magnet 1HM (Fig. 1d) has a first pickup circuit extending from terminal B of the battery over the front point of contact a of relay 1HPR, lead 56, and through the winding of magnet 1HM to terminal N of the battery. This circuit is used in the manual control of heavy and

medium cuts to assist in maintaining a high braking pressure. Magnet 1HM has a second pickup circuit which extends from terminal *e* of speed control unit 13 (Fig. 1c), leads 38 and 39, front contact *b* of relay R1TPP, lead 41, front contact *c* of relay AP, lead 42, front contact *d* of relay RH1, back contact *d* of relay RL1, lead 57, the back point of contact *a* of relay 1HPR, lead 56, and through the winding of magnet 1HM to terminal N of the battery. This circuit is used to energize magnet 1HM in the control of heavy cuts when the combined speed characteristics of the cut demand more braking as evidenced by the energized condition of terminal *e* of speed control unit 13.

Magnet 1HMM has a first pickup circuit extending from terminal B of the battery over the front point of contact *b* of relay 1HPR, lead 58, lead 60, and through the winding of magnet 1HMM to terminal N of the battery. By this circuit, magnet 1HMM is energized in conjunction with magnet 1HM to bring about a rapid increase in braking pressure for the manual control of heavy and medium cuts. Magnet 1HMM has a second pickup circuit extending from terminal *e* of speed control unit 13 over leads 38 and 39, front contact *b* of relay R1TPP, lead 41, front contact *c* of relay AP, lead 42, the front point of contact *e* of relay RH1, lead 61, the back point of contact *b* of relay 1HPR, leads 58 and 60, and through the winding of magnet 1HMM to terminal N of the battery. This circuit is employed to energize magnet 1HMM together with magnet 1HM in the automatic control of heavy cuts, and to energize magnet 1HMM alone, in the automatic control of medium weight cuts, to apply increased braking pressure when requested by the energized condition of speed control terminal *e* in the first section. Magnet 1HMM has a third pickup circuit which extends from terminal B of the battery over the back point of contact *c* of relay R1TPP (Fig. 1c), lead 33, front contact *e* of relay AP, lead 34, the back point of contact *f* of relay RH1, the back point of contact *f* of relay RL1, lead 44, back contact *b* of Bourdon tube 5, leads 59 and 60, and through the winding of magnet 1HMM to terminal N of the battery. This circuit is used to establish a standby pressure of at least 59 p.s.i. in the first section. Magnet 1HMM has a fourth pickup circuit extending from terminal B of the battery over the back point of contact *c* of relay R1TPP, lead 33, front contact *e* of relay AP, lead 34, the front point of contact *f* of relay RH1, the back point of contact *g* of relay RL1, lead 61, back point of contact *b* of relay 1HPR, leads 58 and 60, and through the winding of magnet 1HMM to terminal N of the battery. This circuit is used to preset the first section of the retarder when the approach of a heavy cut is indicated.

Magnet 1LM (Fig. 1d) has a first pickup circuit extending from terminal B of the battery over the back point of contact *c* of relay R1TPP (Fig. 1c), lead 33, front contact *e* of relay AP, lead 34, the back point of contact *f* of relay RH1, the front point of contact *f* of relay RL1, lead 43, lead 37, back contact *b* of Bourdon tube 6, closed when the pressure is below 32 p.s.i., lead 62, and through the winding of magnet 1LM to terminal N of the battery. This circuit is used to preset the first section to at least 32 p.s.i. on the approach of a light weight cut. Magnet 1LM has a second pickup circuit extending from terminal B of the battery over the contacts of lever R1MC (Fig. 1d) in its L position, lead 37, back contact *b* of Bourdon tube 6, lead 62, and through the winding of magnet 1LM to the terminal N of the battery. This circuit is used to maintain the pressure in the first section above 32 p.s.i. in the manual control of light cuts. Magnet 1LM has a third pickup circuit extending from terminal *e* of speed control unit 13 over the leads 38 and 39, front contact *b* of relay R1TPP, lead 41, front contact *c* of relay AP, lead 42, the back point of contact *e* of relay RH1, front contact *h* of relay RL1, leads 43 and 37, back contact *b* of Bourdon tube 6, lead 62, and through the winding of magnet 1LM to terminal N of the battery. This circuit is used in the automatic control of light cuts

to maintain the pressure above 32 p.s.i. when the speed control unit requests more braking.

Exhaust magnet 1X1M (Fig. 1d) has an energizing circuit extending from terminal *f* of speed control unit 13 (Fig. 1c), which is energized when it is desired to reduce the braking pressure during automatic control, over leads 63 and 64, front contact *a* of relay AP, lead 66, front contact *b* of relay RH1 and front contact *b* of relay RL1 in multiple, thus providing a circuit path for any weight registration other than 0, lead 67, back contact *a* of relay 10PR, lead 68, and through the winding of magnet 1X1M to terminal N of the battery. Magnet 1X1M is accordingly energized during automatic control when the combined speed characteristics of the cut are less than the desired value.

Exhaust magnet 1X2M (Fig. 1d) has a first energizing circuit extending from terminal B of the battery over the front point of contact *b* of relay 10PR, lead 69, and through the winding of magnet 1X2M to terminal N of the battery. Magnet 1X2M is accordingly energized under any of the conditions previously described in which relay 10PR is energized. Exhaust magnet 1X2M has a second energizing circuit extending from terminal *g* of speed control unit 13, which is energized when the combined speed characteristics of a cut under automatic control are below the desired value, over leads 70 and 72, front contact *b* of relay AP, lead 73, front contacts *i* of relay RL1 and *g* of relay RH1 in multiple, lead 74, the back point of contact *b* of relay 10PR, lead 69, and through the winding of magnet 1X2M to terminal N of the battery. Magnet 1X2M is accordingly energized in parallel with magnet 1X1M during automatic speed control when it is desired to reduce the braking pressure. As previously described, under these conditions, magnet 1X1M provides a rapid response, which is quickly sensed by the velocity meter, and magnet 1X2M provides additional capacity when its associated valve is opened.

