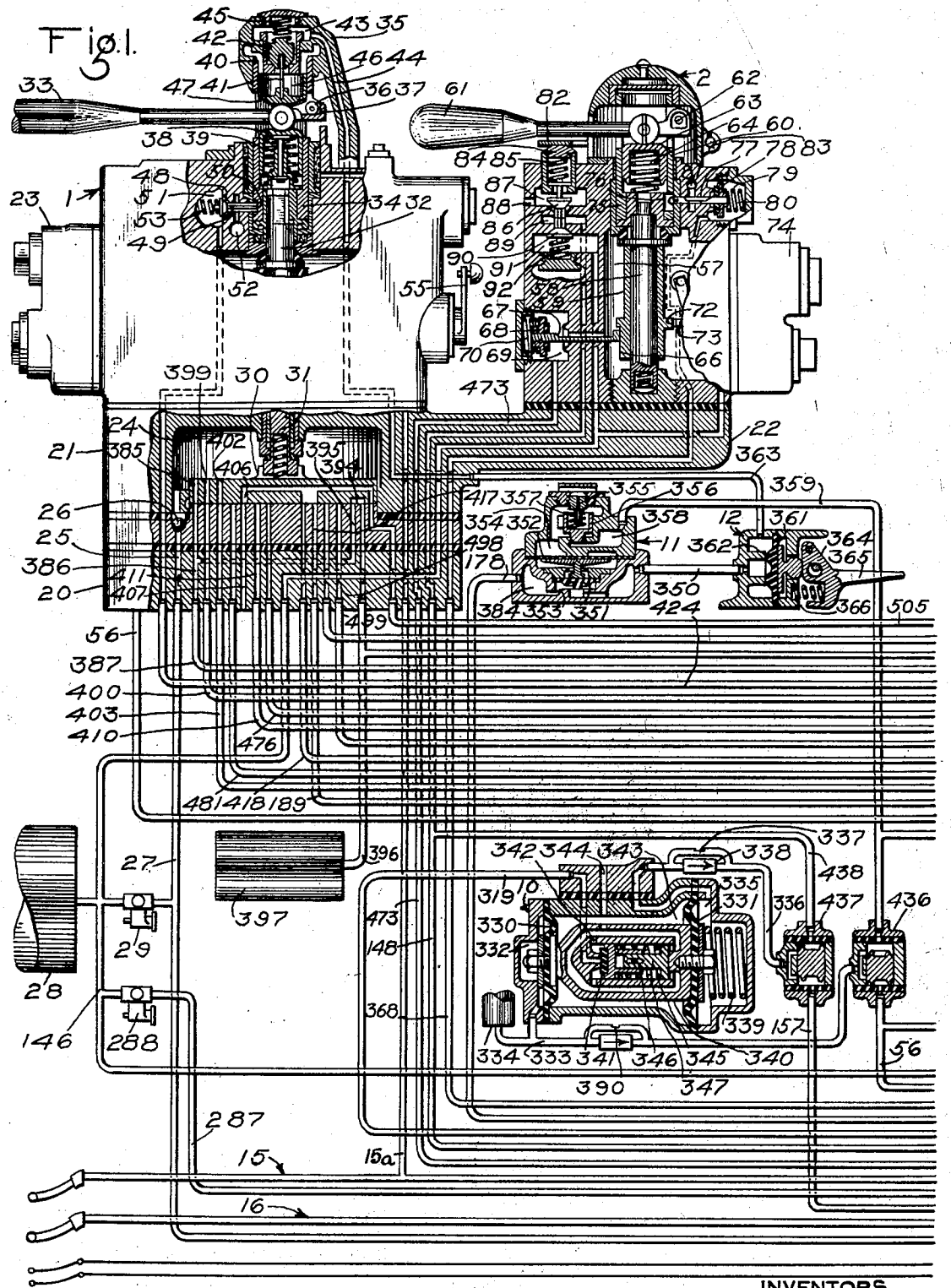
Sept. 16, 1941. E. E. HEWITT ET AL 2,256,283

FLUID PRESSURE BRAKE

Filed March 28, 1940 4 Sheets-Sheet 1

Fig. 1.



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FLUID PRESSURE BRAKE

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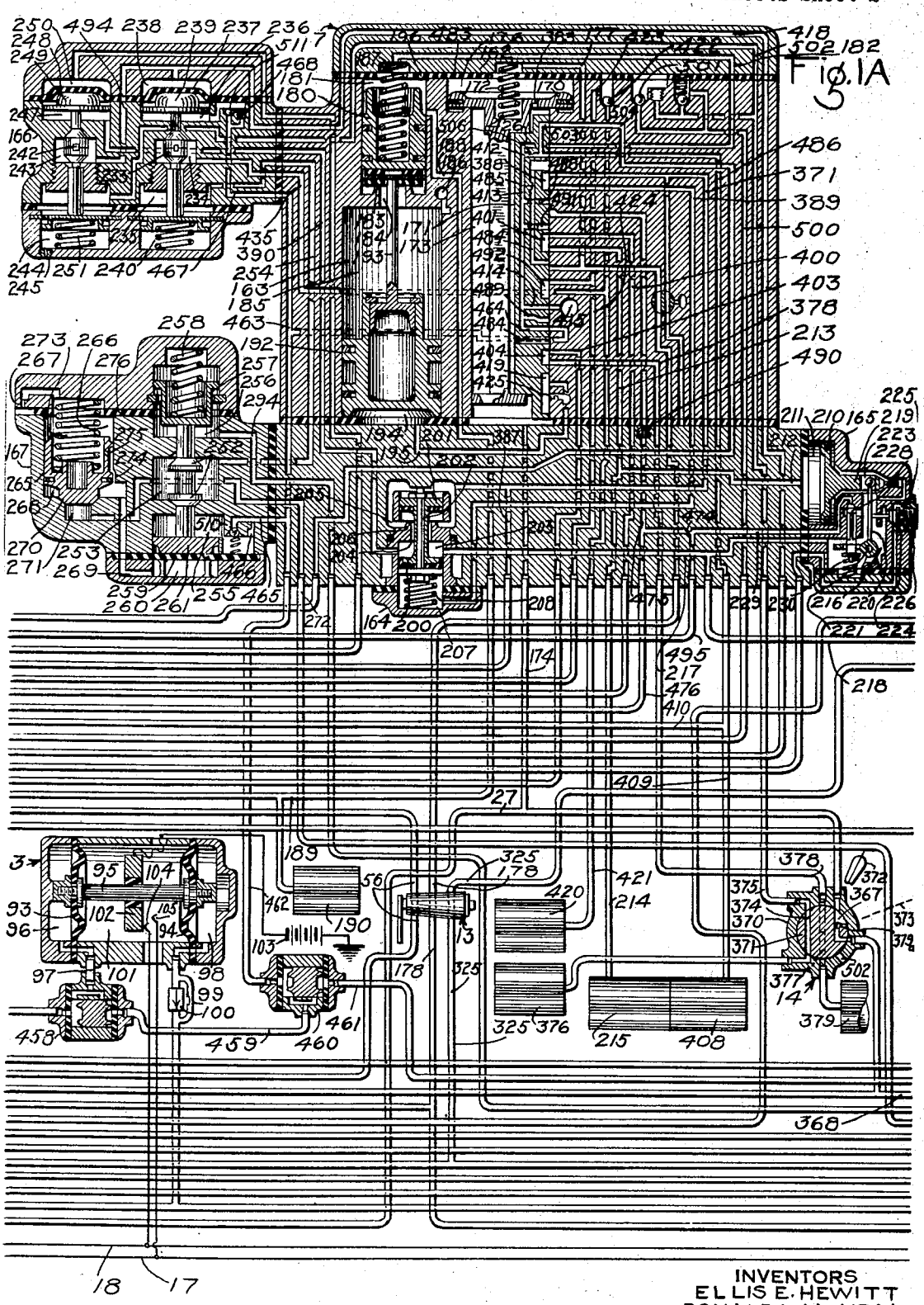

FIG. 1A

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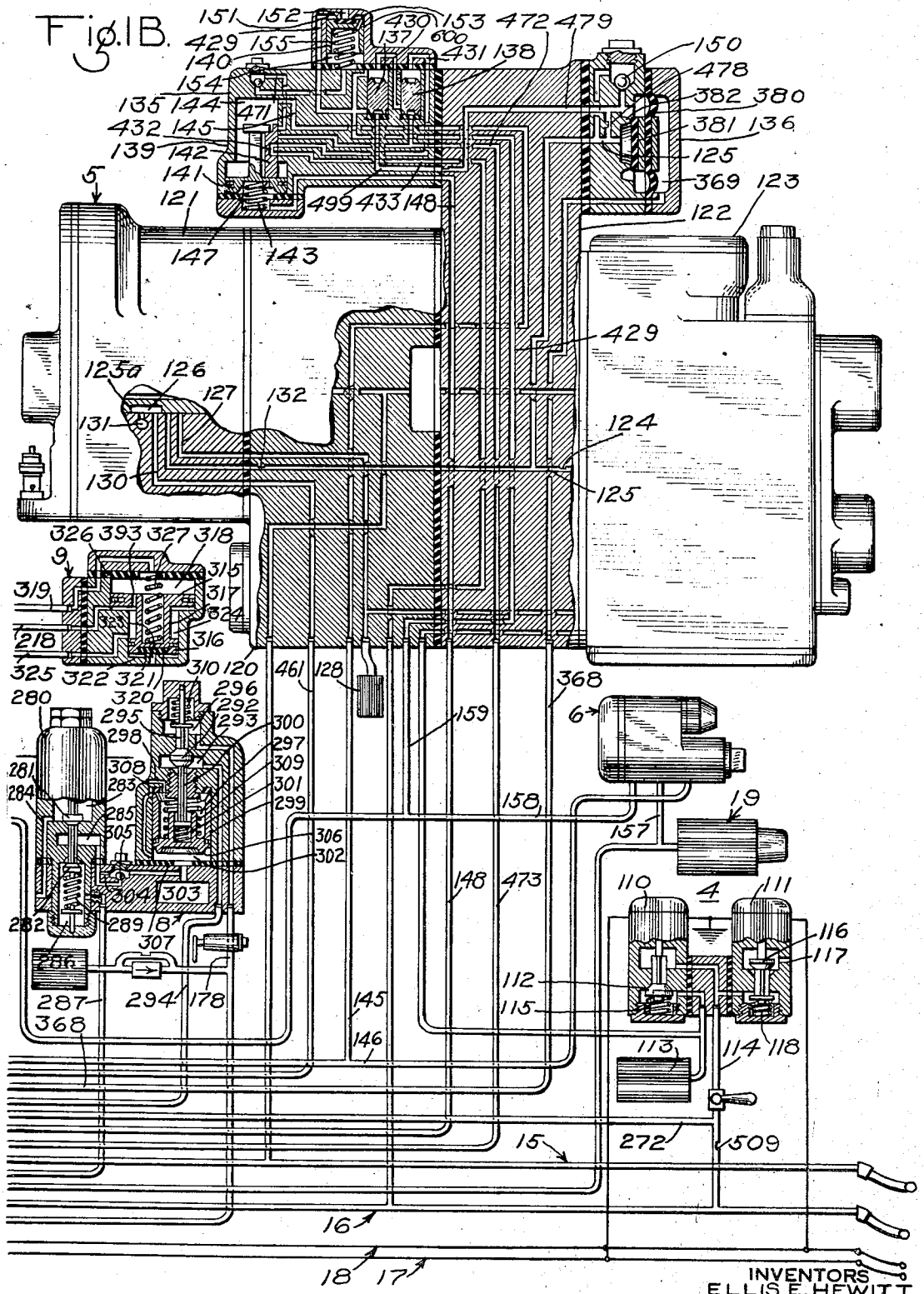
Fig. 1B.



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Filed March 28, 1940 4 Sheets-Sheet 4

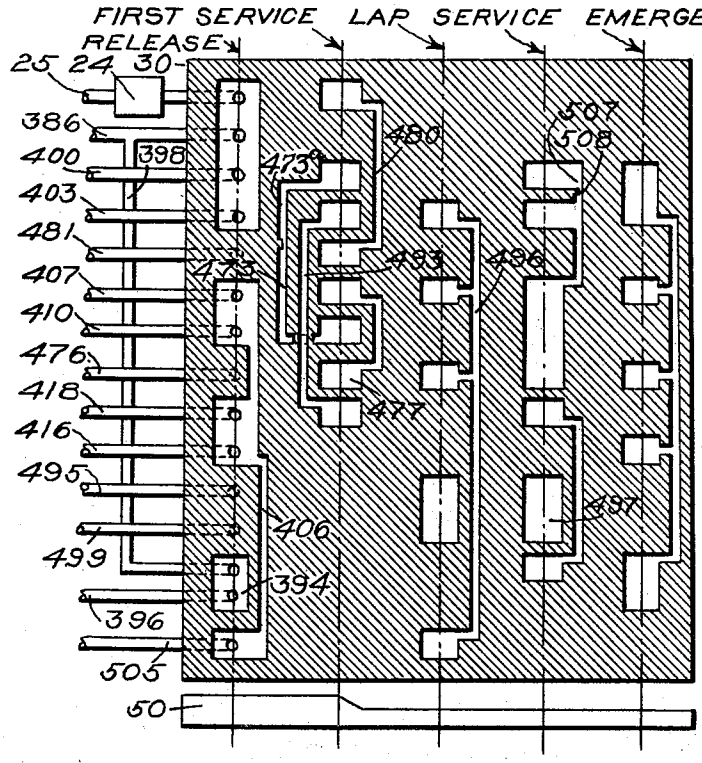

Fig. 3.

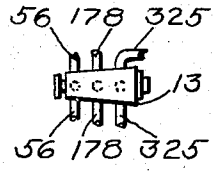

Fig. 5.

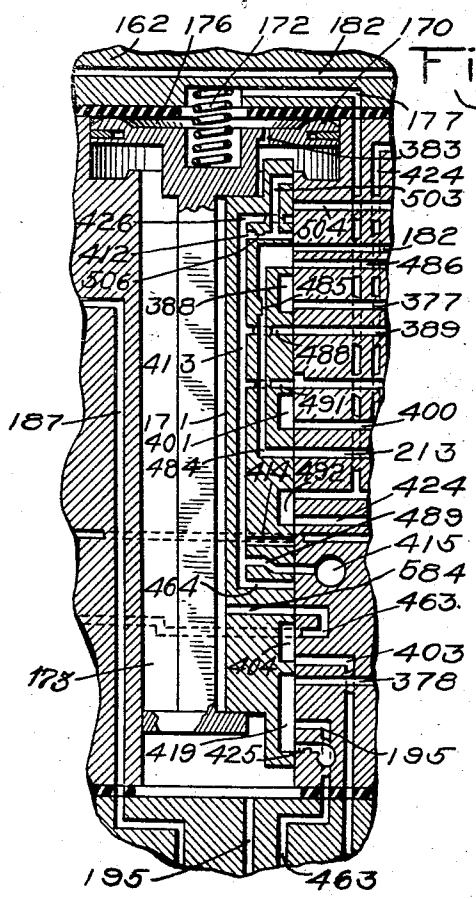

Fig. 2.

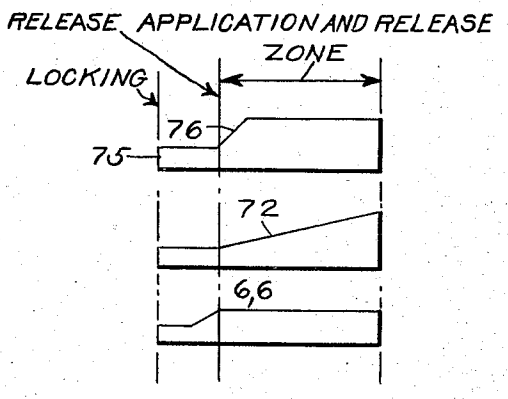

Fig. 4.