Turning now to the control magnets of second section pressure control unit 1-2GR2, intake magnet 2HM (Fig. 1f) has a first energizing circuit extending from terminal B of the battery over the front point of contact *a* of relay 2HPR, lead 75, and through the winding of magnet 2HM to terminal N of the battery. This circuit is employed to assist in establishing and maintaining a high pressure during the manual control of heavy and medium cuts. Magnet 2HM has a second energizing circuit which extends from terminal *e* of the first section speed control unit 13 (Fig. 1c) over leads 38 and 40, the front point of contact *d* of relay 1-2RC, lead 55, front contact *h* of relay AP, lead 56, front contact *b* of relay RH2, back contact *c* of relay RL2, lead 77, the back point of contact *a* of relay 2HPR, lead 75, and through the winding of magnet 2HM to terminal N of the battery. This circuit is used during automatic control of heavy cars when additional braking is requested by the first section speed control unit during the control of the second section by the first section speed control unit when both sections are occupied by a cut. Magnet 2HM has a third energizing circuit extending from terminal *e* of speed control unit 14 (Fig. 1e) over lead 78, the back point of contact *d* of relay 1-2RC, lead 55, front contact *h* of relay AP, lead 56, front contact *b* of relay RH2, back contact *c* of relay RL2, lead 77, the back point of contact *a* of relay 2HPR, lead 75, and through the winding of magnet 2HM to terminal N of the battery. This circuit is used when a cut has cleared the first section of the group retarder to assist in rapidly increasing the braking pressure for heavy cuts when requested by the energized condition of terminal *e* of speed control unit 14.

Magnet 2HMM (Fig. 1f) has a first energizing circuit which extends from terminal B of the battery over the front point of contact *b* of relay 2HPR, lead 79, and through the winding of magnet 2HMM to terminal N of the battery. Magnet 2HMM is accordingly energized in parallel with magnet 2HM during the man-

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ual control of heavy and medium cuts. Magnet 2HMM has a second energizing circuit which extends from terminal *e* of the first section speed control unit 13 over leads 38 and 40, the front point of contact *d* of relay 1-2RC, lead 55, front contact *h* of relay AP, lead 56, the front point of contact *c* of relay RH2, lead 81, the back point of contact *b* of relay 2HPR, lead 79, and through the winding of magnet 2HMM to terminal N of the battery. Magnet 2HMM is accordingly energized during the control of the second section by the first section speed control, when terminal *e* of speed control unit 13 is energized and the cut is of either medium or heavy weight. Magnet 2HMM has a third energizing circuit extending from terminal B of the battery over the front point of contact *c* of relay RITPP, lead 35, front contact *d* of relay AP, lead 45, back contacts *d* of relays RH2 and RL2 in series, lead 47, front contact *a* of differential pressure unit DPU closed when the pressure in the first section is approximately 4 p.s.i. or more, greater than the pressure in the second section, leads 82 and 79, and through the winding of magnet 2HMM to terminal N of the battery. As previously pointed out, this circuit, in conjunction with the previously traced circuit over the back contact *b* of the differential pressure unit, is employed to establish a preset pressure in the second section of the retarder within 4 p.s.i. of the pressure in the first section of the retarder when a cut of cars occupies the track section associated with the first section of the retarder and previous to the cut entering the track section associated with the second section of the retarder. Magnet 2HMM has a fourth energizing circuit which extends from terminal *e* of speed control unit 14 (Fig. 1e), over lead 78, the back point of contact *d* of relay 1-2RC, lead 55, front contact *h* of relay AP, lead 56, the front point of contact *c* of relay RH2, lead 81, the back point of contact *b* of relay 2HPR, lead 79, and through the winding of magnet 2HMM to terminal N of the battery. This circuit is employed in the automatic control of either heavy or medium cuts, after the first section has been cleared, when additional braking pressure is requested by the second section speed control unit 14.

Magnet 2LM (Fig. 1f) has a first energizing circuit which extends from terminal B of the battery over the contacts of lever R2MC in its L position, lead 51, back contact *b* of Bourdon tube 10, closed when the pressure in the second section is below 32 p.s.i., lead 84, and through the winding of magnet 2LM to terminal N of the battery. This circuit keeps the pressure in the second section above 32 p.s.i. during the manual control of light cuts. Magnet 2LM has a second energizing circuit which extends from terminal *e* of speed control unit 13 over leads 38 and 40, the front point of contact *d* of relay 1-2RC, lead 55, front contact *h* of relay AP, lead 56, the back point of contact *c* of relay RH2, front contact *b* of relay RL2, lead 54, lead 51, back contact *b* of Bourdon tube 10, lead 84, and through the winding of magnet 2LM to terminal N of the battery. This circuit is employed in the automatic control of light cuts while such cuts span both sections, when the first section speed control requests more braking and the pressure in the second section is below 32 p.s.i. Magnet 2LM has a third energizing circuit which extends from terminal *e* of speed control unit 14 (Fig. 1e) over lead 78, the back point of contact *d* of relay 1-2RC, lead 55, front contact *h* of relay AP, lead 56, the back point of contact *c* of relay RH2, front contact *b* of relay RL2, leads 54 and 51, back contact *b* of Bourdon tube 10, lead 84, and through the winding of magnet 2LM to terminal N of the battery. This circuit is used in the control of the second section from the second section speed control unit after a cut has cleared the first section to maintain the pressure above 32 p.s.i. for light cuts when increased pressure is requested by the speed control unit.

Exhaust magnet 2X1M has a first energizing circuit which extends from terminal *f* of first section speed control unit 13 over leads 63 and 65, the front point of contact *f* of relay 1-2RC, lead 85, front contact *f* of relay AP, lead 86, front contacts *f* of relays RL2 and RH2 in multiple, lead 87, back contact *b* of relay 20PR, lead 88, and through the winding of magnet 2X1M to terminal N of the battery. Magnet 2X1M is energized by this circuit to cause a relatively rapid decrease in pressure in the automatic control of cuts of light, medium or heavy weight when both sections of the retarder are occupied and reduced pressure is requested by the first section speed control unit 13. Magnet 2X1M has a second energizing circuit which extends from terminal *f* of the second section speed control unit 14 (Fig. 1e) over lead 89, the back point of contact *f* of relay 1-2RC, lead 85, front contact *f* of relay AP, lead 86, front contacts *f* of relays RL2 and RH2 in multiple, lead 87, back contact *b* of relay 20PR, lead 88, and through the winding of magnet 2X1M to terminal N of the battery. This circuit functions the same as the previously traced circuit, except that it is operative after a cut has cleared the first section of the group retarder and is being controlled by the second section speed control unit 14.

Exhaust magnet 2X2M has a first energizing circuit extending from terminal B of the battery over the front point of contact *a* of relay 20PR, lead 90, and through the winding of magnet 2X2M to terminal N of the battery. This circuit is employed to exhaust the retarder cylinders under the various conditions described above in which relay 20PR is energized. Magnet 2X2M has a second energizing circuit which extends from terminal *g* of speed control unit 13 over leads 70 and 71, the front point of contact *e* of relay 1-2RC, lead 91, front contact *g* of relay AP, lead 92, front contacts *e* of relays RL2 and RH2 in multiple, lead 93, the back point of contact *a* of relay 20PR, lead 90, and through the winding of magnet 2X2M to terminal N of the battery. This circuit is employed to obtain reduced pressure in the automatic operation of the second section by the first section speed control. Magnet 2X2M has a third energizing circuit extending from terminal *g* of speed control unit 14 over lead 94, the back point of contact *e* of relay 1-2RC, lead 91, front contact *g* of relay AP, lead 92, front contact *e* of relays RL2 and RH2 in multiple, lead 93, the back point of contact *a* of relay 20PR, lead 90, and through the winding of magnet 2X2M to terminal N of the battery. This circuit is used during the automatic control of the second section from the second section speed control unit 14 after a cut has cleared the first section.

The structure and arrangement of this embodiment of my invention having been described, its operation under various typical conditions will now be described.

The manual operation of the first section of the group retarder will first be considered. For the manual control of heavy cuts, lever R1MC is moved to the H position, causing relay 1HPR to pick up and magnets 1HM and 1HMM to be energized in parallel by their previously traced circuits over the front points of contacts *a* and *b*, respectively, of relay 1HPR. The lever is left in the H position until the desired amount of braking has been obtained. For light cuts, the operation is semi-automatic. The lever is moved to its L position, energizing the movable contact member of Bourdon tube 6 over lead 37. When the pressure rises above 39 p.s.i., front contact *a* of this Bourdon tube will close, and relay 10PR will be picked up over its previously traced circuit including lead 36 and back contact *c* of relay 1HPR. Exhaust magnet 1X2M will then be energized over its previously traced circuit including the front point of contact *b* of relay 10PR, and the pressure will be reduced. Should the pressure fall below 32 p.s.i., back contact *b* of Bourdon tube 6 will be closed and intake

magnet 1LM will be energized over lead 62, causing the pressure to increase. When it is desired to reduce the pressure manually, lever R1MC may be moved to its O position, causing relay 10PR and consequently exhaust magnet 1X2M to be energized, thus reducing the pressure to the desired value or opening the retarder completely.

The manual operation of the second section of the retarder is similar to that described for the first section. With lever R2MC in its H position, relay 2HPR is picked up and both intake magnets 2HM and 2HMM are energized in parallel to bring about a rapid increase in pressure to a relatively high sustained value. When the lever is moved to its L position, the movable contact member of Bourdon tube 10 is energized over lead 51. Should the pressure increase above 39 p.s.i., front contact *a* of Bourdon tube 10 will be closed, and relay 20PR will be picked up over its previously traced circuit including back contact *c* of relay 2HPR. Exhaust magnet 2X2M will then be energized, causing the pressure to decrease. Should the pressure fall below 32 p.s.i., back contact *b* of tube 10 will close, causing intake magnet 2LM to be energized over lead 84 and raising the pressure. In the O position of lever R2MC, relay 20PR will be picked up, exhaust magnet 2X2M will be energized, and the pressure will then be reduced, or the retarder opened completely, as is desired.

With no cars occupying the group retarder, and before any weight information has been registered in relays RL1 and RH1, if the retarder is set for automatic operation by placing levers R1MC and R2MC in their automatic or A positions, the first section only of the retarder will be maintained at a standby pressure. Under these conditions, relay AP will be energized over the A contactor of the levers as previously described.

In the first section of the group retarder, the standby pressure is controlled between 59 and 64 p.s.i. by the action of Bourdon tube 5. The movable contact of this Bourdon tube is energized over a previously traced circuit including the back point of contact *c* of relay R1TPP, lead 33, front contact *e* of relay AP, lead 34, the back point of contact *f* of relay RH1 and the back point of contact *f* of relay RL1 in series, and lead 44. Should the pressure increase above 64 p.s.i., front contact *a* of tube 5 will close and relay 10PR will be energized over lead 36 and back contact *c* of relay 1HPR, causing magnet 1X2M to be energized over the front point of contact *b* of relay 10PR and lead 69, and the pressure will thereby be reduced. Should the pressure fall below 59 p.s.i., back contact *b* of Bourdon tube 5 will close, causing intake magnet 1HMM to be energized over leads 59 and 60 until the pressure is increased above 59 p.s.i.

Once the weight of an approaching cut is registered in relays RL1 and RH1, and before section 1-2GRIT is occupied, in the automatic operation of my equipment the first section of the group retarder will be preset to a pressure value in accordance with the weight of the cut.

For light cars, the pressure in the first section is preset between 32 and 39 p.s.i. by the action of Bourdon tube 6. The movable contact of this Bourdon tube will be energized over a previously traced circuit including the back point of contact *c* of relay R1TPP, lead 33, front contact *e* of relay AP, lead 34, the back point of contact *f* of relay RH1, the front point of contact *f* of relay RL1, and leads 43 and 37. Should the pressure rise above 39 p.s.i., relay 10PR will be energized over its previously traced circuit including front contact *a* of Bourdon tube 6, lead 36, and back contact *c* of relay 1HPR. Exhaust magnet 1X2M will then be energized over the front point of contact *b* of relay 10PR and lead 69 to reduce the pressure. Should the pressure fall below 32 p.s.i., back contact *b* of Bourdon tube 6 will close, and intake magnet 1LM will be energized over lead 62 to restore the pressure to the desired range.

For medium weight cars, when relays RL1 and RH1 are both picked up, the pressure in the first section is

preset between 59 and 64 p.s.i. by the action of Bourdon tube 5. The movable contact of this Bourdon tube is energized at this time over a circuit including the back point of contact *c* of relay R1TPP, lead 33, front contact *e* of relay AP, lead 34, the front point of contact *f* of relay RH1, the front point of contact *g* of relay RL1, and lead 44. Should the pressure rise above 64 p.s.i., front contact *a* of tube 5 will be closed, and relay 10PR will be energized over its previously traced circuit, causing exhaust magnet 1X2M to be energized and reduce the pressure. Should the pressure fall below 59 p.s.i., magnet 1HMM will be energized over leads 59 and 60 to restore it to the desired range.

For heavy cars, relay RH1 is energized, relay RL1 is released, and the pressure in the first section is preset to the existing full pressure of the fluid pressure source by the energization of valve magnet 1HMM over a previously traced circuit including the back point of contact *c* of relay R1TPP, lead 33, front contact *e* of relay AP, lead 34, the front point of contact *f* of relay RH1, the back point of contact *g* of relay RL1, lead 61, the back point of contact *b* of relay 1HPR and leads 58 and 60.

When the first section of the group retarder is on standby pressure or is preset to one of its pressure ranges as described above, the second section remains at the pressure to which it was last controlled by the passage of a cut of cars.