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2,256,283

UNITED STATES PATENT OFFICE

2,256,283

FLUID PRESSURE BRAKE

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Application March 28, 1940, Serial No. 326,352

37 Claims. (Cl. 303—18)

This invention relates to fluid pressure brake equipment for railway locomotives, and more particularly to the combined automatic and straight air type of locomotive equipment embodying means controlled by the engineer and by traffic or signal conditions on a railway system for controlling the brakes on the locomotive and cars of a train.

The principal object of the invention is to provide an improved brake equipment of the above type.

Other objects and advantages will be apparent from the following, more detailed description of the invention.

In the accompanying drawings, Figs. 1, 1A and 1B, when taken together and placed side by side, represent a diagrammatic view, mainly in section, of a locomotive brake equipment embodying the invention; Fig. 2 is a diagramamtic sectional view of a portion of the apparatus shown in Fig. 1A and with the parts in a different position; Fig. 3 is a diagrammatic development view of a rotary valve and rotary valve seat of a brake valve device shown in Fig. 1; Fig. 4 is a diagrammatic development view of three cams employed in the independent brake valve device shown in Fig. 1, these cams being arranged in projected relation to the various operating positions of said device; and Fig. 5 is a diagrammatic view of a double heading cock shown in Fig. 1A and with the parts in a different position.

Description of Parts

As shown in the drawings, the locomotive brake equipment comprises an automatic brake valve device 1, an independent brake valve device 2, a master switch device 3 and an application and release magnet valve device 4 controlled by said switch device, a pneumatic brake controlling valve device 5, a relay valve device 6, an automatic train control device 7, a timing valve device 8, a brake pipe vent valve device 9, an interlock valve device 10, a cut-off valve device 11, a deadman's foot valve device 12, a double heading cock 13, and a selector cock 14.

The equipment further comprises a brake pipe 15, a straight air pipe 16, and application and release train wires 17 and 18, respectively, these pipes and wires extending through the locomotive from one end to the other end being provided at their ends with suitable couplings or connectors for connecting same to like pipes and wires on other vehicles through a train.

The brake equipment further comprises a brake cylinder device 19 under the control of the relay valve device 6 for controlling the brakes on the locomotive, and still further, there are provided a plurality of different reservoirs, double check valve devices etc., which will be brought out in the description to follow.

The automatic brake valve device 1, which is provided for the engineer to control the brakes on the locomotive and cars of a train either by straight air through the straight air pipe 16 or automatically through the medium of brake pipe 15, is substantially the same as that disclosed in Patent 2,106,483 issued to Ellis E. Hewitt on January 25, 1938. Accordingly, only those parts of the automatic brake valve device 1 are shown in the drawings which are essential to the operation and a clear understanding of the present invention.

As shown in the drawings, the automatic brake valve device 1 comprises a pipe bracket 20 upon which is mounted a rotary valve casing section 21 which is provided with an off-set bracket 22 for carrying the independent brake valve device 2 and which also supports a straight air application and release valve portion 23. The rotary valve casing section 21 has a chamber 24 which is connected through a passage 25 containing a ball check valve 26 to a feed valve pipe 27 which is adapted to be supplied with fluid under pressure from a main reservoir 28 by operation of a feed valve device 29. The main reservoir is adapted to be supplied with fluid under pressure in the usual manner and the feed valve device 29 is adapted to reduce said pressure to that desired to be carried in the brake pipe 15 and to supply fluid at this reduced pressure through pipe 27 to rotary valve chamber 24 in the brake valve device 1.

In chamber 24 there is provided a rotary valve 30 and extending into said chamber and having driving engagement with said valve is an operating shaft 31. In addition to other functions which will hereinafter be brought out, the rotary valve 30 is provided to control the brakes on the locomotive and a train on the usual automatic principle through brake pipe 15 and accordingly is rotatable by the engineer to a number of different control positions, namely, release position, first service position, lap position, service position, and an emergency position as illustrated in Fig. 3 of the drawings.

The straight air application and release valve portion 23 of the brake valve device 1 is provided for controlling the brakes on the train by straight air through the medium of the straight air pipe 16 in accordance with the operation of a shaft

32 which is rotatable to different brake controlling positions by a handle 33.

The shaft 32 extends into the lower end of a sleeve 34 which at one end is journaled in the brake valve casing, said sleeve having a driving connection with said shaft. The opposite end of sleeve 34 is journaled in a suitable bearing provided in a bracket 35 extending from the brake valve casing. Between bracket 35 and the top of the brake valve casing the sleeve 34 is provided with a pair of oppositely arranged openings through the sides thereof and secured to said sleeve and extending across the openings at one side of the sleeve is a pin 36. The brake valve handle 33 extends through these openings and the innermost end is provided with a hook 37 arranged for engagement with the pin 36.

A plunger 38 is slidably mounted in sleeve 34 beneath the brake valve handle 33 and is urged into engagement with said handle by a spring 39. A plunger 40 is slidably mounted in the sleeve 34 above the handle 33 and is provided with an upwardly extending pin 41 which engages a safety control valve 42. The valve 42 is contained in a chamber 43 which is connected to a passage 44 and which contains a spring 45 acting on said valve for urging it to its seated position shown. When the brake valve handle 33 is held by manual pressure against the opposing pressure of spring 39 in the position shown, the spring 45 is adapted to seat the valve 42. Upon the removal of manual pressure from handle 33 the spring 39 is adapted to rotate said handle about the pin 36 in a clockwise direction for urging the plunger 40 in an upwardly direction to move the valve 42 away from the seat so as to connect chamber 43 to a chamber 46 within the plunger, which chamber 46 is open to the atmosphere through a vent port 47.

The fit between the side openings in sleeve 34 through which the handle 33 extends and said handle is such that upon movement of the handle in a horizontal plane the sleeve and thereby the shaft 32 will be turned with the handle.

At one side of sleeve 34 in valve portion 23 there is provided a poppet valve 48 having a fluted stem 49 which extends through a suitable bore in the casing for engagement by a cam 50 formed on the exterior of sleeve 34, this sleeve cam being so designed as to unseat said valve whenever the brake valve handle 33 is in positions corresponding to the release and first service positions and to permit closure of the valve in all other positions of the handle. The valve 48 is contained in a chamber 51 and controls communication between said chamber and an atmospheric vent port 52. A spring 53 in chamber 51 acts on valve 48 for urging it to its seat.

On the outside of the brake valve device there is provided a selector handle 55 which is movable to either a straight air brake controlling position or to an automatic brake controlling position for selecting whether the brakes on the locomotive and train will be controlled by straight air by operation of the straight air application and release valve portion 23 or automatically by operation of the rotary valve 30.

When the selector handle 55 is in the straight air position providing for straight air control of the locomotive and train brakes, the rotary valve operating shaft 31 is disconnected by means (not shown) from the handle shaft 32 so that the rotary valve 30 will remain in its release position shown upon operation of the brake valve handle 33, while if the selector handle 55 is in the automatic position said shafts are connected to operate the rotary valve to control the brakes, the straight air application and release valve portion 23 being inoperative under this latter condition and the parts thereof remaining in their release position.

The straight air application and release valve portion 23 of the brake valve device is provided for varying the pressure in a straight air control pipe 56. In the release position of handle 33 the pipe 56 is adapted to be vented for effecting the release of brakes on the locomotive and train. With the selector handle 55 in the straight air position an application of the brakes is effected by moving the brake valve handle 33 to any desired position in an application zone (not indicated) whereupon the straight air control pipe 56 is disconnected from the atmosphere and fluid is supplied to said pipe to a degree dependent upon the extent of movement of said handle into said zone. A release of a straight air application of brakes is effected by return of the handle 33 to the release position.

A further description of the straight air portion 23 of the brake valve device 1 is not deemed essential, while the operation of the automatic portion of the brake valve device including the rotary valve 30 will be explained hereinafter.

The independent brake valve device 2 is similar to that disclosed in our Patent No. 2,173,940, issued September 26, 1939, and comprises a casing mounted on the bracket 22 and having a chamber 57 containing an operating shaft 58 carrying a cam sleeve 59. The lower end of the shaft 58 is journaled in the casing, while the upper end has a driving connection with a sleeve 60 which is journaled in the casing and which carries at its upper end an operating handle 61. This handle extends through suitable slots provided in the opposite sides of sleeve 60 and the end of the handle is pivotally connected to a pin 62 carried by said sleeve, the sides of said slots cooperating with the handle to effect rotation of the sleeve 60 and thereby shaft 58 and cam sleeve 59 upon movement of the handle 61 in a horizontal plane. A plunger 63 is slidably mounted in sleeve 60 beneath the handle 61 and is urged into engagement with said handle by a spring 64.

The cam sleeve 59 is provided at its lower end with a cam 66 engaging a stem 67 of a cut-off valve 68 which is contained in a chamber 69, and in said chamber there is provided a spring 70 for urging said valve toward its seated position. Immediately above the cam 66 the cam sleeve 59 is provided with another cam 72 which engages a plunger 73 of a self-lapping straight air application and release valve mechanism 74 which is operative by said plunger upon movement in the direction of the right hand to supply fluid to chamber 57 at a pressure depending upon the extent of such movement. Upon movement of the plunger 73 in the direction of the left hand the operation of the release valve mechanism 74 is adapted to reduce the pressure in chamber 57 to a degree dependent upon the extent of such movement. In the position in which plunger 73 is shown, the self-lapping application and release valve mechanism 74 is adapted to be conditioned to effect a complete release of fluid under pressure from chamber 57.

Within the lower end of sleeve 60 there is mounted a member 75 adapted to turn with said sleeve and having a cam 76 provided for engagement with a stem 77 projecting from an appli-

cation delay valve 78, said stem extending through a suitable slot provided in the lower end of said sleeve. The application delay valve 78 is contained in a chamber 79 and a spring 80 in said chamber acts on said valve for urging it toward its seat. The delay valve 78 is provided for controlling communication between the chamber 79 and an atmospheric port 81.

In Fig. 1 the independent brake valve handle 61 and other parts of the independent brake valve device, just described, are shown in their release position, which they normally occupy. The handle 61 is movable from the release position in one direction into an application and release zone, shown in Fig. 4, for operating the self-lapping straight air application and release valve mechanism 74 to supply fluid to chamber 57 at a pressure dependent upon the deposition of said handle in said zone. Upon movement of the handle back toward the release position, the application and release valve mechanism 74 is adapted to operate to vent fluid under pressure from the chamber 57 to an extent depending upon the position of the handle with respect to the release position, and at the time the release position is obtained said mechanism is adapted to provide for a complete venting of the chamber 57. To accomplish this operation the cam 72 for operating the plunger 73 is designed, as shown in Fig. 4, to vary the position of said plunger in accordance with the position of the brake valve handle.

It will be noted from Fig. 4 that the cam 66 is so designed that the cut-off valve 68 will be maintained open during movement of handle 61 in the application and release zone, while the cam 76 for controlling the delay valve 78 will effect opening of said valve promptly upon movement of the handle out of release position and maintain said valve open in the application and release zone.

The handle 61 is movable in the opposite direction from release position to a locking position indicated in Fig. 4, and it will be apparent from the development of the cams that the delay valve 78 and the cut-off valve 68 will both be closed in the locking position.

Below the handle 61 there is provided a bail 82 over which the handle is adapted to turn upon movement to its different positions. The bail 82 is pivoted on a pin 83 in the casing of the brake valve device, and at a point remote from said pin is supported on a plunger 84 which is slidably mounted in the brake valve casing. The plunger 84 is carried by a spring 85 supported on a valve 86 which is contained in a chamber 87 open to the atmosphere through a vent port 88. The valve 86 has a fluted stem slidably mounted to a suitable bore in the casing and extending into a chamber 89 where it engages the fluted stem of an oppositely disposed valve 90 contained in a chamber 91. A spring 92 in chamber 91 acts on the valve 90 for normally urging it to its seated position and for unseating the valve 86, as shown, and is of sufficient strength to normally support the plunger 84 and bail 82 in the position shown through the medium of spring 85.

The handle 61 is adapted to be turned on pin 62 against the pressure of spring 64 on plunger 63 in a downwardly direction into engagement with the bail 82 for effecting movement thereof in a downwardly direction, and this movement acting through the plunger 84 and spring 85 is adapted to effect seating of the valve 86 and unseating of the valve 90 against spring 92. The release of manual pressure on the handle 61 is adapted to permit operation of spring 92 to seat valve 90 and unseat the valve 86.

The master switch device 3 comprises a casing containing two flexible diaphragms 93 and 94 operatively connected together by a stem 95. The diaphragm 93 has at its outer face a chamber 96 connected to a pipe 97 while the diaphragm 94 has at its outer face a chamber 98 connected to a straight air pipe 16 through a choke 99 and a parallel arranged check valve device 100. A chamber 101 is formed intermediate the diaphragms, and secured to but insulated from the stem 95 in this chamber is a movable contact 102 to which is connected one terminal of an electric supply such as a battery 103, the other terminal of which is grounded. Two flexible contacts or fingers 104 and 105 carried by and insulated from the casing in any suitable manner project into the chamber 101 and are arranged to be successively engaged by the movable contact 102 upon movement thereof in the direction of the right-hand, and disengaged in the reverse order upon movement of the contact member 102 toward the left-hand. The contact fingers 104 and 105 are connected, respectively, to the release and application train wires 18 and 17.

The application and release magnet valve device 4 comprises an application magnet 110 having one terminal connected to the application train wire 17 and the other to ground, and a release magnet 111 having one terminal connected to the release train wire 18 and the other to ground.

The application magnet 110 is operative upon energization to unseat an application valve 112 to supply fluid under pressure from an auxiliary reservoir 113 to a branch pipe 114 which leads to the straight air pipe 16. A spring 115 acts on the application valve 112 for seating same upon deenergization of magnet 110 for thus cutting off the supply of fluid under pressure to the straight air pipe.

The release magnet 111 is provided for seating a release valve 116 upon energization of the magnet to close communication between the straight air branch pipe 114 and an atmospheric port 117. A spring 118 acting on valve 116 is provided for unseating said valve upon deenergization of magnet valve 111, to thus open communication between the straight air pipe and the atmospheric port 117.

The brake controlling valve device 5 comprises a pipe bracket 120, an emergency valve device mounted on one face of the pipe bracket and adapted to be controlled by variations in pressure in brake pipe 15, a filler piece 122 mounted on the opposite face of said bracket and a service application valve device 123 mounted on said filler piece and also adapted to be controlled by variations in pressure in the brake pipe 15. This brake controlling valve device may be similar to that disclosed in our Patent 2,173,940 issued September 26, 1939, and the description thereof will therefore be limited to only those parts which are required to bring out clearly the present invention.

The service application valve device 123 is adapted to operate upon a reduction in brake pipe pressure at either a service or an emergency rate to supply fluid under pressure from the auxiliary reservoir 113 through a service choke 124 to a passage 125 for effecting an application

of brakes on the locomotive as it is adapted to operate upon an increase in pressure in the brake pipe to vent fluid under pressure from said passage for effecting a release of brakes and to also supply fluid under pressure from the brake pipe to the auxiliary reservoir 113 and to an emergency reservoir 128 by way of a passage 127 for charging same. This operation of a valve device of this type is well known.