The operation of the group retarder to control a light weight cut will now be described. It will be assumed that both sections of the retarder are in their automatic conditions with levers R1MC and R2MC set to their automatic or A positions. Relay AP will accordingly be energized. It will be further assumed that the cut has moved over the hump through approach track section AT, the two sections of the master retarder, and detector track sections 1-8T and 1-4T with switches 1-8W and 1-4W in their normal positions, and is occupying track section 1-2AT. It will be further assumed that weight-rail contactor WRC has functioned to transfer the weight of the cut to the weight coding, storage, and transfer circuits, as described in the above-mentioned copending application, and that relay 1-2ALP is now energized and relay 1-2AHP is released. It will be further assumed that V3 computer 2, Fig. 1b, has functioned to supply a proper leaving speed voltage between its output lead 3 and its grounded lead 4, which is supplied to input terminal *a* of storage unit 1-2GR1-ESU over front contact *a* of relay 1-2ATP.

With the cut occupying track section 1-2AT, track relay 1-2ATR will be released and repeater relay 1-2ATP will be picked up.

The output of V3 computer 2 will now be supplied to input terminal *a* of storage unit 1-2GR1-ESU over lead 3 and front contact *a* of relay 1-2ATP. At the same time, relay RL1 will be picked up over its previously traced circuit including front contact *a* of relay 1-2ALP, lead 28, front contact *c* of relay 1-2ATP and back contact *c* of relay GAEC. The circuit for relay RH1 will be interrupted at the open front point of contact *a* of relay 1-2AHP.

The first section of the group retarder will now be preset, as previously described, between a pressure of 32 and 39 p.s.i. The second section of the group retarder will be maintained at a preset pressure to which last controlled as previously described.

As the cut moves into section 1-2GRIT, track relay R1TR will be released and repeater relays R1TP and R1TPP will be picked up. The output of velocity meter 15 appearing at its output terminal *a* will now be connected to input terminal *b* of speed control unit 13 over front contact *b* of relay R1TP. The desired speed storage in unit 1-2GR1-ESU will be made final when relay R1H is picked up over front contact *d* of relay R1TP.

The output from terminal *c* of storage unit

1-2GR1-ESU will now be connected to terminal *a* of speed control unit 13 over front contact *c* of relay R1TP. The speed control unit will then begin to function as described in the above-mentioned copending application to compare the measured speed with the selected speed and, when required, energize either its intake terminal *e* or its exhaust terminals *f* and *g*.

With relay R1TPP picked up, the previously described circuit for presetting the first section of the retarder will be interrupted at the open back point of contact *c* of relay R1TPP. The retarder will now be controlled from terminals *e*, or *f* and *g* of speed control unit 13.

Under this condition the pressure in the first section of the group retarder, if the cut is overspeed, will be maintained between 32 and 39 p.s.i., or the same pressure range as the preset pressure for a registered light cut.

Should the speed of the cut decrease below the desired value, terminals *f* and *g* of speed control unit 13 will be energized. Exhaust magnet 1X1M will then be energized over its previously traced circuit extending from terminal *f* of speed control unit 13 over leads 63 and 64, front contact *a* of relay AP, lead 66, front contact *b* of relay RL1, lead 67, back contact *a* of relay 10PR, lead 68, and through the winding of magnet 1X1M to terminal N of the battery. The valve controlled by magnet 1X1M will respond quite rapidly, causing a relatively slight decrease in braking which will rapidly be reflected in the higher time derivatives of the speed of the cut, to prevent overcorrection, and consequent hunting of the system. Exhaust magnet 1X2M will be energized from terminal *g* of speed control unit 13 over leads 70 and 72, front contact *b* of relay AP, lead 73, front contact *i* of relay RL1, lead 74, the back point of contact *b* of relay 10PR, and lead 69. The valve controlled by this magnet, when opened, will provide a large exhaust capacity if still needed to reduce the speed of the cut.

At this time the second section of the group retarder is preset to a pressure within 4 p.s.i. of that of the first section by the Bourdon tubes of differential pressure unit DPU and the action of the movable contact associated with these tubes. The movable contact is energized over a previously traced circuit which extends from terminal B of the battery over the front point of contact *c* of relay R1TPP, front contact *d* of relay AP, lead 45, back contacts *d* of relays RH2 and RL2 in series, and lead 47 to the movable contact of the differential pressure unit. When the pressure in the first retarder section is 4 p.s.i. or more in excess of that in the second retarder section, front point *a* of the pressure unit contact is closed, and magnet 2HMM will be energized over leads 82 and 79 and restore pressure in the second section until it is less than 4 p.s.i. under the pressure in the first retarder section. When the pressure in the second retarder section is 4 p.s.i. or more in excess of that in the first retarder section, back point *b* of the pressure unit contact is closed, relay 20PR is picked up by the previously traced circuit over back contact *c* of relay 2HPR, and exhaust magnet 2X2M will be energized over the front point of contact *a* of relay 20PR and lead 90 to reduce the pressure in the second section until it is under 4 p.s.i. more than the pressure in the first retarder section. It is therefore, apparent that the differential pressure unit maintains the pressure in the second retarder section to within 4 p.s.i. of that in the first section. While section 1-2GR1T is occupied, and before section 1-2GR2T becomes occupied, terminal *a* of storage unit 1-2GR2-ESU is energized from terminal *c* of storage unit 1-2GR1-ESU over lead 96 and back contact *h* of relay R2TP to transfer the desired speed to the second section storage unit.

As the cut moves into section 1-2GR2T, track relay R2TR will be released and relay R2TP will pick up. Relay 1-2RC will now be picked up over its previously traced circuit including front contact *b* of relay R2TP, lead 24, the winding of relay 1-2RC, and back contact *d*

of relay R1EC. The desired speed storage in unit 1-2GR2-ESU will be made final, since relay R2H will be picked up over front contact *g* of relay R2TP.

With relay 1-2RC picked up, the previously traced circuit from output terminal *c* of storage unit 1-2GR1-ESU to input terminal *a* of storage unit 1-2GR2-ESU is interrupted at the open back point of contact *h* of relay R2TP.

At the same time, the output appearing at terminal *a* of radar velocity meter 16 will be connected to input terminal *b* of the speed control unit 14 over front contact *e* of relay R2TP. The output appearing at terminal *c* of storage unit 1-2GR2-ESU will be applied to input terminal *a* of speed control unit 14 over front contact *f* of relay R2TP. Speed control unit 14 will now begin to follow the action of the cut, but will not yet exert any influence on the retarder.

With relay 1-2RC picked up, the weight information stored in relays RL1 and RH1 will be transferred to relays RL2 and RH2 by their previously described circuits. That is, relay RL2 will be picked up over front contact *b* of relay 1-2RC, front contact *c* of relay RL1 and lead 30. The pickup circuit for relay RH2 will be interrupted at the open front point of contact *c* of relay RH1.

During the joint occupancy of sections 1-2GR1T and 1-2GR2T, the second section pressure control unit 13. Should terminal *e* of speed control unit 13 be energized, the movable contact of Bourdon tube 10 will be energized over a circuit including leads 38 and 40, the front point of contact *d* of relay 1-2RC, lead 55, front contact *h* of relay AP, lead 56, the back point of contact *c* of relay RH2, front contact *b* of relay RL2, and leads 54 and 51. The action of this tube will maintain the pressure between 32 and 39 p.s.i. while terminal *e* of speed control unit 13 is energized. Should the pressure exceed 39 p.s.i., relay 20PR and exhaust magnet 2X2M will be energized, as previously described, to reduce the pressure. Should the pressure go below 32 p.s.i., back contact *b* of tube 10 will be closed and intake magnet 2LM will be energized.

If terminals *f* and *g* of speed control unit 13 are energized, exhaust magnets 2X2M and 2X1M will be energized over their previously traced circuits including front contacts *e* and *f* of relay 1-2RC, and the pressure will be decreased to the extent necessary to restore the speed characteristics of the cut to the desired value.

When relay RL2 picks up due to the weight information stored in relay RL1 being transferred by the pickup of relay 1-2RC as described above, the preset circuit for the second section of the retarder is opened at back contact *d* of relay RL2 and this circuit is no longer operative to control the pressure range of the second retarder section.

When the cut clears section 1-2AT, track relay 1-2ATR will be energized and relay 1-2ATP will be released. The V3 voltage supplied from computer 2 to storage unit 1-2GR1-ESU will now be interrupted at the open front point of contact *a* of relay 1-2ATP. However, the stored voltage will remain in the unit under the control of relay R1H, which is energized over front contact *d* of relay R1TP. The energizing circuits for relays RL1 and RH1 will now be interrupted at the open front points of contacts *b* and *c* of relay 1-2ATP. However, relay RL1 will be held up at this time over its previously traced stick circuit including front contact *e* of relay R1TP and its own front contact *a*.

With relay 1-2ATP released, relay GAEC will now pick up over its previously traced circuit including back contact *d* of relay 1-2ATP, front contact *f* of relay R1TP, and back contact *c* of relay R1EC. The opening of back contacts *c* and *d* of relay GAEC thus provides further check on the interruption of the transfer circuits from unit 1 to relays RL1 and RH1, but this will obviously have no effect on these relays at this time since their pickup

circuits are already interrupted and the stick circuit for relay RL1 is already established.

As the cut clears section 1-2GR1T, track relay R1TR will be picked up and relay R1TP will be released. Relay R1TPP will be held up briefly over its stick circuit including back contact *b* of relay R1EC and its own front contact *a*. Relay R1EC will now be picked up over its previously traced circuit including the back point of contact *a* of relay R1TP, lead 21, front contact *a* of relay R2TP, lead 22, front contact *b* of relay GAEC, the winding of relay R1EC, lead 23, and the back point of contact *a* of relay R2EC. Relay R1TPP will then be released.

With relay R1EC picked up, relay GAEC will be released at the end of its predetermined time delay period due to the interruption of its stick circuit at the open back point of contact *c* of relay R1EC. At the same time, relay 1-2RC will be released, due to the interruption of its stick circuit at the open back point of contact *d* of relay R1EC.

With relay R1TP released, relay RL1 will be released, due to the interruption of its stick circuit at the open front point of contact *e* of relay R1TP.

The first section of the group retarder will now be restored to its previously described standby condition, in which the pressure is maintained between 59 and 64 p.s.i. by the action of Bourdon tube 5. The second section will now be controlled from its own speed control unit 14. At this time, relay RL2 is held up over its stick circuit including front contact *d* of relay R2TP and its own front contact *a*, while relay RH2 remains released.

When the cut enters track section 1-2T, track relay 1-2TR will be released. However, no further action will take place at this time.

The intake control circuit from terminal *e* of speed control unit 14 extends from terminal *e* over lead 78, the back point of contact *d* of relay 1-2RC, lead 55, front contact *h* of relay AP, lead 56, the back point of contact *c* of relay RH2, front contact *b* of relay RL2, and leads 54 and 51 to the movable contact of Bourdon tube 10. As long as terminal *e* is energized, Bourdon tube 10 will function as previously described to maintain the pressure between 32 and 39 p.s.i. by energizing intake magnet 2LM, or relay 20PR and exhaust magnet 2X2M, as required. The exhaust control circuit from terminal *f* of speed control unit 14 extends over lead 89, the back point of contact *f* of relay 1-2RC, lead 85, front contact *f* of relay AP, lead 86, front contact *f* of relay RL2, lead 87, back contact *b* of relay 20PR, and lead 88 to the winding of magnet 2X1M. The exhaust control circuit from terminal *g* of speed control unit 14 extends over lead 94, the back point of contact *e* of relay 1-2RC, lead 91, front contact *g* of relay AP, lead 92, front contact *e* of relay RL2, lead 93, the back point of contact *a* of relay 20PR, and lead 90 to magnet 2X2M. Magnets 2X1M and 2X2M will accordingly be energized in parallel to the extent necessary to restore the speed of the cut to the desired value.

When the cut clears section 1-2GR2T, track relay R2TR will be energized and relay R2TP will be released. Relay R2EC will now be picked up over back contact *a* of track relay 1-2TR, lead 25, the winding of relay R2EC, lead 26, front contact *e* of relay R1EC, lead 27, and back contact *c* of relay R2TP.

With relay R2EC energized, the stick circuit for relay R1EC will be interrupted at the open back point of contact *a* of relay R2EC, and at the end of its predetermined time delay period, relay R1EC will release. With relay R2TP released, speed control unit 14 will be disconnected both from radar velocity meter 16 and storage unit 1-2GR2-ESU. At the same time, relay R2H will be released and the storage in unit 1-2GR2-ESU will be cancelled. Relay RL2 will now be released due to the interruption of its stick circuit at the open front point of contact *d* of relay R2TP.

The second section of the retarder will now be returned

to its standby condition, in which it remains at the pressure to which last controlled by the passage of the cut.

When the cut clears section 1-2T, track relay 1-2TR will be energized. Relay R2EC will accordingly release and the apparatus will be restored to its initial condition.

The sequence of operations for a medium weight cut is substantially the same as for the light cut just described, and accordingly, in considering the operation of such a cut, only those circuits which function differently will be described. It will be initially assumed that both sections of the group retarder are in their standby conditions, with the first section maintained between 59 and 64 p.s.i. by Bourdon tube 5 and the second section remaining at the pressure to which last controlled.

It will next be assumed that the weight of an approaching medium weight cut is registered by the energization of both relays RL1 and RH1. The preset pressure of the first section of the group retarder will now be maintained at a pressure between 59 and 64 p.s.i. by the maintained application of energy to the movable contact of Bourdon tube 5 by the previously described circuit over front points of contacts *f* and *g* of relays RH1 and RL1, respectively. The pressure in the second section of the retarder remains as before.