In the emergency valve device 121 the reference numeral 125a indicates a portion of the main slide valve in said device in its normal or release position. Upon an emergency reduction in pressure in the brake pipe 15 the slide valve 125a is adapted to be moved to an emergency position in which a cavity 126 in said valve will connect passage 127 communicating with the emergency reservoir 128 to passage 125 to which, in effecting an emergency application of the brakes, fluid under pressure is also supplied by the service application valve device 123. An emergency choke 132 is provided to control the rate of flow of fluid under pressure from the emergency reservoir 128 to the passage 125. Fluid under pressure will thus be supplied from both the auxiliary reservoir 113 and emergency reservoir 128 to passage 125 through the service and emergency chokes 124 and 132, respectively, for effecting an emergency application of the brakes on the locomotive. The cavity 126 in the emergency slide valve 125a in its emergency position also connects the emergency reservoir passage 127 to a passage 130 for reasons which will be later brought out, it being noted that in the release position of the slide valve 125a the cavity 126 therein connects the passage 130 to an atmospheric vent port 131.

The filler piece 122 carries on one face an interlock valve device 135 for interlocking the automatic and straight air control of the brakes on the locomotive and the independent control of the brakes of the locomotive, and carried on another face of said filler piece is an emergency application delay valve device 136.

The interlock valve device 135 comprises two double check valves 137 and 138 of usual construction, a selector valve device 139 and a release valve 140.

The selector valve device 139 comprises a piston 141, a slide valve 142 movable by said piston, and a spring 143 acting on said piston for urging same and thereby the slide valve 142 in an upwardly direction to an independent position. The slide valve 142 is contained in a chamber 144 formed at one side of the piston, which chamber is connected by a passage and pipe 145 to a pipe 146 connected to and charged at all times with fluid under pressure from the main reservoir 28. At the opposite side of piston 141 there is provided a chamber 147 containing the spring 143 and connected by a passage and pipe 148 to chamber 89 in the independent brake valve device 2 between the valves 86 and 90.

The release valve 140 is preferably in the form of a valve piston slidably mounted in the casing of the interlock valve device 135 and having on one face a valve seat arranged to seal against an annular seat rib 151 encircling a vent port 152 for closing communication between said port and a chamber 153 provided at one side of the valve piston around said seat rib. At the opposite side of the valve piston there is provided a chamber 154 containing a spring 155 acting on said valve piston for urging same in the direction of and into engagement with the seat rib 151. A port 600 is provided through the valve piston 140 connecting chambers 153 and 154 to permit charging of the latter upon supply of fluid under pressure to the former as will be later described.

The emergency delay valve device comprises a flexible diaphragm 380 having at one side a chamber 369 connected to a pipe 368 which communicates with the delay valve chamber 79 in the independent brake valve device 2. The diaphragm is provided on its opposite face with a valve 381 provided for engagement with an annular valve seat 382 to close communication between space within said seat rib which is connected to the application and release passage 125 and an annular space encircling the seat and open to a passage 479. Passages 125 and 479 are in permanent communication through a restricted passage 478, and in addition there is a one-way flow release communication from passage 479 to passage 125 past a check valve 150.

The relay valve device 6 may be of any desired construction and as shown is connected to the main reservoir pipe 146, to a pipe 157 leading to the brake cylinder device 19 and to a pipe 158 which is connected by a pipe 159 to the brake controlling valve device 5. In effecting an application of brakes on the locomotive fluid under pressure is adapted to be supplied through the pipes 159 and 158 to the relay valve device 6 for actuating same to supply fluid at a corresponding pressure from the main reservoir pipe 146 to the brake cylinder device 19 for applying the brakes on the locomotive, while upon the venting of fluid under pressure from the control pipe 158 the relay valve device is adapted to operate to effect corresponding venting of fluid under pressure from the brake cylinder device 19. The manner in which fluid under presure is supplied to and released from the relay valve device by way of pipe 158 for controlling the brakes on the locomotive will be hereinafter described.

The automatic train control device 7 comprises a brake application valve device 162, a split reduction control valve device 163, a cut-off valve device 164, a combined brake pipe equalizing discharge valve mechanism and maintaining valve device 165, an automatic suppression valve device 166 and a straight air suppression valve device 167.

The brake application valve device 162 comprises a piston 170, a slide valve 171 movable with said piston, and a spring 172 acting on said piston for moving same and the slide valve 171 to their normal position shown. The slide valve 171 is contained in a valve chamber 173 which is connected by a passage and pipe 174 to pipe 27 leading to and supplied with fluid under pressure from the feed valve device 29 whereby said chamber is constantly charged with fluid at feed valve pressure. At the opposite side of the application piston 70 there is provided a chamber 176 which contains the spring 172 and which is connected through a passage 177 to a pipe 178 leading to the timing valve device 8 and also to the cut-off valve device 11.

The split reduction valve device 163 comprises a valve piston 180 slidingly mounted in the casing and having at one side a chamber 181 in constant communication with a passage 182 which leads to the seat of slide valve 171. At the opposite side of the valve piston 180 there is provided an annular seat rib 183 encircling an opening 184 leading to a chamber 185 which is constantly open to the atmosphere through a vent port 186. A spring 187 in chamber 181 acts to urge

the valve piston 180 into engagement with the seat rib 183 and in this position of said valve piston communication is adapted to be established between passage 182 and a passage 188 which is connected to a pipe 189 leading to a second reduction reservoir 190 and to the seat of rotary valve 30 is the brake valve device 1. A piston 192 slidably mounted in the casing is provided with a stem 193 extending through chamber 185 and opening 184 for engagement with the valve piston 180. One face of the piston 192 is thus open to the vented chamber 185 while at the opposite face of said piston there is provided a chamber 194 which is connected to a passage 195 leading to the seat of slide valve 171. The piston 192 is provided for moving the valve piston 180 from the position shown in an upwardly direction into sealing engagement with a gasket 196 to close communication between passage 182 and the passage 188 which is connected to the second reduction reservoir, under conditions which will be later brought out.

The cut-off valve device 164 comprises a piston 200, a cut-off valve 201 connected to said piston by a stem 202 which extends through a chamber 203 at one side of said piston and a bore 204 connecting said chamber to a chamber 205. In chamber 205 there is provided a seat rib 206 encircling the bore 204 and provided for engagement by the cut-off valve 201 to close communication between the chamber 205 and the chamber 203. At the opposite face of piston 200 there is provided a chamber 207 containing a spring 208 acting on the piston for urging same and thereby the cut-off valve 201 to the position shown in which said valve is spaced from the seat rib 206 and establishes communication between chambers 205 and 203.

The combined equalizer discharge valve mechanism and maintaining valve device 165 comprises an equalizing piston 210 having at one side a chamber 211 which is connected to a passage 212 leading to a passage 213. The passage 213 at one end is connected to a pipe 214 leading to an equalizing reservoir 215 while the other end of passage 213 terminates at the seat of slide valve 171.

At the opposite side of the equalizing piston 210 there is provided a chamber 216 which is connected to a passage 217 leading to chamber 203 in the cut-off valve device 164, the passage 217 being also connected to a pipe 218 leading to the brake pipe vent valve device 9.

The equalizing piston 210 is provided with a stem 219 extending through the chamber 216 and having its end slidably mounted and thereby guided in a suitable bore provided in the casing. A bell crank 220 in chamber 216 is rockably mounted on a pin 221 secured in the casing. The end of one arm of this bell crank is disposed in a recess 223 in the equalizing piston stem 219 for movement by and with said stem. At one side of this arm there is provided a maintaining valve 224 having a stem extending into operative alignment with said arm. The maintaining valve 224 is contained in a chamber 225 and is provided for controlling communication between said chamber and the chamber 216, a spring 226 in chamber 225 acts on the valve 224 for seating same, while the equalizing piston 210 is operative upon movement from the normal position shown in the direction of the right hand to actuate the bell crank 210 to unseat said valve.

A brake pipe discharge valve 228 slidably mounted in the casing is provided for controlling communication between chamber 216 and a brake pipe discharging passage 229, said valve being operatively connected to the other arm of the bell crank whereby upon movement of the equalizing piston 210 in the direction of the left hand, as viewed in the drawing, said bell crank will unseat said valve. A spring 230 acting on the discharge valve 228 is provided for seating same when the bell crank 220 and equalizing piston 210 are in their normal positions shown, under which conditions the maintaining valve 224 is also seated by the spring 226.

The automatic suppression valve device 166 comprises a double beat valve 233 contained in a chamber 234 and arranged to control communication between said chamber and a chamber 235 at one side of the valve and a chamber 236 at the opposite side of the valve. A flexible diaphragm 237 is provided for moving the double beat valve 233 from the position shown to its lower seated position. One face of the diaphragm 237 is open to chamber 236, while the opposite face is open to a chamber 238. In chamber 236 there is a follower 239 engaging the diaphragm 237 and providing an operating connection between said diaphragm and the double beat valve 233. A spring 240 in chamber 235 acts on the double beat valve for urging it to the seated position shown.

The automatic suppression valve device 166 also comprises a double beat valve 242 contained in a chamber 243 and arranged to control communication between said chamber and a chamber 244 which is open to the atmosphere through a restricted vent 245 and also between the chamber 243 and a chamber 247 provided at one side of a flexible diaphragm 248. The diaphragm 248 is operatively connected to the double beat valve 242 through the medium of a follower 249 and has at its opposite face a chamber 250. In chamber 244 there is provided a spring 251 acting on the double beat valve 242 for normally maintaining said valve in the position shown.

The straight air suppression valve device 167 comprises a double beat valve 252 contained in a chamber 253 which is connected by a passage 254 to chamber 235 in the automatic suppression valve device 166. The valve 252 is provided to control communication between chamber 253 and a chamber 255 on the one hand, and between the chamber 253 and a chamber 256 on the other hand. In chamber 256 there is provided a plunger 257 which is subject to the pressure of a spring 258, said plunger being adapted to be operated by said spring to urge said valve to the normal position shown. The chamber 255 is provided at one side of a flexible diaphragm 259 having at the opposite side a chamber 260, said diaphragm being operatively connected through the medium of a follower 261 to the double beat valve 252 for moving said double beat valve to a seated position opposite to that shown.

The straight air suppression valve device further comprises a valve piston 265 slidably mounted in the casing and having at one side a chamber 266 which is in constant communication with the atmosphere through a vent port 267. The valve piston 265 has at the opposite side a chamber 268 connected by a passage 269 to a diaphragm chamber 260. The valve piston 265 is provided in chamber 268 with a coaxially arranged valve 270 of smaller diameter than that of the valve piston and arranged to engage a seat for controlling communication between said chamber and a chamber 271 which is in constant

communication with the straight air pipe 16 through a passage and pipe 272 which leads to the straight air pipe branch 114 connecting the straight air pipe to the application and release magnet valve device 4. In chamber 266 a spring 273 is provided which acts on the valve piston 265 for urging it to the position shown for seating the valve 270. In this seated position of valve 270 the chamber 268 at one side of the valve piston 265 is opened to the atmosphere by way of a groove 274 provided in the casing and forming a by-pass from said chamber to a port 275 which is provided in the valve piston and which is open to the chamber 266. The valve piston 265 is adapted to be moved from the position shown against the opposing pressure of spring 273 into sealing engagement with a gasket 276 for unseating the valve 270 and for at the same time closing communication between the chambers 268 and 266, all of which will be hereinafter fully described.

The timing valve device 8 comprises a magnet 280 which is adapted to be controlled by any suitable means (not shown) which are operative in response to favorable and unfavorable track signals on a railway. When the track signal is favorable the magnet 280 is adapted to be energized and when unfavorable deenergized.

The magnet 280 is provided for controlling a pair of valves 281 and 282 which are coaxially arranged and movable together. The valve 281 is contained in a chamber 283 which is at all times open to the atmosphere through a vent passage 284, said valve being provided to control communication between said chamber and a chamber 285. The valve 282 is contained in a chamber 286 which is connected to a pipe 287 leading to a feed valve device 288 which is adapted to operate to supply fluid from the main reservoir to the pipe 287 at a pressure desired for control of the timing valve device. The valve 282 is provided for controlling communication between the chamber 286 and the chamber 285. A spring 289 in chamber 286 acts on the valve 282 for seating same and for at the same time unseating valve 281 upon deenergization of magnet 280.

The timing valve device 8 further comprises a double beat valve 292 contained in a chamber 293 which is connected by passage and pipe 294 to chamber 256 in the straight air compression valve device 167. The valve 292 is provided with a fluted stem 295 which extends into a chamber 296 connected with the pipe 178 and is also provided with another fluted stem 300 oppositely arranged and extending into a chamber 297 which is constantly open to the atmosphere through a vent port 298. The chamber 297 is provided at one side of a valve piston 299 which is operatively connected to the valve stem 300 through a spring 301. At the opposite face of the valve piston 299 there is provided a chamber 302 in constant communication with a timing reservoir 303 and also connected by way of passages containing a choke 304 and a check valve 305 to the chamber 285. On the face of valve piston 299 open to chamber 302 there is provided an annular seat rib 306 of smaller diameter than that of the valve piston and which is adapted to effect sealing engagement with a gasket 307 in the lower position of the valve piston, the space outside of said rib being open to the atmosphere through a groove 308 by-passing the valve piston and connected to the chamber 297 under this condition. With the valve piston 299 in its upper and normal seated position shown, communication between the groove 308 and chamber 297 is closed. In chamber 297 there is provided a spring 309 for moving the valve piston 299 to its lower position, under which condition a spring 310 in chamber 296 is adapted to move the double beat valve 292 from its normal position shown to a lower seated position for closing communication between chambers 293 and 297 and for opening communication between chamber 293 and chamber 296.

The brake pipe vent valve device 9 comprises a casing containing two pistons 315 and 316 connected together in spaced relation by a stem 317 and slidably mounted in suitable coaxially arranged bores in said casing, the piston 315 being of greater area than piston 316. The piston 315 has at its outer face a chamber 318 which is connected by passages and pipe 319 to the interlock valve device 10. On the opposite or outer face of the piston 316 there is provided a valve 320 adapted to engage an annular seat rib 321 for closing communication between a chamber 322 provided around said seat rib and an atmospheric vent port 323. Between the pistons 315 and 316 there is provided an annular chamber 324 which, with the pistons in the position shown, is connected adjacent the piston 316 to a pipe 325 leading to the brake pipe 15. The chamber 324 adjacent the larger piston 315 is connected to the passage and pipe 218 leading to chamber 216 in the combined equalizing discharge valve mechanism and maintaining valve device and also to chamber 203 in the cut-off valve device 164. The pistons 315 and 316 are adapted to be moved from the position shown in an upwardly direction to a brake pipe venting position defined by engagement of the piston 315 with a gasket 326 and in which position the piston 316 is adapted to be disposed above the passage 325 so as to connect said passage to chamber 322 and thereby to the atmospheric vent port 323.. In chamber 318 there is a spring 327 acting on the pistons 315 and 316 for urging and normally holding said pistons in the lower position shown.

The interlock valve device 10 comprises a casing containing two spaced flexible diaphragms 330 and 331. The diaphragm 330 is of smaller area than diphragm 331 and has at its outer face a chamber 332 connected to a pipe 333 to which is also connected a timing reservoir 334, while the diaphragm 331 has at its outer face a chamber 335 which is connected to a pipe 336 through a choke 337 and a check valve 338 and which contains a spring 339 acting on the diaphragm. The diaphragms 330 and 331 are operatively connected together by a yoke 340 which is provided for controlling a vent valve 341 slidably mounted in a suitable bore in the casing for controlling communication between the passage 319 and a vent port 342 which is open to the atmosphere through a chamber 343 formed intermediate the diaphragms and an atmospheric passage 344. The vent valve 341 has a stem telescopically connected to the stem of a plunger 345 by means of a pin and slot connection 346, and a spring 347 is interposed between said valve and plunger for normally urging same apart. The plunger 345 is engaged by an extension of one end of the yoke 340 and is operative thereby upon movement of said yoke towards the left hand to seat the valve 341, while upon movement toward the right hand the valve is relieved of seating pressure to permit same to be opened by pressure of fluid from the pipe 319.