When the cut enters track section 1-2GR1T, the speed control unit 13 becomes effective to control unit 1-2GR1, the intake control circuit from terminal *e* of speed control unit 13 will extend over leads 38 and 39, front contact *b* of relay R1TPP, lead 41, front contact *c* of relay AP, lead 42, the front point of contact *e* of relay RH1, lead 61, the back point of contact *b* of relay 1HPR, and leads 58 and 59 to the movable contact of Bourdon tube 5. As previously described, this tube will function to keep the pressure between 59 and 64 p.s.i. by alternately energizing intake magnet 1HMM and relay 10PR, the latter controlling exhaust magnet 1X2M, as required.

The exhaust control circuit from terminal *f* of speed control unit 13 extends at this time over leads 63 and 64, front contact *a* of relay AP, lead 66, front contacts *b* of relays RL1 and RH1 in multiple, lead 67, back contact *a* of relay 10PR, and lead 68 to exhaust magnet 1X1M. The exhaust control circuit from terminal *g* of speed control unit 13 extends over leads 70 and 72, front contact *b* of relay AP, lead 73, front contacts *i* of relay RL1 and *g* of relay RH1 in multiple, lead 74, the back point of contact *b* of relay 10PR, and lead 69 to magnet 1X2M. Magnets 1X1M and 1X2M will accordingly be energized in parallel to effect the necessary reduction in braking pressure.

Meanwhile, the preset pressure of the second section of the retarder is preset, as previously described, to with 4 p.s.i. of the pressure in the first section.

When the cut occupies both sections 1-2GR1T and 1-2GR2T, the second section pressure control unit 1-2GR2 will be controlled from the first section speed control unit 13. The first section has been maintained, as previously described, between 59 and 64 p.s.i. At this time, relays RL2 and RH2 will be picked up and the preset circuit for the second section of the retarder will be open at back contacts *d* of relays RH2 and RL2.

A circuit from terminal *e* of speed control unit 13 will now extend over leads 38 and 40, the front point of contact *d* of relay 1-2RC, lead 55, front contact *h* of relay AP, lead 56, the front point of contact *c* of relay RH2, lead 81, the back point of contact *b* of relay 2HPR, and lead 79 to intake magnet 2HMM. This magnet will cause the pressure to increase to the extent necessary to reduce the speed characteristics of the cut to the desired value. It will be noted that in this case there is no pressure ceiling established, other than the value of the fluid supply pressure.

At this time, exhaust magnets 2X1M and 2X2M will be controlled from terminals *f* and *g*, respectively, of

speed control unit 13 in the same manner as previously described as in the case of a light cut.

When the cut clears section 1-2GR1T, the first section will return to its standby condition. The second section will be operated from the second section speed control unit 14. The intake circuit in this case extends from terminal *e* of speed control unit 14 over lead 78, the back point of contact *d* of relay 1-2RC, lead 55, front contact *h* of relay AP, lead 56, the front point of contact *c* of relay RH2, lead 81, the back point of contact *b* of relay 2HPR, and over lead 79 to magnet 2HMM. The exhaust circuits are the same as those described for the light weight cut, controlling exhaust magnets 2X1M and 2X2M from terminals *f* and *g*, respectively, of speed control unit 14 over the back points of contacts *f* and *e*, respectively, of relay 1-2RC.

When the cut clears section 1-2GR2T, the second section will remain in its standby condition as previously described.

Since the operation of the retarder in braking a heavy cut is substantially the same as for the light and medium weight cuts, only those aspects that are different will be described. When a heavy cut is registered in the first section by energizing relay RH1 and maintaining relay RL1 released, the previously described preset circuit for heavy cuts will be established, and the pressure in the first section will be changed to the existing pressure of the fluid pressure source by the preset circuit to magnet 1HMM including front point of contact *f* of relay RH1 and the back point of contact *g* of relay RL1.

The pressure in the second section at this time will again remain at the pressure to which the section was last controlled.

When the heavy cut is in the first section under the control of speed control unit 13, the intake control circuit extends from terminal *e* of unit 13 over leads 38 and 39, front contact *b* of relay R1TPP, lead 41, front contact *c* of relay AP, lead 42, and thence over two branches. The first extends over the front point of contact *e* of relay RH1, lead 61, the back point of contact *b* of relay 1HPR, and over leads 58 and 60 to intake magnet 1HMM. The second branch extends from lead 42 over front contact *d* of relay RH1, back contact *d* of relay RL1, lead 57, the back point of contact *a* of relay 1HPR and lead 56 to intake magnet 1HM. Magnets 1HM and 1HMM will accordingly be energized in parallel to rapidly increase the braking pressure to a high sustained value, limited only by the pressure of the supply source, until speed control terminal *e* becomes deenergized.

Exhaust terminals *f* and *g* of speed control unit 13 control exhaust magnets 1X1M and 1X2M in parallel in the same manner as described for light and medium cuts.

The preset pressure in the second section of the retarder is established, as previously described, to within 4 p.s.i. of the pressure in the first retarder section during the movement of the heavy cut over track section 1-2GR1T only.

When the cut occupies both sections 1-2GR1T and 1-2GR2T, relay RH2 will be picked up and relay RL2 will remain released. Pressure control unit 1-2GR2 will now be controlled from speed control unit 13. The intake control circuit for this purpose extends from terminal *e* of speed control unit 13 over leads 38 and 40, the front point of contact *d* of relay 1-2RC, lead 55, front contact *h* of relay AP, lead 56, and thence over a pair of paths; the first extending over the front point of contact *c* of relay RH2, lead 81, the back point of contact *b* of relay 2HPR, and over lead 79 to intake magnet 2HMM; and the second extending from lead 56 over front contact *b* of relay RH2, back contact *c* of relay RL2, lead 77, the back point of contact *a* of relay 2HPR, and lead 75 to intake magnet 2HM. Magnets 2HM and 2HMM will accordingly be energized in parallel for as long as

required to bring the speed characteristics down to the desired value.

At this time, terminals *f* and *g* of speed control unit 13 control exhaust magnets 2X1M and 2X2M in parallel, in the same manner as described for light and medium cuts, when required to reduce the amount of applied braking.

When the cut clears section 1-2GR1T, the first section is returned to its standby condition. The second section is now controlled by second section speed control unit 14. The intake control circuits in this case extend from terminal *e* of speed control unit 14 over lead 78, the back point of contact *d* of relay 1-2RC, lead 55, front contact *h* of relay AP, lead 56, and thence over two paths to magnets 2HM and 2HMM which are the same as previously traced when describing the control by the first section speed control unit. Magnets 2HM and 2HMM thus continue to be controlled in parallel when increased braking pressure is required.

Exhaust magnets 2X1M and 2X2M are controlled in parallel from terminals *f* and *g* of speed control unit 14 in the manner previously described for light and medium cuts. When the second section is vacated, it remains at the last pressure to which controlled, as previously described.

The operation of the circuits of this embodiment of my invention having been described for single cuts under various conditions which are typical of those encountered in practice, the operation of the apparatus for two cuts of different characteristics sequentially occupying the group retarder will now be considered.

Let it be assumed that two cuts which will require different leaving speeds V3 and which are of different average weight approach the group retarder separated by a distance greater than the length of the track circuits, and for example, by a distance of 75 feet. It will be assumed that the weight coding, storage and transfer circuits 1 function in the manner described in the above copending application to register the weight of each cut in terms of the energized or deenergized conditions of relays 1-2ALP and 1-2AHP as each cut occupies approach track section 1-2AT. It will also be assumed at this time that V3 computer 2 supplies the appropriate leaving speed voltage for each cut.

Initially, both sections of the retarder will be in their previously described standby conditions. As the first cut occupies section 1-2AT, its weight will be registered in relays RL1 and RH1 and its selected leaving speed V3 will be supplied to storage unit 1-2GR1-ESU.

When the first cut enters section 1-2GR1T, storage unit 1-2GR1-ESU and radar velocity meter 15 will be connected to speed control unit 13 and the cut will be controlled, at a rate depending on its weight, by the action of speed control unit 13 on retarder control 1-2GR1 as previously described.

When the first cut clears section 1-2AT, both V3 computer 2 and weight unit 1 will be disconnected and will become available to handle information relating to the second cut. The weight storage in relays RL1 and RH1 will be maintained over their stick circuits including front contact *e* of relay R1TP, accordingly as said relays RL1 and RH1 are energized. The leaving speed stored in unit 1-2GR1-ESU will be retained, due to the energization of relay R1H over front contact *d* of relay R1TP.

When the first cut enters section 1-2GR2T, relay 1-2RC will pick up and the weight information stored in relays RL1 and RH1 will be transferred to relays RL2 and RH2. The storage of the desired leaving speed for the first cut will have been made in storage unit 1-2GR2-ESU and this storage will now be made final by the energization of relay R2H over front contact *g* of relay R2TP. Radar velocity meter 16 in storage unit 1-2GR2-ESU will now be connected to speed control unit 14, which now commences to follow, but not yet to control, the first cut. The second section pressure con-

trol unit 1-2GR2 will be operated at this time in response to speed control unit 13 as previously described.

When the first section is vacated by the first cut, it will be restored to its standby condition as previously described, with relay R1H being released due to the opening of its energization circuit at the open front point of contact *d* of relay R1TP, to cancel the leaving speed stored in storage unit 1-2GR1-ESU; and the established stick circuits for relays RL1 and RH1 will be interrupted at the open front point of contact *e* of relay R1TP.

With track section 1-2GR1T cleared, relay GAEC will be released as previously described at the end of its predetermined time delay period and will close its back contacts *c* and *d*. The first section of the group retarder is now in condition to receive information pertaining to the second cut.

When the second cut occupies track section 1-2AT, its leaving speed will be supplied to storage unit 1-2GR1-ESU from V3 computer 2 over front contact *a* of relay 1-2ATP. At the same time, its weight registration will be transferred from unit 1 over leads 28 and 29, and front contacts *b* and *c* of relay 1-2ATP.

The first section of the group retarder will now be preset to a pressure in accordance with the weight classification of the second cut. The second section of the retarder may still be occupied by the first cut, with pressure control unit 1-2GR2 being controlled by second section speed control unit 14 as previously described.

When the second cut enters section 1-2GR1T, it will be controlled by pressure control unit 1-2GR1 in response to the action of speed control unit 13 as previously described for a single cut.

When the second section of the group retarder is vacated by a first cut, the circuit energizing a combination of the relays RL2 and RH2 will be opened at front contact *d* of relay R2TP and both relays will be released. Relay R2H will be released to clear storage unit 1-2GR2-ESU. At this time, the storage in unit 1-2GR1-ESU will be transferred to unit 1-2GR2-ESU over back contact *h* of relay R2TP.

The previously described circuit, including back contacts *d* of relays RL2 and RH2, for supplying energy to the movable contact member of differential pressure unit DPU is now again completed and unit DPU operates to control the preset pressure in the second retarder section to within 4 p.s.i. of the pressure in the first section as previously described.

The further operation of the retarder to control the second cut will be the same as that previously described for a single cut and will not be repeated.

From this description it is apparent that with the apparatus and circuit arrangement of my invention as shown in the drawings, a system is provided wherein the preset pressure in the second section of a group retarder is closely controlled in accordance with the pressure ranges in the first section of the retarder only when the first section of the retarder is occupied by a cut of cars and the second section is void of a cut of cars.

Although I have herein shown and described only one embodiment of my invention in detail, it will be understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

1. In combinations with a stretch of railway track provided with a first railway car retarder and a second railway car retarder, means for controlling the retardation settings of said car retarders, a retardation setting sensing device responsive to the retardation setting of said first car retarder, a retardation setting sensing device responsive to the retardation setting of said second car retarder; an electrical contact device controlled by said retardation setting sensing devices, said contact device being controlled to a first position when the retardation setting

of said first car retarder exceeds the retardation setting of said second car retarder by a predetermined value and to a second position when the retardation setting of the second retarder exceeds the retardation setting of the first retarder by a predetermined value; and circuit means controlled by said electrical contact device and operating to increase the retardation setting of said second car retarder when said contact device is controlled to said first position and to decrease the retardation setting of said second retarder when said contact device is controlled to said second position.

2. In a control system for two section fluid pressure actuated railway car retarders in a classification yard, in combination, a source of fluid pressure, means for controlling the supply of fluid pressure from said source to the first retarder section of a two section retarder, a differential pressure unit connected to the fluid pressure supply for each retarder section, a movable contact member on said unit, and means controlled by said contact member of said differential pressure unit for controlling the supply of fluid pressure to the second retarder section of said two section retarder, said contact member closing a first circuit for increasing said supply of fluid pressure when the pressure supplied to the first retarder section exceeds the pressure supplied to the second retarder section by a preselected value and said contact member closing a second circuit for reducing said supply of fluid pressure when the pressure supplied to the second retarder section exceeds the pressure supplied to the first retarder section by a pre-selected value.