The cut-off valve device 11 is provided for con-

trolling communication between pipe 178 which is connected to the application piston chamber 176 and a pipe 350 leading to the foot valve device 12 and comprises in a casing two spaced operatively connected flexible diaphragms 351 and 352, the diaphragm 352 being of greater diameter than the diaphragm 351.

The diaphragm 351 is provided to control communication between the pipes 178 and 350 and is normally spaced from a seat rib 353 to open said communication and is adapted to be moved into engagement with said seat rib to close said communication upon the supply of fluid under pressure to a chamber 354 provided at the outer face of the larger diaphragm 352. The chamber 354 is normally open to the atmosphere through a port 355 which is controlled by a valve piston 356 and opened to the chamber 354 which said valve piston is in the normal position shown. This valve piston is subject on one face to the pressure of a spring 357 which normally urges it to the closed position shown and on the opposite face is subject to the pressure of fluid in a chamber 358. When the pressure of fluid in chamber 358 exceeds a certain degree said pressure is adapted to move the valve piston 356 against the opposing pressure of spring 357 to thereby connect chamber 358 to chamber 354 and through the communication just established fluid under pressure is adapted to be supplied for actuating the larger diaphragm 352 to move the smaller diaphragm into seating engagement with the seat rib 353. When the pressure in chamber 358 and in chamber 354 is reduced to a certain low degree the spring 357 is adapted to return the valve 356 to its normal position shown and in which the pressure of fluid in chamber 354 is adapted to be dissipated through the release port 355 to permit the diaphragm 351 to move out of engagement with the seat rib 353 and thereby reopen communication between pipes 178 and 350.

The foot valve device 12 comprises a casing containing a flexible diaphragm 361 adapted to cooperate with a valve seat 362 to control communication between pipe 350 and a safety control pipe 363 leading to the safety control valve chamber 43 in the brake valve device 1. For controlling the position of the diaphragm 361 there is provided a bell crank 364 which is pivoted in the casing and which is provided with a horizontally extending pedal arm 365 adapted when subject to foot pressure from the locomotive engineer to move the diaphragm 361 into sealing engagement with valve seat 362 for closing communication between pipes 350 and 363. A spring 366 is interposed between the casing and bell crank for operating the bell crank upon the release of manual pressure thereon in a direction away from the diaphragm 361 to permit said diaphragm to flex away from the valve seat 362 and thereby open communication between the pipes 350 and 363.

The double heading cock 13 is provided for controlling communication through the pipes 325, 178 and 56 and is normally carried in the position shown in which such communications are open and it is movable from this position to another or double heading position shown in Fig. 5 for closing said communications when an engine equipped with this brake equipment is employed as the second engine in double heading service or as a pusher engineer under which condition it is desired that the service application and release of brakes on the locomotive and train be controlled from the leading locomotive only.

The selector cock 14 comprises a casing 370 containing a rotary plug valve 371 which is movable to either one of two control positions one of which is provided for use when the locomotive is employed for controlling the brakes on relatively long trains such as freight trains, while the other position is adapted to be employed when the locomotive is controlling relatively short trains such as passenger trains. A handle 372 is provided for turning the plug valve 371 from the long train position in which it is shown to the short train position in which said handle will occupy the position indicated by the dash line 373.

In the long train position of handle 372 as shown, a port 374 in plug valve 371 is adapted to open communication through a pipe 375 to a timing reservoir 376. Another port 377 in the plug valve 371 is adapted to open communication through a pipe 378 to a suppression reservoir 379, while a port 367 in said valve is adapted to establish communication through pipe 27 to a pipe 368, a choke 379*a* being provided in the port 367 for limiting the rate at which fluid at feed valve pressure will be supplied from the pipe 27 to the pipe 368. The function of plug valve 371 in the short train position will be hereinafter described and until that time it will be assumed that the plug valve 371 of the selector plug valve 371 is in the long train position shown.

Operation

Charging of brake equipment

In operation, fluid under pressure is supplied to the main reservoir 28 and thence to the main reservoir pipe 146 in the usual manner. From pipe 146 fluid at main reservoir pressure is supplied to the lockout valve chamber 91 and to the self-lapping straight air application and release valve mechanism 74 in the independent brake valve device 61 and also from said pipe to the relay valve device 6 and to pipe 145 through which fluid at main reservoir pressure is supplied to valve chamber 144 in the interlock valve device 135 of the brake controlling valve device 5.

Let it be assumed that handle 61 of the independent brake valve device 2 is in its normal release position shown. Under this condition spring 92 acts to seat valve 90 and unseat valve 86 thereby opening the interlock piston chamber 147 in the brake controlling valve device 5 to the atmosphere which permits fluid at main reservoir pressure supplied to chamber 144 as just described to move the interlock piston 141 and slide valve 142 to their normal positions shown in the drawing against the opposing pressure of spring 143.

The feed valve device 29 operates to supply fluid from the main reservoir pipe 146 to the feed valve pipe 27 at a pressure desired to be carried in the brake pipe 15. Fluid pressure thus supplied to pipe 27 flows through passage 25 and past ball check valve 26 in the brake valve device 1 to the rotary valve chamber 24 therein and also through pipe 27 to the slide valve chamber 173 in the train control application valve device 7 and to the selector cock 14.

Fluid at feed valve pressure thus supplied to the selector cock 14 flows through port 367 in the plug valve 371 to pipe 368 one end of which is connected to diaphragm chamber 369 in the emergency application valve device 136 while the other end of pipe 368 is connected to the delay valve chamber 79 in the independent brake valve

device 2. With handle 61 of the independent brake valve device 2 in the normal or release position shown the delay valve 78 is seated. Under this condition the pipe 368 and diaphragm chamber 369 will become charged with fluid at feed valve pressure and said pressure acting on diaphragm 380 will actuate said diaphragm to move the valve 381 into sealing engagement with the annular valve seat 382.

The feed valve device 288 operates to supply fluid at reduced pressure from the main reservoir pipe 146 to the pipe 287 leading to valve chamber 286 in the timing valve device 8.

Now let it be assumed that the handle 33 of the brake valve device 1 is in release position and held depressed by the engineer as shown in Fig. 1, and let it further be assumed that the traffic or signal conditions are favorable and the timing magnet 280 is, as a consequence, energized seating the valve 281 and unseating the valve 282. With the valve 282 unseated fluid supplied to chamber 286 flows past said valve to chamber 285 and thence through the choke 304 and past the check valve 305 to the timing reservoir 303 and to chamber 302 beneath the valve piston 299. When the pressure of fluid thus supplied to chamber 302 is increased sufficiently it is adapted to move the valve piston 299 and thereby the double beat valve 292 to their upper seated positions in which said valve closes communication between chambers 296 and 293.

Fluid at feed valve pressure supplied to the slide valve chamber 173 in the train control application valve device 7 equalizes through a port 383 in the piston 170 into chamber 176 and from said chamber into passage 177 and pipe 178 leading to chamber 296 in the timing valve device 8 and also to chamber 384 in the cut-off valve device 11. With the lower diaphragm 351 of the cut-off valve device unseated from rib 353, the fluid pressure supplied through pipe 178 equalizes past said diaphragm into pipe 350 and with the diaphragm 361 of the foot valve device 12 unseated the pressure in the pipe 350 equalizes into pipe 363 and consequently into chamber 43 above the safety control valve 42 in the brake valve device 1, it being understood that the valve 42 is seated with the brake valve handle 33 held in its depressed position. It will now be apparent that with the various parts of the apparatus conditioned as just described, the fluid pressure is equalized through port 383 on the opposite faces of piston 170 in the train control application valve device and this permits spring 172 to hold the piston 170 and thereby the slide valve 171 in their normal or release position shown.

If desired, the engineer may, instead of holding the brake valve handle 33 in a depressed condition, apply foot pressure to the pedal 365 of the foot valve device 12 and seat the diaphragm 361 against the valve seat 322 and thereby close communication between pipes 350 and 363 and accomplish the same end as by holding the brake valve handle in a depressed condition. Either the brake valve handle 33 must be held depressed or the pedal 365 must be subjected to manual pressure according to the preference of the engineer.

With the brake valve rotary valve 30 in the running position shown fluid at feed valve pressure supplied to rotary valve chamber 24 flows through a port 385 in said valve to a passage 386 and thence through a pipe 387 to the cut-off valve chamber 205 in the train control application valve device and also to the seat of slide valve 171. In release position of the slide valve 171, a cavity 388 therein connects the passage 371 to a passage 389 which leads to the piston chamber 207 in the cut-off valve device 164. The chamber 207 is thereby charged with fluid at feed valve pressure which acting in conjunction with spring 208 on piston 200 moves said piston and thereby the cut-off valve 201 to the open position shown in the drawings. In this position of the cut-off valve 201 fluid at feed valve pressure supplied to chamber 205 flows to chamber 203 and thence in one direction through a passage 390 to chamber 247 below diaphragm 248 in the reduction insuring valve device. Fluid at feed valve pressure supplied to the cut-off valve chamber 203 also flows therefrom through passage 217 to chamber 216 in the combined equalizing discharge valve mechanism and maintaining valve device 165 and also from said passage to pipe 218 leading to chamber 324 in the brake pipe vent valve device 9.

Fluid at feed valve pressure thus supplied to chamber 324 in the vent valve device 9 equalizes through a port 393 in piston 315 into chamber 318 and thereby into pipe 319 leading to the interlock valve device 10, the valve 341 in said interlock valve device being normally closed by the action of spring 339 on the diaphragm 331. With the fluid pressure thus equalized on the opposite sides of piston 315 in the vent valve device 9 said piston and thereby the piston 316 are positioned as shown due to the action of spring 327 and in this position fluid at feed valve pressure supplied to chamber 324 flows into pipe 325 and thence to the brake pipe 15 for charging same on the locomotive and train.

Fluid at feed valve pressure thus supplied to the brake pipe 15 flows therefrom to the emergency application valve device 121 and to the service application valve device 123 of the brake controlling valve device 5 on the locomotive. Both of these devices are thereby conditioned during charging of the brake pipe for operation in the well known manner upon a reduction in brake pipe pressure to apply to the brakes on the locomotive, it being desired to point out however that during charging of the brake pipe the service application valve device 123 operates in the usual manner to establish communications through which the auxiliary reservoir 114 and emergency reservoir 128 are charged with fluid under pressure from the brake pipe.

A cavity 394 in rotary valve 30 connects a passage 395 which is supplied with fluid at feed valve pressure from passage 386, to a passage and pipe 396 leading to a suppression reservoir 397 and to diaphragm chamber 250 in the reduction insuring valve device whereby said reservoir and chamber in the release position of the brake valve device are charged with fluid at the same pressure as carried in brake pipe 15.

Fluid at feed valve pressure supplied to the rotary valve chamber 24 also flows through a port 399 in the rotary valve to a pipe 400 which leads to the seat of slide valve 171 of the train control application valve device and in said slide valve there is provided a cavity 401 which in the release position of the valve connects the passage 400 to the passage 213. The passage 213 is connected by passage 212 to the equalizing piston chamber 211 and by pipe 214 to the equalizing reservoir 215 whereby said chamber and reservoir are also charged with fluid at feed valve pressure

as carried in the brake pipe 15. The equalizing discharge valve piston 210 is thus subject in chamber 211 to equalizing reservoir pressure and in chamber 216 to brake pipe pressure, since the chamber 216 is in communication with the brake pipe 15 through the vent valve device 9 as hereinbefore described. Consequently, the equalizing piston 210 is in a state of equilibrium with respect to opposing fluid pressures which permits the springs 226 and 230 to seat the maintaining valve 224 and brake pipe discharge valve 228, respectively.

The rotary valve 30 is also provided with a port 402 which in the normal release position of said valve permits fluid at feed valve pressure to flow from chamber 24 to a passage and pipe 403 which leads to the seat of slide valve 171. A cavity 404 in slide valve 171 connects the passage 403 to the passage and pipe 378 which is connected through the selector cock 14 to the suppression reservoir 379 so that said reservoir also becomes charged with fluid at feed valve pressure from the rotary valve chamber 24 in brake valve device 1.

In the rotary valve 30 there is provided a cavity 406 which in the release position of said valve is open to an exhaust port 407. A first reduction limiting reservoir 408 is connected by pipes 409 and 410 to a passage 411 in the brake valve device which passage is lapped by the rotary valve 30. The pipe 409 also leads to the seat of the application slide valve 171 and in the normal position thereof is connected by ports 412 and 503 to a passage 504 which is connected by a pipe 505 to the vented cavity 406 in the rotary valve 30. The first reduction reservoir is also open to the atmosphere by way of ports 412, 413 and 414 in slide valve 171 in the release position thereof and from port 414 through an atmospheric exhaust port 415, a choke 506 being provided in port 412 to restrict this vent communication but not that to passage 504 leading to the brake valve device.

The second reduction reservoir 190 connected to pipe 189 is also normally open to the atmosphere by way of said pipe and a passage 417 in the brake valve device which is open to the exhaust cavity 406 in the rotary valve 30. Further, diaphragm chamber 238 in the suppression valve device 166 is also normally open to the atmosphere through cavity 406 in rotary valve 30 of the brake valve device by way of passage and pipe 418 connecting said chamber and cavity. A stop reservoir 420 is also at atmospheric pressure when the parts of the brake mechanism are in the release positions above described, due to the connection through a pipe 421, past a ball check valve 422 to a passage 423 which is connected by a passage and pipe 424 to the poppet valve chamber 51 in the brake valve device 1 and thence past the poppet valve 48 to the atmospheric exhaust port 52, said poppet valve being in the open position when the brake valve handle 33 is in release position as hereinbefore described.

With slide valve 171 of the train control application valve device in its release position chamber 194 below the split reduction piston 192 is open to the atmosphere through passage 195, a cavity 419 in said slide valve and an atmospheric exhaust port 425. As a consequence, the valve piston 180 is normally held in its lower position by spring 187 thereby connecting passage 188 from the second reduction reservoir 190 to passage 182 which in release position of slide valve 171 is open to the atmosphere through a port 426 in said slide valve which port is connected to the vented port 413.

As above described the diaphragm chamber 250 in the automatic suppression valve device 166 is charged with fluid at brake pipe pressure along with the suppression reservoir 397, while chamber 247 at the opposite side of the diaphragm 248 is charged with fluid at brake pipe pressure by way of the cut-off valve device 164, as a consequence of which spring 251 is adapted to hold the double beat valve 242 in its upper seated position shown, in which position diaphragm chamber 238 above the suppression diaphragm 237 is open to the atmosphere through chambers 243 and 244 and the restricted vent 245. With the diaphragm chamber 238 thus vented, the spring 240 is adapted to hold the double beat valve 233 in its upper position shown.

Let it be further assumed that the selector handle 55 on the side of the brake valve device 1 is in position for controlling the brakes on the locomotive and train electro-pneumatically by straight air through the straight air pipe 16. With the brake valve handle 33 in its release position, the straight air control pipe 56 will therefore be vented to the atmosphere through the selflapping straight air application valve portion 23 of the brake valve device 1. When the straight air control pipe 56 is thus vented, diaphragm chamber 96 in the master switch device 3 will also be vented through pipe 97 and a double check valve device 458 and thence by way of the straight air control pipe 56 and as a consequence the diaphragms 93 and 94 and thereby the contact 102 will be moved to the position shown in which the fingers 104 and 105 are disengaged from said contact. The application and release train wires 17 and 18 will, as a result, be deenergized and likewise the application magnet 110 and release magnet 111. The supply valve 112 will therefore be closed and the release valve 116 will be open so that the straight air pipe 16 will be vented to the atmosphere.

With the straight air pipe 16 thus vented, the control pipes 158 and 159 for the relay valve device 6 will also be vented by way of passage 429 in the brake controlling valve device 5, past the upper end of the double check valve 137 to a port 430, from said port past the upper end of the double check valve 138 to port 431 and thence through a cavity 432 in slide valve 142 to a passage 433 which is connected directly to the straight air pipe. As a result, the relay valve device 6 will be conditioned in the usual manner to connect the brake cylinder device 19 with the atmosphere to thereby provide for the release of the brakes on the locomotive.