3. In combination with a stretch of railway track provided with first and second fluid pressure operated railway car retarders, means for controlling the pressure of the operating fluid in the cylinders of said first car retarder, a pressure sensitive device responsive to said pressure of the operating fluid in the cylinders of said first car retarder, a pressure sensitive device responsive to pressure of operating fluid in the cylinders of said second car retarder, a circuit controller operated by said pressure sensitive devices, a first electrical circuit including a first contact on said controller closed only when the pressure of the operating fluid in the cylinders of said first car retarder exceeds the pressure of the operating fluid in the cylinders of said second car retarder by a predetermined amount, a second electrical circuit including a second contact on said controller closed only when the pressure of the operating fluid in the cylinders of the second retarder exceeds the pressure in the cylinders of the first retarder by a predetermined amount, means controlled by said first electrical circuit for increasing the fluid pressure in the cylinders of said second car retarder when said first electrical circuit is closed, and means controlled by said second electrical circuit for decreasing the fluid pressure in the cylinders of the second car retarder when said second electrical circuit is closed, said means operating only when said first car retarder is occupied by a railway car and said second car retarder is unoccupied.

4. In a control system for multiple section fluid pressure actuated railway car retarders in a classification yard, in combination, a source of fluid pressure, a plurality of electrically actuated fluid pressure control valves associated with each retarder section of one of said multiple section retarders for controlling the supply of fluid pressure to the associated retarder section; a differential pressure unit associated with each retarder section subsequent to the first retarder section of said one multiple section retarder, each said unit consisting of an electrical contact operated to first and second positions by mechanically linked Bourdon tubes one of which is connected to be subjected to the fluid pressure supplied to the retarder section next preceding its associated retarder section and the other of which is connected to be subjected to the fluid pressure supplied to its associated retarder section, said contact being operated to said first

position when the pressure to which said one Bourdon tube is subjected exceeds that to which said other Bourdon tube is subjected by a predetermined value and said contact being operated to said second position when the pressure to which said other tube is subjected exceeds that to which said one tube is subjected by a predetermined value; and means associated with each retarder section subsequent to said first retarder section and controlled by said electrical contact on the differential pressure unit for that subsequent section for controlling the said plurality of electrically actuated fluid pressure control valves associated with that section to increase or decrease the pressure supplied to the section according as said contact is operated to its first or second positions respectively.

5. In a braking system for railway cars traversing a stretch of railway track in which braking force is applied to the wheels of the cars by a fluid pressure actuated retarder consisting of a series of separate retarder sections mounted adjacent the rails of said track, in combination, a source of fluid pressure, a plurality of fluid pressure control valves for controlling the pressure supplied to said first retarder section from said fluid pressure source, a plurality of fluid pressure control valves associated with each section of the retarder subsequent to said first retarder section for controlling the pressure supplied to each said associated subsequent retarder section from said fluid pressure source; a set of first and second mechanically linked Bourdon tubes associated with each section of the retarder subsequent to said first retarder section, each said first tube being connected to be subject to the pressure supplied to the retarder section immediate preceding its said associated retarder section, each said second tube being connected to be subject to the pressure supplied to its associated retarder section, and each said set of tubes being so proportioned and linked that an electrical contact operated thereby closes a back contact point when the pressure in the associated retarder section exceeds that in the retarder section immediate preceding by a predetermined value and closes a front contact point when the pressure in the retarder section immediate preceding exceeds that in the associated section by said predetermined value; and a plurality of means, one associated with each said set of Bourdon tubes and each means controlled by said electrical contact of the associated set of tubes for controlling the plurality of fluid pressure control valves also associated with the respective retarder section to increase or decrease respectively the pressure in the section according as said front or back contact of the respective set of Bourdon tubes is closed.

6. In combination, a stretch of railway track over which cuts of railway cars move in a given direction by the force of gravity, a first and second fluid pressure actuated car retarder located adjacent the rails of said stretch of railway track, a source of fluid pressure, a first group of fluid pressure control valves for controlling pressure supplied to said first car retarder from said source of fluid pressure, a second group of fluid pressure control valves for controlling pressure supplied to said second car retarder from said source of fluid pressure; a first, second and third pressure sensitive device connected to be subject to the fluid pressure supplied to said first retarder; a fourth pressure sensitive device connected to be subject to the fluid pressure supplied to said second retarder, an electrical contact on said first pressure sensitive device closed when the fluid pressure supplied to said first retarder is in excess of a first predetermined value, an electrical contact on said first pressure sensitive device closed when the fluid pressure supplied to said first retarder is below a second predetermined value less than said first predetermined value, an

electrical contact on said second pressure sensitive device closed when the fluid pressure supplied to said first retarder is in excess of a third predetermined value less than said second predetermined value, an electrical contact on said second pressure sensitive device closed when the fluid pressure supplied to said first retarder is below a fourth predetermined value less than said third predetermined value, an electrical contact on said third and fourth pressure sensitive devices closed in a first position when the fluid pressure supplied to said first retarder is a first preselected degree in excess of the fluid pressure supplied to said second retarder and closed in a second position when the fluid pressure supplied to said second retarder is a second preselected degree in excess of the fluid pressure supplied to said first retarder; means, including circuits over said contacts on said first and second pressure sensitive devices and including said first group of fluid pressure control valves, for controlling pressure supplied to said first retarder; and means, including circuits over said contact on said third and fourth pressure sensitive devices and including said second group of fluid pressure control valves, for controlling the pressure supplied to said second retarder to a pressure within the greater degree of pressure of said first and second preselected degrees of pressure, of the pressure supplied to said first retarder, said means operating only when said first retarder is occupied by a cut of cars and said second retarder is void of a cut of cars.

7. In a railway car retarder control system for fluid pressure actuated car retarders and in which the speed of railway cars traversing the retarders is controlled in accordance with the weight and rolling resistance of said cars, in combination, a first Bourdon tube pipe-connected to the cylinders of the first retarder section of a double section car retarder, a second Bourdon tube pipe-connected to the cylinders of the second retarder section of said double section car retarder; a contact on said Bourdon tubes, said contact closing a front contact point when the pressure of the operating fluid supplied to the cylinders of said first retarder section exceeds the pressure of the operating fluid supplied to the cylinders of said second retarder section by a first preselected pressure and said contact closing a back contact point when the pressure of the operating fluid supplied to the cylinders of said second retarder section exceeds the pressure of the operating fluid supplied to the cylinders of said first retarder section by a second preselected pressure; and circuit means controlled by said front and back contact points of said contact to increase and decrease, respectively, the pressure of the operating fluid supplied to the cylinders of said second retarder section.

8. In combination with a first railway car retarder and a second railway car retarder, adjustable means for each car retarder for selectively controlling the retardation settings of the respective retarder, a retardation setting sensing device responsive to the retardation setting of said first retarder, a retardation setting sensing device responsive to the retardation setting of said second retarder, and means controlled by said retardation setting sensing devices for adjusting the adjustable retardation setting control means for said second retarder to control the retardation setting of that retarder to within a predetermined range of the retardation setting of said first retarder.

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