With the straight air pipe 16 open to the atmosphere chamber 271 below the valve 270 in the independent suppression valve device 167 is also at atmospheric pressure due to the connection through passage and pipe 272 and, as a result, the valve 270 will be seated by the action of spring 273 on valve piston 265. With the valve piston 265 in this position chamber 260 below the diaphragm 259 is open to the atmosphere through chamber 268, leakage groove 274, chamber 266 and vent port 267 and this permits spring 258 acting on plunger 257 to move the double beat valve 252 to the position shown.

With the double beat valve 252 in the independent suppression valve device conditioned as just described and with the double beat valve 233 in the automatic suppression valve device 168

conditioned as shown, the pipe and passage 294 connected to the timing valve device 8 is placed in communication with the poppet valve chamber 51 in the automatic brake valve device 1 past said double beat valves in series, i. e., through chamber 256 and past the double beat valve 252 to chamber 253 and thence through passage 254 to chamber 235 in the automatic suppression valve device and from said chamber past the double beat valve 233 to chamber 234 which is connected through a passage 435 to passage and pipe 421 from the stop reservoir 420 and thus vented with said reservoir as before described.

Pipe 158 through which fluid under pressure is adapted to be supplied to and released from the relay valve device 6 for controlling the pressure of fluid in the brake cylinder device 19 communicates through pipe 359 with chamber 358 in the cut-off valve device 11 and also with one end of a double check valve device 436. The opposite end of the double check valve 436 is open to the straight air control pipe 56. The chamber 358 in the cut-off valve device 11 is thus normally vented by way of the relay valve control pipe 158 and the valve piston 356 is therefore seated by spring 357 so that chamber 354 above the large diaphragm 352 is vented to the atmosphere through the vent port 355 as a result of which the lower diaphragm 351 is disengaged from the valve seat 353 and the pipes 178 and 350 are in communication as above mentioned.

Pipe 157 connected to the brake cylinder device 19 is also connected to one end of a double check valve device 437 and the opposite end of this double check valve device is connected by a pipe 438 to pipe 148 which leads to chamber 89 in the independent brake valve device and which in the release position of said brake valve device is open to the atmosphere past the lockout valve 86 and through the vent 88. The opposite ends of the double check valve device 437 are thus both normally vented and as a result pipe 336 connected to diaphragm chamber 335 in the interlock valve device 10 will likewise be normally vented through said double check valve device and either one or the other of said pipes. The two diaphragm chambers 332 and 335 in the interlock valve device thus being both normally vented permits the spring 339 to hold the vent valve 341 seated as above mentioned.

The straight air control pipe 56 is connected to one end of the double check valve device 458, the side outlet of which is connected to pipe 97 leading to diaphragm chamber 96 in the master switch device 3 while the other end of this double check valve device is connected to a pipe 459 which leads to the side outlet of a double check valve device 460. One end of double check valve device 460 is connected by a pipe 461 to passage 130 in the emergency valve device 121 of the brake controlling valve device 5 which passage is normally open to the atmosphere through cavity 126 in the emergency slide valve 125 and the atmospheric passage 131. The other end of the double check valve device 460 is connected to a pipe 462 leading to a passage 463 in the train control application valve device and such passage is normally vented to the atmosphere through a port 464 in slide valve 171 and thence through ports 413, 414 and the atmospheric exhaust passage 415. The passage 463 is also connected by a passage 465 containing a choke 466 with diaphragm chamber 255 in the straight air suppression valve device 167 so that said chamber is also normally open to the atmosphere. The passage 463 is also connected by a passage 467 and through a choke 468 with diaphragm chamber 236 in the automatic suppression valve device 166 so that said chamber is likewise normally at atmospheric pressure.

The locomotive brake equipment is now in condition for operation to control the brakes on the locomotive and the cars of a train, it being noted that the handles 33 and 61 of the two brake valve devices are in their brake release positions and that the magnet 280 of the timing valve device is energized due to the traffic conditions or track signals being favorable to permit movement of the locomotive. Let it be assumed that the selector handle 55 on the side of the brake valve device 1 is in the position providing for electropneumatic straight air control of the brakes on the locomotive and cars of a train by operation of the brake valve device 1, under which condition the straight air application and release valve portion 23 of the brake valve device is cut in for response to operation of the brake valve handle 33 while the rotary valve 30 will remain in the normal release position shown.

Electropneumatic straight-air application of locomotive and train brakes

With the parts of the locomotive brake equipment conditioned as above described, if it is desired to effect an electropneumatic straight-air application of the brakes on the locomotive and cars of a train, the handle 33 of the brake valve device 1 is operated to actuate the straight-air application and release valve portion 23 of the brake valve device to supply fluid to the straight air control pipe 56 at a desired pressure determined by the extent of movement of the brake valve handle 33 from its normal release position. Fluid pressure thus supplied to the straight air control pipe 56 flows to the double check valve device 458 and through said device to pipe 97 and thence to diaphragm chamber 96 in the master switch device 3.

The pressure of fluid thus supplied to diaphragm chamber 96 and acting on diaphragm 93 moves the diaphragm and thereby stem 95 and contact 102 in the direction of the right hand into engagement first with the contact finger 104 and then the contact finger 105. As the contact fingers 104 and 105 are thus successively engaged by contact 102, electric current from the battery 103 is supplied first to the release train wire 18 and then to the application train wire 17 for applying the brakes throughout the train.

On the locomotive, the release magnet 111 is energized by the electric current supplied to wire 18 and operated to close the release valve 116, while the subsequent energization of the application magnet 110 by electric current from wire 17 acts to unseat the supply valve 112 for supplying fluid under pressure from the auxiliary reservoir 113 to the straight air pipe 16 which is connected through the train.

Fluid pressure thus supplied to the straight air pipe 16 on the locomotive flows therefrom to the relay valve device 6 by way of passage 433 in the brake controlling valve device 5, cavity 432 in the interlock slide valve 142, passage 431, past the upper end of the double check valve device 138, to passage 430, thence past the upper end of the double check valve device 137 to passage 429 connected to pipe 159 and thence through pipe 158 to the relay valve device 6. The relay valve device is then operated by the fluid pres-

sure supplied from the straight air pipe to supply fluid at a corresponding pressure from the main reservoir pipe 146 to pipe 157 and thence to the brake cylinder device 19 for actuating same in the usual manner to apply the brakes on the locomotive.

Fluid under pressure supplied to passage 429 for effecting operation of the relay valve device 6 as just described also flows to chamber 153 above the release valve 140 and equalizes through port 600 in said valve into spring chamber 154 so as to permit spring 155 to maintain said release valve in sealing engagement with the seat rib 151.

Fluid pressure supplied to the straight air pipe 16 by operation of the application and release magnet valve device 4 also flows from said pipe through the choke 99 into diaphragm chamber 98 of the master switch device 3 and when the pressure of said fluid becomes increased to a degree substantially equal to or slightly exceeding that acting in chamber 96, as supplied by the brake valve device 1, the diaphragm 94 is operated to shift the stem 95 and thereby the contact 102 in the direction of the left hand to a lap position in which said contact is disengaged from finger 105. The application wire 17 and consequently the application magnet 110 are thus deenergized which permits spring 115 to close the supply valve 112 and thus cut off the further supply of fluid under pressure to the straight air pipe 16. By thus limiting the pressure in diaphragm chamber 98 to substantially that acting in chamber 96 movement of the contact 102 is stopped upon disengagement from finger 105 and before moving out of contact with the release finger 104. The release train wire 17 and thereby the release magnet 111 on the locomotive are consequently retained energized so that the pressure in the straight air pipe 16 will be held substantially equal to that supplied by the brake valve device through the straight air control pipe 56 to diaphragm chamber 96.

The relay valve device 6 will operate in the well known manner upon movement of the master switch device 3 to lap position to limit the pressure of fluid supplied to the brake cylinder 19 to a degree corresponding to the straight air pipe pressure supplied to and controlling the operation of said relay valve device.

If the engineer desires to increase the degree of straight air application of brakes he may operate the brake valve handle 33 to increase the pressure of fluid in the straight air control pipe 56 and the master switch device 3 will thus operate to provide a corresponding increase in pressure in the straight air pipe 16 as will be apparent. The relay valve device 6 will then in turn respond to provide a like increase in pressure in the brake cylinder 19 for increasing the degree of brake application on the locomotive. In other words, by varying the position of the brake valve handle 33, the pressure of fluid in straight air control pipe 56 and in the straight air pipe 16 may be varied and the relay valve device 6 will operate to vary the pressure of fluid in the brake cylinder 19 and thereby the degree of brake application on the locomotive accordingly.

At the same time as fluid under pressure is supplied through the straight air control pipe 56 for operating the master switch device 3, fluid also flows from said pipe through the double check valve device 436 to pipe 333 leading to the timing reservoir 334 and to diaphragm chamber 332 in the interlock valve device 10, the build up in pressure in said reservoir and chamber being restricted by choke 390. This pressure acting on the diaphragm 330 tends to deflect same and thereby the diaphragm 331 in the direction of the right hand for unseating the valve 341. However, if the brake mechanism operates as intended, as above described, the diaphragm chamber 335 in the interlock valve device is also charged with fluid under pressure at substantially the same time from the brake cylinder pipe 157 through the double check valve device 437 and pipe 336 by way of choke 337, under which condition the spring 339 in the interlock valve device will maintain the valve 341 in the seated condition. Thus if the brakes on the locomotive are applied in response to operation of brake valve handle 33 as intended, the valve 341 will be maintained in a closed position. If an application of the brakes on the locomotive fails to materialize, however, in a required period of time subsequent to operation of the brake valve handle 33 to effect a straight air service application of the brakes on the locomotive and train, then the interlock valve device 10 will operate to effect an emergency application of brakes on the locomotive and train in a manner which will be later brought out.

When fluid under pressure is supplied to pipe 158 for operating the relay valve device 6 as above described, fluid under pressure flows from said pipe through pipe 359 to chamber 358 in the cut-off valve device 11 and when the pressure of fluid in said pipe and thereby the degree of application of brakes on the locomotive is increased sufficiently to assure the safety of the locomotive, said pressure moves the valve piston 356 to its upper seated position against the pressure of spring 357 for closing communication between the diaphragm chamber 354 and the vent port 355. Fluid pressure then flows from chamber 358 to chamber 354 and this pressure acting on the diaphragm 352 moves the diaphragm 351 into sealing engagement with seat rib 353 thereby closing communication between the pipes 178 and 350. The pedal 365 of the foot valve device as well as handle 33 on the brake valve device 1 may then be relieved of manual pressure, permitting communication to be established between pipes 350 and 363 and permitting unseating of the poppet valve 42 in the brake valve device 1 which thereby opens the pipe 350 to the atmosphere. Only when the cut-off valve device 11 is in its closed position just described can the operator release both the foot pedal 365 and brake valve handle 33 as just described, since otherwise a safety control or deadman's application of the brakes on the locomotive and cars of the train will be effected in a manner to be hereinafter described.

Control of brakes on locomotive independently of the brakes on the train

In order to avoid excessive retardation of a train or excessive heating of the tires on the driver wheels of the locomotive, it is desirable that the engineer be able to release or prevent an application of the locomotive brakes due to operation of the brake valve handle 33 and this independent control of locomotive brakes is accomplished in the manner to be now described.

If the engineer desires to prevent an application of the brakes on the locomotive while applying the brakes on the train through the straight air pipe 16 by operation of the brake

valve device 1, he may depress the handle 61 of the independent brake valve device 2 and thereby seat the valve 86 and unseat the valve 90. The unseating of valve 90 permits fluid at main reservoir pressure supplied to chamber 91 to flow past said valve to chamber 89 and thence through passages and pipe 148 to the interlock piston chamber 147 in the brake controlling valve device 5. The valve chamber 139 at the opposite side of the interlock piston 141 is constantly supplied with fluid from the main reservoir, so that upon the supply of fluid to chamber 147 the fluid pressure is equalized on the opposite sides of the piston 141 which permits spring 143 to move said piston and thereby the slide valve 142 in an upwardly direction to a position defined by engagement of said piston with the casing.

In this position of the interlock slide valve 142 communication is broken between passage 433 to which fluid under pressure is adapted to be supplied from the straight air pipe 16, and passage 431 through which such fluid is adapted to be supplied to the relay valve 6, as above described. It will thus be apparent that if this communication is broken prior to obtaining fluid pressure in the straight air pipe 16 due to operation of the brake valve handle 33, the brakes on the locomotive will not be applied, but since the selector slide valve 142 has no control over the pressure in the straight air pipe 16, the pressure therein may be varied to control the brakes on a train regardless of the brake condition on the locomotive.

In order to prevent the interlock valve device 10 from operating to unseat the vent valve 341 when the brakes on the locomotive are held in a release condition with fluid under pressure supplied to the straight air pipe for applying the brakes on a train as just described, fluid pressure supplied by the operation of the independent brake valve device to pipe 148 for effecting operation of the interlock piston 141 and slide valve 142 also flows therefrom through pipe 438 and past the double check valve device 437 to pipe 336 and then to diaphragm chamber 335 in the interlock valve device 10 in order to maintain the valve 341 seated under this condition.

Let it be assumed that the brakes on the locomotive have been applied by fluid under pressure supplied from the straight air pipe 16 to the relay valve device 6 as previously described and that the engineer desires to release the brakes on the locomotive without releasing the brakes on the cars of the train. In order to accomplish this he depresses the independent brake valve handle 61 in its release position for thereby seating the valve 86 and unseating the valve 90 to supply fluid under pressure for operating the interlock piston 141 to move slide valve 142 to its upper position as above described.

In the upper position of slide valve 142 the cavity 432 therein connects a passage 471 communicating with chamber 154 at the lower face of release valve 140 to a passage 472 which is connected by pipe and passage 473 to the poppet valve chamber 69 in the independent brake valve device 1. In the release position of the independent brake valve handle 61 the chamber 69 is open past valve 68 to chamber 57, and chamber 57 is open to the atmosphere through the self-lapping straight air application and release valve mechanism 74 and as a result, fluid under pressure supplied to chamber 154 beneath the release valve 140 in the brake controlling valve device 5 in effecting an electro-pneumatic application of brakes will be vented therefrom.

Upon the venting of fluid under pressure from chamber 154 the fluid pressure in chamber 153 then moves the release valve 140 away from the seat rib 151 and flows to the atmosphere through the vent port 152 thereby releasing the actuating pressure from the relay valve device 6, it being noted that in the upper position of the selector slide valve the communication through which fluid under pressure was originally supplied from the straight air pipe to the relay valve device for actuating same is closed. The relay valve device 6 will then operate upon the release of actuating pressure from pipe 156 to effect a release of fluid under pressure from the brake cylinder 19 thereby releasing the brakes on the locomotive independently of the pressure of fluid in the straight air pipe and thus independently of the brakes on the train.

If the operator desires to apply the locomotive brakes after having held them released or after having effected a release thereof independently of the straight air pipe 16 he relieves the independent brake valve handle 61 of manual pressure which permits spring 92 to seat the valve 90 and to unseat the valve 86 and thus vent fluid under pressure from piston chamber 147 of the interlock valve device in the brake controlling valve device 5. As a result, main reservoir pressure acting in chamber 144 on the opposite face of the selector piston 141 returns said piston and thereby the slide valve 142 to their normal position shown thereby breaking the release communication just described and reestablishing communication between passage 433 supplied with fluid under pressure from the straight air pipe 16 and passage 431 so that fluid under pressure will again be supplied from the straight air pipe to the relay valve device 6 and actuate same to reapply the brakes on the locomotive.

Release of an electropneumatic straight air application of brakes on the locomotive and train

When the operator desires to effect a release of an electropneumatic application of brakes on the locomotive and cars of the train he returns the brake valve handle 33 to its release position and thereby operates the straight air self-lapping application and release valve mechanism 23 to vent fluid under pressure from the straight air control pipe 56 and thereby from diaphragm chamber 96 in the master switch device 3. Straight air pipe pressure acting in diaphragm chamber 98 of said switch device then moves the diaphragm 94, stem 95 and contact 302 back to their normal position in which both the application and release train wires 17 and 18 are deenergized and consequently the application and release magnets 110 and 111 are also deenergized. With the application magnet 110 deenergized the supply valve 112 is closed so that there can be no flow of fluid under pressure to the straight air pipe 16, while deenergization of the release magnet 111 permits spring 118 to open the release valve 116 and vent the fluid under pressure from straight air pipe 16 to the atmosphere. With the interlock slide valve 142 in the brake controlling valve device 5 is in its normal position shown, the actuating pressure previously supplied to the relay valve device 6 is then vented back to the straight air pipe 16 and past the release magnet valve 116. The relay valve device 6 then operates to release the fluid pressure from the brake cylinder device 19 for thereby releasing the brakes on the locomotive

unless previously released by operation of the independent brake valve device 2 as above described.

Automatic service application of locomotive and train brakes

Now let it be assumed that the selector handle 55 on the brake valve device 1 is in the position connecting the rotary valve 30 for movement with the brake valve handle 33 for controlling the brakes on the locomotive and train through the medium of brake pipe 15 on the usual automatic principle.

In order to effect a service application of the brakes on the locomotive on the automatic principle the engineer may move the handle 33 either directly from release position to service position or first to the first service position and then to the service position. The service position may be employed to effect a straight away full service application of the brakes on the locomotive and train, but particularly in the braking of long freight trains, such operation is considered undesirable due to rough gathering of slack in the train and consequently the possibility of damaging of cars which will result therefrom. It is therefore preferred that in handling long trains the engineer first moves the brake valve handle 33 to the first service position for effecting a light controlled reduction in brake pipe pressure and consequently a light application of the brakes on the train to cause a gentle gathering of the slack in the train following which he may move the brake valve handle to service position for completing the reduction thereby effecting what is commonly known as a split reduction, which will now be described.

When the brake valve handle 33 and the rotary valve 30 are moved to the first service position, the equalizing reservoir 215 and connected equalizing piston chamber 211 are connected through passage 213 in the train control valve device 7, cavity 401 in the application slide valve 171, pipe 400 leading to the rotary valve 30, a cavity 473 in the rotary valve containing the usual service choke 473a (Fig. 3) and thence through passage and pipe 410 to the first reduction reservoir 408 which at this time is at atmospheric pressure, so that the pressure of fluid in the equalizing reservoir and equalizing piston chamber 211 is adapted to equalize at a service rate into said reduction reservoir, the consequent reduction in equalizing reservoir pressure being sufficient to cause a light reduction in brake pipe pressure and thus a light application of brakes on the locomotive and train, as will be presently described.

It will be noted that at this time the first reduction reservoir is open to the atmosphere through the application slide valve 171 by way of port containing the choke 506, but this choke is small and merely acts to continue the reduction in equalizing reservoir at a very slow rate after equalization into the first reduction reservoir at a service rate as just described.

When the pressure in the equalizing piston chamber 211 is reduced, as just described, brake pipe pressure in chamber 216 at the opposite side of the equalizing piston 210 effects movement of said piston in the direction of the left hand to actuate the bell crank 220 to unseat the brake pipe discharge valve 228. The chamber 216 being in communication with the brake pipe 15 through the vent valve device 9, the unseating of the brake pipe discharge valve 228 permits fluid under pressure to flow from the brake pipe to the atmosphere through passage 229, the usual service choke 474, passage 475, pipe 476, a cavity 477 in rotary valve 30 and thence through the atmospheric exhaust passage 407, for thereby effecting a service rate of reduction in brake pipe pressure to initiate a service application of the brakes on the locomotive and cars of the train.

On the locomotive the service application valve device 123 responds to the service reduction in brake pipe pressure to supply fluid under pressure from the auxiliary reservoir 113 through the service choke 124 to the application passage 125 through which it flows to the emergency delay valve 136. With the valve 381 seated against the rib 382 in the delay valve device 136, the fluid pressure supplied to passage 125 flows therefrom through the restricted passage 478 to passage 479 leading to the lower face of double check valve 137 and shifts said double check valve to its upper position. The fluid pressure supplied to passage 179 then flows past check valve 137 to passage 429 and thence to the relay valve device 6 for operating same to supply fluid under pressure to the brake cylinder device 19 for initiating the application of brakes on the locomotive.

When the brake pipe pressure acting in chamber 216 on the equalizing piston 210 becomes reduced by flow past discharge valve 228 to a degree substantially equal to the first reduction in equalizing reservoir pressure in chamber 211, the spring 230 acting on the brake pipe discharge valve 228 moves same towards its seat to throttle further venting of fluid under pressure from the brake pipe to a rate substantially equal to the very restricted venting of fluid under pressure from the equalizing reservoir through choke 506 in slide valve 171 to thereby substantially limit the first reduction in brake pipe pressure to a degree equal to the equalization of equalizing reservoir pressure into the first reduction reservoir 408.

In the brake controlling valve device 5 the service application valve device 123 then operates in the usual manner to limit the reduction in auxiliary reservoir pressure, due to flow to the relay valve device 6, to the same degree as the reduction in brake pipe pressure for thereby limiting the degree of brake application on the locomotive so as to cause a general gathering of the slack in the train.

In case there is leakage of fluid under pressure from the brake pipe 15 and consequently from chamber 216 at the brake pipe side of the equalizing piston 10, said piston will operate to limit the degree of opening of the discharge valve 228 so that the brake pipe pressure will not reduce at a rate exceeding the rate of reduction in equalizing reservoir pressure in chamber 211 at the opposite side of the equalizing piston 210.

However, if the brake pipe leakage is excessive and tends to reduce brake pipe pressure at a rate exceeding the service rate of reduction in the equalizing reservoir pressure, then the brake pipe pressure in chamber 216 will tend to become lower than the equalizing reservoir pressure acting at the opposite face of the equalizing piston 10, and as a consequence the reservoir pressure will move said piston in the direction of the right hand and actuate the bell crank 220 to unseat the maintaining valve 224. In the first service position of rotary valve 30 fluid at feed valve pressure is supplied from the rotary valve chamber 24 to the maintaining valve chamber 225 through a port 480 in the rotary valve and a pipe 481, so that with the maintaining valve unseated fluid

under pressure will be supplied to the brake pipe to off-set leakage of fluid under pressure therefrom. The maintaining valve will be opened by the equalizing piston 210 to a degree depending upon the degree of brake pipe leakage and sufficient to supply the required amount of fluid to the brake pipe to prevent the brake pipe pressure from reducing at a rate exceeding the rate of reduction in equalizing reservoir pressure and, as a result, excessive brake pipe leakage will not increase the rate of brake application above the desired service rate so that the gentle gathering of slack in the train is assured.

After the slack in the train has been gathered due to the application of brakes effected by the initial light reduction in brake pipe pressure, the brake valve handle 33 is turned to service position in which the supply of fluid under pressure to the maintaining valve chamber 225 is cut off and in which the equalizing reservoir 215 and equalizing piston chamber 211 are connected to the atmosphere through pipe 400, a cavity 507 containing a service choke 508 in rotary valve 30 and the atmospheric exhaust passage 407 and through this communication the reduction in pressure in the equalizing reservoir and equalizing piston chamber is continued until a full service reduction therein has been effected after which the brake valve handle 33 is operated to turn the rotary valve 30 to lap position to lap pipe 400 so as to prevent further and unnecessary venting of fluid under pressure from the equalizing reservoir and the equalizing piston chamber.

The equalizing discharge valve mechanism 165 responds to this further reduction in equalizing reservoir pressure to effect a corresponding increased reduction in brake pipe pressure and the service application valve device 123 of the brake controlling valve device 5 on the locomotive then operates to supply fluid under pressure from the auxiliary reservoir 113 to the relay valve device 6 as hereinbefore described to increase the degree of brake application on the locomotive to a full service degree in the usual manner.

If the brake apparatus operates in the manner intended and as just described to effect an application of the brakes on the locomotive, the interlock valve device 10 is conditioned to hold the valve 341 closed in the same manner as when an electropneumatic straight air application of the brakes is effected. The cut-off valve device 11 is also operated as hereinbefore described by fluid under pressure supplied for operating the relay valve device 6 to close communication between the pipe 178 and the pipe 358 so that the engineer may remove manual pressure from the treadle 365 of the foot valve device 12 and/or handle 33 of the brake valve device 1.

Release of an automatic service application of brakes

In order to effect a release of the brakes after an automatic service application thereof the brake valve handle 33 is returned to release position and moves the rotary valve 30 back to the normal position shown in the drawing and in this position the brake pipe 15 is recharged with fluid under pressure and the service application valve device 123 of the brake controlling valve device 5 is thereby operated to effect operation of the relay valve device 6 to release fluid under pressure from the brake cylinder device 19 for releasing the brakes on the locomotive in a manner which will be apparent from the description in connection with charging of the equipment.

Graduated release of an automatic service application of brakes and subsequent automatic reapplication

Particularly in braking passenger trains to bring them to a stop at a desired relatively high rate of deceleration but without material shock to either the vehicles or passengers, it is customary on certain properties to initially effect a full automatic service application of the brakes and then graduate the application off by moving the brake valve handle 33 successively from lap position to release position and then back to lap position in order to increase the pressure in the brake pipe 15 in such increments as required to effect operation of the brake controlling valve device 5 and relay valve device 6 to reduce the pressure in the brake cylinder device 19 in the desired steps. With this type of control the brake cylinder pressure may become so depleted before the stop is obtained that it is necessary to make another or further light application of brakes to bring the train to the desired stop.

In order that the brakes may be controlled automatically through the brake pipe in the manner just described, fluid under pressure supplied to the first reduction limiting reservoir 408 in effecting an automatic service application of brakes is vented therefrom in the lap and release positions of the brake valve rotary valve 30 by way of pipe 409, port 412 in the application slide valve 171, port 503, passage 504 (with said slide valve in release position), and pipe 505 which is open to the exhaust cavity 406 in the rotary valve 30 in the release position of the brake valve handle 33 and to the vented cavity 496 in the lap positon. By this arrangement, the first reduction reservoir 408 will be promptly vented while graduating a release of brakes by moving the brake valve handle 33 back and forth between the release and lap positions and thus be in condition to effect a reduction in pressure in the equalizing reservoir 215 in the manner hereinbefore described in case the engineer moves the brake valve handle 33 to first service positon to obtain an increase in the degree of brake application to stop the train as desired.

The communication through which the first reduction reservoir is vented is interlocked through the application slide valve 171 as just described so that the vent will be closed when an automatic train control application is effected as will be later described.

Automatic emergency application of locomotive and train brakes

If the engineer desires to effect an emergency application of the brakes on the locomotive and train, regardless of the position of the selector handle 55, he moves the brake valve handle 33 to emergency position indicated in Fig. 3 and thereby turns the rotary valve 30 from the normal release position shown to a position in which passage 386 is lapped to cut off the supply of fluid under pressure to the brake pipe. In this position of the handle 33 means (not shown) is operated thereby to effect a sudden emergency reduction in brake pipe pressure, such reduction occurring through a branch pipe 15a connecting the brake pipe to the brake valve device.

On the locomotive the service application valve device 123 of the brake controlling valve device

5 responds to the emergency reduction in brake pipe pressure to supply fluid under pressure from the auxiliary reservoir 113 through the service choke 124 to the application passage 125, and at the same time the emergency application valve device 121 of said brake controlling valve device responds to the emergency reduction of brake pipe pressure to position the slide valve 125a in emergency position and thus connect passage 127 from the emergency reservoir 128 through cavity 126 to the application and release passage 125. Fluid under pressure then flows from the emergency reservoir to passage 125 at a rate determined by the emergency choke 132 and along with the fluid supplied from the auxiliary reservoir to said passage flows to the emergency delay valve device 136 and through choke 478 therein to passage 479 and thence to relay valve device 6 in the same manner as in effecting a service application of the brakes. The relay valve device 6 is thereby operated to supply fluid to the brake cylinder device 19 at a pressure corresponding to that of the actuating fluid for thereby applying the brakes on the locomotive in emergency.

The choke 478 is the application valve device 136 is of such size as to have no effect upon a service application of the brakes the rate of which is controlled by the service choke 124 but it is adapted to restrict the rate at which fluid under pressure is supplied to the relay valve device 6 in effecting an emergency application of the brakes when the delay valve 381 is seated as shown. It is intended that the delay valve 381 be seated as just described when the locomotive is controlling the brakes on a long train under which condition it is desirable that an emergency application of the brakes be retarded as by the choke 478 in order to avoid too rapid gathering of the slack in the train which might cause damage to the train.

The emergency application of the brakes effected as just described due to sudden venting of fluid under pressure from the brake pipe 15 by movement of the brake valve handle 33 to emergency position is of the well known type, but in case a locomotive provided with this improved equipment is coupled to a train provided with electro-pneumatic control straight air control arrangements including application and release magnet valve devices 4, it is desired that the emergency application of brakes on the train be effected electropneumatically and therefore substantially simultaneously on all cars in the train. In order to accomplish this the emergency slide valve 125 in the brake controlling valve device 5 on the locomotive in its emergency position supplies fluid from the emergency reservoir 128 to passage 130 and thence through pipe 461 to one end of the double check valve device 460. The fluid thus supplied to this double check valve device actuates same to open pipe 461 to pipe 459 so that fluid from the emergency reservoir then flows to double check valve device 458 and shifts same to the position for connecting pipe 459 to the pipe 97, whereupon fluid from the emergency reservoir is supplied to the diaphragm chamber 96 in the master switch device 3. Since on the locomotive the pressure of fluid in the emergency and auxiliary reservoirs equalize into the relay valve device 6 at a desired emergency pressure it will be apparent that the same degree of pressure as provided in the brake cylinder device 19 on the locomotive for applying the locomotive brakes is provided in chamber 96 of the master switch device 3, which is thereby operated to effect operation of the application and release magnet valve devices 4 through the train for supplying a corresponding pressure to the straight air pipe 16. If the electropneumatic apparatus on the cars of the train are operating as intended then the brakes on said cars will be applied electropneumatically by straight air in emergency substantially in synchronism with the application of the brakes on the locomotive. However, it will be noted that on the locomotive the brakes are applied by operation of the brake controlling valve device 5 since its operation is required to effect operation of the master switch device 3. The pressure of fluid supplied by the brake controlling valve device 5 to the relay valve device 6 flows past the lower end of the double check valve 137 and will hold said check valve in its upper position against pressure supplied from the straight air pipe 16 to the upper end of said check valve. Thus electropneumatic straight air control is ineffective on the locomotive under this particular condition.

It will be noted that in effecting both an automatic service and an automatic emergency application of the brakes on the locomotive through the brake pipe 15 the supply of fluid under pressure from the brake controlling valve device 5 to the relay valve device 6 for actuating same is independent of the selector slide valve 142, and can not therefore be prevented by the engineer by depressing handle 61 by the independent brake valve device 2, as when the brakes on the locomotive are applied electropneumatically with the selector handle 55 of the brake valve device 1 in the straight air control position, as above described. However, if desired, the engineer can effect a release of either an automatic service or emergency application of brakes by depressing the independent brake valve handle 61 in the manner hereinbefore described.

When it is desired to effect a release of the brakes after an emergency application, the brake valve handle 33 is operated to turn the rotary valve 30 back to the release position shown for thereby again supplying fluid under pressure to the brake pipe 15 for recharging same and for effecting operation of the service application valve device 123 to release the fluid under pressure from the relay valve device 6 and thereby brake cylinder device 19 and for recharging the auxiliary reservoir 113 and emergency reservoir 128. The emergency valve 121 of the brake controlling valve device 9 is also returned to its release condition upon recharging the brake pipe.

It should also be noted that when an emergency application of the brakes is effected as just described the cut-off valve device 11 is operated to close communication between pipe 178 and pipe 350 so that the engineer may release the treadle 365 of the foot valve device 1 and handle 33 of the brake valve device without venting pipe 178 which is in communication with piston chamber 176 of the train control application valve device whereby said train control device may be prevented from operating under this condition.

Automatic train control application of brakes in response to unfavorable traffic condition and stop signal

With the brake valve handle 33 in release position and the brakes on the locomotive and train released, an automatic application of the brakes on the locomotive and train will be automatically effected in case an unfavorable traffic condition and stop signal is encountered which will effect deenergization of magnet 280.

Upon deenergization of magnet 280 spring 289 seats valve 282 closing off the supply of fluid under pressure to chamber 285 and at the same time the valve 281 is unseated connecting said chamber to the vent port 284. The fluid pressure in the timing volume 303 and chamber 302 is then gradually vented to the atmosphere through choke 304, chamber 285, chamber 283 and through the atmospheric vent port 284, and after a predetermined time, determined by the size of the volume 303 with respect to the flow capacity of choke 304, the pressure acting on valve piston 299 will become reduced sufficiently for spring 309 to move the valve piston from the position shown downwardly into engagement with gasket 307 thereby relieving pressure on valve 292 and permitting said valve to be moved to its lower seated position by spring 310.

With the double beat valve 292 in its lower seated position, fluid under pressure from the train control application piston chamber 176 is vented to the atmosphere through passage 177, pipe 178, past the double beat valve 292, through pipe 294 to chamber 256 in the straight air suppression valve device 167, from said chamber past the double beat valve 252 to chamber 253, thence through passage 254 to chamber 235 in the automatic suppression valve 166 and from chamber 235 past the double beat valve 233 to chamber 234 and thence through passage 435 to pipe 421 leading to the previously vented stop reservoir 420 which at this time is open to the atmosphere through passage 435 past a ball check valve 422 and through passage 423 and pipe 424 leading to the poppet valve chamber 51 in the brake valve device 1, the poppet valve 48 being opened with the brake valve handle 33 in the release position so that the chamber 51 is thus opened to the atmospheric vent port 52. The fluid from the application piston chamber 176 is thus vented to the atmosphere through the brake valve device 1 in release position and when reduced sufficiently below the pressure acting in valve chamber 173, the piston 170 is moved upwardly against spring 172 into engagement with a gasket 483 which defines the application position of the piston and thereby of the slide valve 171.

In the application position of the train control slide valve 171, port 584 therein establishes a communication between the valve chamber 173 and passage 463 (Fig. 2) which is connected through pipe 462 to one end of the double check valve device 460 and through this communication fluid under pressure supplied by the feed valve device 29 to the valve chamber 173 is supplied to the double check valve device 460 and actuates same to connect the pipe 462 to the pipe 459. The fluid pressure thus supplied to pipe 459 flows through the double check valve 458 to diaphragm chamber 96 in the master switch device 3 and actuates said switch device to cause the application and release magnet valve devices on the locomotive and throughout the train to supply fluid at a corresponding pressure to the straight air pipe 16.

On the locomotive this fluid supplied to the straight air pipe 16 upon operation of the train control application valve device 7 flows through the brake controlling valve device 5 to the relay valve device 6 and actuates said device to supply fluid to the brake cylinder device 19 at a pressure corresponding to the pressure of fluid in the straight air pipe 16 for thereby effecting an application of the brakes on the locomotive.

At the same time as fluid under pressure is supplied through port 584 in the slide valve 171 for actuating the master switch device 3, fluid under pressure is vented from the cut-off valve piston chamber 207 to the atmosphere through passage 389, and ports 488, 413 and 489 in slide valve 171 to the atmospheric vent port 415. The brake pipe pressure acting in chamber 203 at the opposite side of the cut-off valve piston 200 then actuates said piston against the pressure of spring 208 to seat the cut-off valve 201 and thereby cut off the supply of fluid under pressure from the brake valve device to passage 217 connected to the equalizing discharge valve chamber 216 and to the brake pipe 15 through the vent valve device 9.

At the same time, the equalizing reservoir 215 and equalizing piston chamber 211 are connected through passage 213 and port 484 in the slide valve 171 to passages 486 and 182 leading, respectively, to the first reduction reservoir 408 and to chamber 181 above the split reduction control valve piston 180. Also in this position of slide valve 171 cavity 419 therein connects passage 378 from the previously charged suppression reservoir 379 to passage 195 leading to chamber 194 below the split reduction piston 192 so that fluid under pressure from said reservoir is supplied to chamber 194 to cause said piston to operate the stem 193 to move the valve piston 180 to its upper position into sealing engagement with the gasket 196 to close communication between the passage 182 and passage 188 leading to the second reduction reservoir 190.

Through the communication just described between the equalizing reservoir 215 and the first reduction reservoir 408 fluid under pressure in the equalizing reservoir and in the equalizing piston chamber 211 is adapted to equalize into the first reduction reservoir 408, and the equalizing discharge valve mechanism 165 is adapted to respond to such reduction and unseat the brake pipe discharge valve 228 to effect a corresponding initial reduction in pressure in the brake pipe 15. The fluid vented past the discharge valve 228 at this time is vented to the atmosphere through passages 229, service choke 474, passage 475, a choke 490, port 491 in the slide valve 171 and from thence through ports 413, 489 and the atmospheric vent port 415.

The pressure of fluid supplied from the first suppression reservoir 379 to actuate the split reduction piston 192 as above described is gradually dissipated to the atmosphere through the restricted vent port 425, the venting capacity of such port being so related to the volume of said suppression reservoir as to maintain said piston in a position holding the valve piston 180 in engagement with gasket 196 for a sufficient period of time to provide for gentle gathering of the slack in the train due to the application of train brakes resulting from the reduction in equalizing reservoir pressure caused by equalization into the first reduction reservoir 408. After the pressure in chamber 194 becomes sufficiently reduced as just described, spring 187 returns the valve piston 180 to its normal position shown and thereby connects the passage 182 which at this time is in communication with the equalizing reservoir and first reduction reservoir to passage 188 leading to the second reduction reservoir 190. The pressure of fluid in the equalizing reservoir 215 and the first reduction reservoir 408 then flows to the second reduction reservoir 190 which, with the rotary valve 30 in the normal release position shown, is

open to the atmosphere through pipe 189, exhaust cavity 406 in said rotary valve and exhaust port 407. The consequent reduction in pressure in the equalizing reservoir and equalizing piston chamber 211 effects further operation of the discharge valve mechanism 165 to reduce brake pipe pressure to a corresponding degree.

On the locomotive, the service application portion 123 of the brake controlling valve device 5 responds to the two stage reduction in brake pipe pressure effected upon operation of the train control slide valve 171, as just described, to supply fluid under pressure from the auxiliary reservoir 113 through choke 124 to the application and release passage 125 and thence through the delay valve device 136 and passage 479 to the lower face of the double check valve 137. At this time the upper face of the double check valve 137 is, however, subjected to fluid under pressure supplied from the straight air pipe 16 as above described, so that said double check valve device remains in its lower seated position shown, thus preventing the flow of fluid pressure supplied by the service application valve 123 to the relay valve device 6. In case, however, the fluid pressure supplied by the service application valve device 123 is obtained on the double check valve device 137 ahead of that from the straight air pipe 16, the relay valve device 6 will be operated by the fluid supplied by the service application valve device, as will be apparent, but this is immaterial so long as the brakes on the train are applied in response to an unfavorable traffic condition.

As will be apparent, the operation just described particularly relates to a locomotive on which both the electropneumatic straight air apparatus and the pneumatic devices controlled through the medium of the brake pipe are both operative. In case the locomotive were coupled to a train not provided for electropneumatic straight air control, then such control apparatus would be cut out of operation on the locomotive under which condition the locomotive brakes would be applied by operation of the brake controlling valve device 5. It is to be noted that this apparatus is adapted for controlling either conventional types of trains or trains equipped with the dual control apparatus.

As long as the brake valve handle 33 is left in the release position, the train control application piston 170 and slide valve 171 will remain in their application positions, since the application piston chamber 176 is maintained open to the atmosphere past the valve 48 in the brake valve device, even in case the timing magnet 280 should subsequently become energized and cause the double beat valve 292 to return to its upper seated position, since said chamber under this condition would remain vented by way of passage 177, and cavity 492 in slide valve 171 connecting said passage to the vented pipe 424 leading to the brake valve device. This is desirable from the standpoint of safety, but it will be noted that under this condition there will be a continual loss of fluid under pressure to the atmosphere through choke 383 in the application piston.

Furthermore, if the slide valve 171 remains in application position there will be a complete venting of fluid under pressure from the equalizing reservoir 215 since the second reduction reservoir 190, to which it is connected, is open to the atmosphere through pipe 189 and rotary valve 30 in the brake valve device, as above described. As a result, the equalizing discharge valve mechanism 165 will operate to completely vent the fluid under pressure from brake pipe 15. In case of emergency this is desirable in order to insure that the brakes on the locomotive and train will be applied to their maximum degree and then be held applied in order to bring the train to a stop. However, from the standpoint of economizing in the use of compressed air and the delay incident to obtaining a release of brakes on the locomotive and train and the resulting interference with the operating schedule of the train, this loss of air, particularly from the brake pipe 15, is undesirable and may be prevented by the engineer if promptly, after movement of the application piston 170 to the application position, as above described, he moves the brake valve handle 33 from the release position to the lap position.

In lap position of the brake valve handle 33, spring 53 closes the poppet valve 48 in the brake valve device and thus cuts off the venting of fluid under pressure from the application piston chamber 176 to the atmosphere, following which the fluid pressure supplied to said chamber through the restricted port 383 equalizes into the stop reservoir 420. The volume of this reservoir and the flow capacity of port 383 are so related that a sufficient differential of fluid pressures will be maintained on the application piston 170 to hold same in application position for an interval of time which will insure a full service application of brakes on the locomotive and train either through the straight air pipe 16 or due to operation of the equalizing discharge valve mechanism 165 and the service application portion 123 of the brake controlling valve device 5, after which the pressure in the application piston chamber 176 and in the stop reservoir 420 will become increased to a degree sufficient for spring 172 to move the application piston 170 and slide valve 171 back to their normal position shown.

If the selector handle 55 on the brake valve device 1 is in the electropneumatic straight air position, then upon return of the application slide valve 171 to its normal position shown, the cut-off valve device 164 will open and the brake pipe 15 and equalizing reservoir 215 will be recharged with fluid under pressure and the service application portion 123 of the brake controlling valve device 5 will be operated to its release position for venting fluid under pressure from the service application passage 125, and at the same time this occurs, passage 463 previously supplied with fluid under pressure through the slide valve 171 for actuating the master switch device 3 will be open to the atmosphere through ports 464, 413 and 414 in the slide valve and the atmospheric vent passage 415. The brakes on the locomotive and train will not, however, be released with the brake valve handle 33 in lap position and with the selector handle 55 in the straight air position, since the straight air application and release valve portion 23 of said brake valve device is operative in lap position to supply fluid at a maximum straight air pressure to the straight air control pipe 56 and thence to one end of the double check valve device 458, so that as the fluid pressure is released from the opposite end of the double check valve device following movement of the slide valve 171 to release position, said double check valve device is operated to close communication between pipes 97 and 459 and to connect the pipe 97 to the straight air control pipe 56, whereupon the

master switch device 3 is supplied with fluid under pressure from the straight air control pipe 56 to maintain said switch device in the position for providing a full electropenumatic straight air application of the brakes on the locomotive.

If the application of brakes on the locomotive due to operation of the application piston 170 and slide valve 171 to their application positions was effected by fluid pressure supplied by the service application control valve device 123, past the lower end of the double check valve 137, then upon the release of such fluid pressure upon movement of the service application control valve portion 123 to its release position in response to the increase in brake pipe pressure following movement of the application piston 170 and the slide valve 171 to their release positions, the straight air pressure acting on the opposite side of the check valve 137 will shift same to its lower position so that the brakes on the locomotive will be held applied by fluid pressure supplied from the straight air pipe, as will be apparent.

If the selector handle 55 on the brake valve device 1 is in the automatic position at the time an automatic train control application of the brakes is effected, then movement of the brake valve handle 33 to lap position will permit seating of poppet valve 48 to cut off the venting of fluid under pressure from the application piston chamber 176 and will also turn the rotary valve 30 to lap position to cut off the supply of fluid under pressure to pipe 387 for charging the brake pipe and also will lap pipe 189 from the second reduction reservoir 416. Thus upon return of the application piston 170 and the slide valve 171 to their normal positions, fluid under pressure will not be supplied to the brake pipe and the reduction in equalizing reservoir pressure will be limited to equalization into the first and second reduction reservoirs 408 and 190, respectively, thereby insuring full service reduction in brake pipe pressures and a full service application of the brakes. Under these conditions there will be no fluid supplied to the straight air control pipe 56 as when the selector handle 55 is in straight air position, so that diaphragm chamber 96 in the master switch device will be vented upon return of the application slide valve 171 to its release position, and the brakes on the locomotive will be held applied by fluid supplied by the service application device 123 to the relay valve device 6 past the lower end of the double check valve device 137.

If the brake valve handle 33 remains in the release position shown after an automatic train control application of the brakes has been effected by movement of the application piston 170 and slide valve 171 to their application positions, a release of the brakes will not occur upon energization of the timing magnet 280 and subsequent movement of the double beat valve 292 to its upper seated position, in case the traffic signal becomes favorable, due to the fact that in the application position of slide valve 171 the piston chamber 176 is vented through cavity 492 in said slide valve and the poppet valve 48 in the brake valve device independently of the timing valve device 8, as hereinbefore mentioned. However, if the brake valve handle 33 has been moved to lap position and the application piston 170 and slide valve 171 have returned to their normal positions with the timing magnet 280 energized, said handle may be returned to release position to effect a release of the brakes due to the fact that the slide valve 171 in its release position closes communication between the application piston chamber 176 and the poppet valve 48 in the brake valve device. Thus after an automatic train control application of brakes has been effected, it is essential in order to effect a release of the brakes for the handle 33 to be moved first to the lap position to effect movement of the application piston and slide valve 171 to their release positions and then back to the release position after reenergization of the timing magnet 280. With the apparatus thus conditioned the brake pipe 15 will be recharged with fluid under pressure, the straight air control pipe 56 and the straight air pipe 16 will be vented and other parts of the apparatus will be conditioned as hereinbefore described for subsequent operation by the engineer or in response to an unfavorable traffic condition.

It will be noted that when the train control apparatus 7 operates in response to an unfavorable traffic condition to effect an application of brakes, the brakes on the locomotive will be applied either by straight air by operation of the master switch device 3 or automatically by operation of the service application portion 123 of the brake controlling valve device 5. It will therefore be evident that the engineer cannot prevent the brakes on the locomotive from applying by depressing the independent brake valve handle 61 and effecting movement of the selector piston 141 and slide valve 142 in the brake controlling valve device 5 to their upper positions for closing the communication through which the straight air application of the brakes is normally effected, since the brakes will be applied by operation of the service control portion 123 in the brake controlling valve device 5 independently of said selector piston and slide valve. The engineer may however release the brakes on the locomotive independently of those of the train after being applied in the manner just described by depressing the brake valve handle 61 and effecting movement of the selector piston 141 and slide valve 142 to their upper position for thereby releasing the brake application by way of the release poppet valve 140, in the manner hereinbefore described.

When an automatic train control application of brakes is effected, the interlock valve device 10 is operated to hold the valve 341 seated and the cut-off valve device 11 is operated to hold the diaphragm 351 in engagement with the valve seat 353, as before described.

Suppression of automatic train control device 7 by the engineer

If the engineer on the locomotive is alert, he may prevent operation of the automatic train control device 7 in response to an unfavorable track condition by operating the brake valve device 1 to effect either a full straight air electropneumatic application of brakes or a full service reduction in brake pipe pressure for effecting a full service automatic application of brakes, dependent upon the position of the selector handle 55 on brake valve device 1.

Electropneumatic straight air suppression of automatic train control device 7

Let it be assumed that the selector handle 55 of the brake valve device 1 is in the straight air control position. A signal device (not shown) is usually associated with the timing magnet 280 to operate upon deenergization thereof in re-

sponse to an unfavorable traffic condition to call the engineer's attention to the situation, so that he may operate the brake valve device 1 to apply the brakes and in so doing prevent the application valve device 7 from moving from its normal position.

The timing volume 303 and the choke 304 in the timing valve device 8 are provided to prevent movement of the valve piston 299 to its lower position for venting the application piston chamber 176 until a predetermined time after deenergization of the magnet 280, and while this time is relatively short it is of sufficient duration to permit the engineer to operate the brake valve device 1 as just mentioned to prevent operation of the automatic train control device 7.

If upon deenergization of the magnet 280 and consequent operation of the signal device above mentioned, the engineer promptly moves the brake valve handle 33 to the position for effecting a full electropneumatic straight air application of brakes on the train, fluid under pressure is supplied through the straight air control pipe 56 to the master switch device 3 and operates same to effect energization of the application and release magnet valve device 4, to provide a corresponding pressure in the straight air pipe 16 and thereby in the brake cylinder device 19, as before described.

As fluid under pressure is thus supplied to the straight air pipe 16 it also flows from the straight air branch pipe 114 through the pipe 272 to chamber 271 below valve 270 in the straight air suppression valve device 167. The pressure of spring 266 is sufficient to hold valve 270 seated however until the straight air pipe pressure acting in chamber 271 becomes substantially equal to that required for effecting a full straight air application of the brakes on the locomotive, at which time said pressure unseats said valve against said spring.

Upon movement of the valve 270 away from its seat fluid pressure flows from chamber 271 into chamber 268 and the greater area of the valve piston 265 becomes exposed to straight air pipe pressure whereupon the valve piston is promptly moved to its uppermost position into sealing engagement with gasket 276. In this position communication between chambers 268 and 266 is closed and fluid under pressure supplied from the straight air pipe to chambers 271 and 268 flows through passage 269 to chamber 260 below the flexible diaphragm 259. This diaphragm is deflected by this fluid pressure in an upwardly direction and acts to seat the double beat valve 252 in its upper position.

With the double beat valve 252 thus conditioned, fluid under pressure can not be vented from the application piston chamber 176 upon movement of the double beat valve 292 in the timing valve device to its lower seated position. Thus if the engineer operates the brake valve device 1 to provide an electropneumatic straight air application of the brakes of sufficient degree prior to the pressure in volume 303 in the timing valve device 8 becoming reduced sufficiently for the double beat valve 292 to move to its lower position, the vent communication from the application piston chamber 176 will be closed in the straight air suppression valve device and the application piston 170 and slide valve 171 will therefore be maintained in their normal positions shown, thus preventing an automatic train control application of the brakes.

In order that the suppression valve device 167 will be promptly operated as above described when an electropneumatic straight air application of brakes is initiated, a choke 509 is provided in the straight air branch pipe 114 between the connections with the straight air pipe 16 and the pipe 272. This choke acts to slightly restrict the flow of fluid to the straight air pipe 16 so as to thereby obtain a prompt increase in pressure through pipe 272 for operating the independent suppression valve device 167. The delay in build up of pressure in the straight air pipe 16 due to choke 509 and the consequent delay in obtaining an application of the brakes on the locomotive is however so slight as not to be immaterial.

It will be apparent that if the electropneumatic straight air application of brakes effected by operation of the brake valve handle 33 is insufficient in degree to effect movement of the valve piston 265 in the independent suppression valve device 167 to hold same in its upper seated position, then with the double beat valve 292 in the timing valve device 8 in its lower position an automatic train control application of the brakes will be effected in the same manner as hereinbefore described. In other words, in order to suppress an automatic train control application of brakes the engineer must, with the selector handle 55 in the straight air position, effect a sufficient straight air electropneumatic application of brakes to insure the safety of the train.

The engineer must then maintain the brakes applied with sufficient force to hold the suppression valve device 167 in the suppressing position just described until the track conditions again become favorable to effect energization of the timing magnet 280 and consequent movement of the double beat valve 292 to its upper position, following which the brake valve handle 33 may be returned to release position for effecting a release of the brakes on the locomotive and train.

In case the engineer fails to operate the brake valve device to initiate an electropneumatic straight air application of brakes before movement of the application piston 170 and slide valve 171 to their application positions, then the operation of the brake valve device cannot effect movement of the independent suppression double beat valve 252 to its upper position, since in application position of the slide valve 171, fluid under pressure supplied through port 584 and passage 463 to pipe 462 for operating the master switch device 3 to apply the brakes also flows from port 463 through port 465 and past a ball check valve 510 into diaphragm chamber 255 so that the spring 258 will be able to hold the valve 252 in the position shown upon the subsequent supply of fluid under pressure to diaphragm chamber 260 from the straight air pipe. By this arrangement, the application piston chamber 176 will be maintained in communication with the stop reservoir 420 to ensure a full application of the brakes by operation of the train control device 7.

Automatic suppression of automatic train control device 7

In case the selector handle 55 of the brake valve device 1 is in the automatic position, the engineer may prevent operation of the application valve device upon deenergization of the timing magnet 280 by operating the brake valve device handle 33 to initiate a service reduction in brake pipe pressure. This reduction in brake pipe pressure may be effected by movement

first to the first service position and then to the service position to provide a split reduction in brake pipe pressure or by movement directly to the service position for providing a straight-away reduction in brake pipe pressure for thereby applying the brakes in either two stages or in one stage as above described. The method by which the application valve device 7 is prevented from operating under this condition will now be described.

When the signal device operates in response to deenergization of the timing magnet 280 and the engineer moves the brake valve handle 33 to the first service position to initiate an automatic service application of brakes, the first suppression reservoir 379, which is charged with fluid under pressure when the brakes are released, is connected to the suppression valve diaphragm chamber 238 through pipe 378, cavity 404 in the application slide valve 171, passage and pipe 403, a cavity 493 (Fig. 3) in rotary valve 30 and passage and pipe 418. The fluid pressure from the suppression reservoir 379 thus supplied to chamber 238 to act on the suppression diaphragm 237 deflects said diaphragm in a downwardly direction and moves the double beat valve 233 from the position shown to its lower seated position for closing communication between passage 254 from the independent suppression valve device 167 to passage 435 leading to the stop reservoir 420. With this communication closed, fluid under pressure cannot be vented from the application piston chamber 176 upon movement of the double beat valve 292 in the timing valve device 8 to its lower seated position, whereby movement of the application piston 170 and the application slide valve 171 out of their normal release positions is prevented.

The fluid pressure supplied from the first suppression reservoir 279 to the suppression valve chamber 238 is gradually vented to the atmosphere through a choke 494 in a passage connecting chamber 238 to valve chamber 243, and with the double beat valve 242 in its upper position shown, chamber 243 is open past said valve to chamber 244 which is open to the atmosphere through the restricted port 245. Fluid pressure from the suppression reservoir 279 is thus adapted to provide prompt movement of the suppression diaphragm 237 and valve 233 to the position for suppression operation of the train control device 7, but is gradually vented and therefore will maintain the suppression valve 233 in this suppression position only for a certain limited time which is adequate to complete a first reduction in brake pipe pressure and to permit the slack in the train to be gently gathered.

In case the engineer leaves the brake valve handle 33 in this first service position for a greater length of time, the suppression reservoir pressure acting in diaphragm chamber 238 of the suppression valve device will become sufficiently reduced through the vent port 245 to permit spring 240 to move the double beat valve 233 to its upper position and thereby open the vent communication from the application piston chamber 176 which would result in an automatic train control application of the brakes being effected on the locomotive and train. In order to avoid this, the engineer therefore has to move the brake valve from the first service position to the service position for completing a full service reduction in brake pipe pressure before the suppression reservoir pressure acting on the suppression diaphragm chamber 238 becomes reduced to a degree at which the double beat valve 233 of the suppression valve device will move from its lower position.

If the brake valve handle 33 and rotary valve 30 are thus turned to service position before the suppression valve 233 moves out of its lower seated position, fluid vented from the brake pipe past the discharge valve 28, due to operation of the equalizing discharge valve mechanism, flows to the atmosphere as previously described by way of the service choke 474, but due to said choke, a portion of the fluid pressure vented by the discharge valve 228 to passage 229 also flows from said passage to pipe 495 and through a cavity 497 (Fig. 3) in the rotary valve to a passage 498, connected to a pipe 499. Fluid thus discharged from the brake pipe into the pipe 499 flows through a passage 500 in the train control device 7, past a ball check valve 501 to a passage 502, which is connected through port 374 in the selector cock 14 to the timing reservoir 376 and which also leads to chamber 244 in the automatic suppression valve device 166. The fluid pressure thus supplied to the timing reservoir 376 and to chamber 244 in the automatic suppression valve device is adapted to counteract the venting of fluid under pressure from the suppression reservoir 379 through the vent port 245 and to thus maintain a sufficient pressure in diaphragm chamber 238 of the suppression valve device to hold the double beat valve 234 in its lower suppressing position while effecting the second reduction in brake pipe pressure.

In service position of the brake valve handle 33 it will be noted that pipe 189 connected to the second reduction reservoir 190 is lapped by the rotary valve 30 so that the reduction in equalizing reservoir pressure will be limited to equalization into the first reduction reservoir 408 and the second reduction reservoir 190, with the result that the equalizing discharge valve mechanism 165 will operate to effect a full service reduction in pressure in the brake pipe 15, for thereby effecting a full service application of brakes on the locomotive.

Since the suppression valve device 166 is operated by fluid discharged from the brake pipe for preventing movement of the application piston 170 and slide valve 171 to their application positions, it will be apparent that the double beat suppression valve 233 will be held in its lower seated position until after the brake pipe discharge valve 228 seats at the completion of the brake pipe reduction and regardless of the train length.

When the rotary valve 30 is moved out of release position, passage 396 through which the suppression reservoir 397 and diaphragm chamber 250 are charged in the release position of the brake valve device is lapped, so that the fluid pressure in said reservoir and chamber is bottled up, said pressure being equal to that in the brake pipe when the brake pipe is in a fully charged condition. The chamber 247 below the diaphragm 248 is normally in direct communication with the brake pipe by way of the brake pipe vent valve device 9, and the pressure in said chamber therefore reduces as the brake pipe pressure is reduced with respect to the bottled opposing pressure in diaphragm chamber 250.

The spring 251 acting on the diaphragm 250 is of such strength that when brake pipe pressure acting in the diaphragm chamber 247 is re-

duced to a full service degree the bottled pressure in chamber 250 will deflect the diaphragm 248 downwardly and move the double beat valve 242 to its lower seated position, and thereby permit fluid to flow from the brake pipe through the diaphragm chamber 247 to valve chamber 243 and thence through the choke 494 to diaphragm chamber 238 in the suppression valve device for maintaining the diaphragm 237 deflected downwardly to hold the double beat valve 233 in its lower seated position, thus providing permanent closure of the vent communication from the application piston chamber 176, or permanent suppression of an automatic train control application of the brakes.

It will be apparent that this permanent suppression is dependent upon the engineer having effected a full service reduction in brake pipe pressure as measured by the differential in pressures in diaphragm chambers 248 and 247. In case the engineer moves from the service position to the lap position prior to effecting a full service reduction in equalizing reservoir pressure and consequently in brake pipe pressure, the spring 251 will maintain diaphragm 248 and double beat valve 242 in their upper positions. As a result, after the brake pipe discharge valve 228 becomes seated and the fluid pressure supplied therefrom to the timing reservoir 376 becomes dissipated past the reduction insuring valve 243 and through the choke 245, spring 240 will move the double beat suppression valve 233 to its upper position and thus open the vent communication from the application piston chamber 176 and thereby cause an automatic train control application of brakes. It is therefore apparent that the engineer must follow a prescribed series of operations and effect a full service reduction in brake pipe pressure and consequently a full service application of brakes in order to obtain permanent suppression of the train control device 7.

After an application of brakes has been effected on the locomotive by operation of the brake valve device 1 to suppress operation of the train control device 7, the application cannot be released until after the traffic conditions again become favorable to effect energization of the timing magnet 280 and in turn movement of the double beat valve 292 to its upper seated position for closing the vent communication from the application piston chamber 176. After this occurs, the engineer may move the brake valve handle 33 back to release position in which the brake equipment will be recharged with fluid under pressure and the brakes on the locomotive will be released in the manner above described.

It will be noted that if the brake valve handle 33 is moved to release position prior to reenergization of the timing magnet 280, the consequent increase in brake pipe pressure in diaphragm chamber 247 will cause unseating of double beat valve 242 and venting of the suppression diaphragm chamber 238 as a result of which the double beat suppression valve will be moved to its upper position and the application piston chamber 176 will be vented by way of the poppet valve 48 in the brake valve device so that the train control apparatus 7 will then operate, but this operation can be prevented by the engineer in the manner just described.

The brake valve device 1 must be operated to initiate an automatic application of brakes as above described before movement of the application piston 170 and slide valve 171 to the application position, or otherwise the application of brakes will be effected by the application valve device 7. This is due to the fact that as soon as the slide valve 171 obtains application position and supplies fluid under pressure through port 584 to passage 463 for initiating a train control application of brakes, a portion of this fluid flows from said passage past a ball check valve 511 to diaphragm chamber 236 and this pressure acting on diaphragm 237 will permit spring 240 to maintain same in the position shown upon any subsequent supply of fluid under pressure to diaphragm chamber 238 from the brake valve device. The double beat valve 233 will thus be held in its upper seated position maintaining communication between the application piston chamber 176 and the stop reservoir 420 so as to ensure a full application of brakes by operation of the train control device 7.

Operation of interlock valve device 10

The interlock valve device 10 is provided to insure that an application of brakes on the locomotive and train will be obtained in case an application fails to materialize due to operation of the brake valve device 1 by the engineer or due to operation of the train control device 7, and therefore is controlled by the pressure of fluid in brake cylinder device 19 acting in diaphragm chamber 335 and by a control pressure in diaphragm 332 supplied either from the straight air control pipe 56 through the double check valve device 436 in effecting a straight air electro-pneumatic application of the brakes on the locomotive and train or by fluid pressure supplied by the brake controlling valve device 5 for operating the relay valve device 6, which fluid is supplied from the relay pipe 158 to the opposite end of the double check valve device 436. Thus in effecting an application of brakes, if the brake cylinder pressure in diaphragm chamber 335 fails to materialize within a certain time limit after the control pressure is obtained in the diaphragm chamber 332, the pressure of fluid in the chamber 332 will deflect the diaphragms 330 and 331 in the direction of the right-hand, which movement acting through the yoke 340 will relieve the seating pressure on valve 341 and permit same to be unseated by the fluid pressure in pipe 319.

With the valve 341 unseated, fluid under pressure is vented from piston chamber 318 in the brake pipe vent valve device 9 at a rate exceeding the rate of supply through the port 393, past the valve 341 to chamber 343, and thence through exhaust port 344. When the pressure in piston chamber 318 of the vent valve device 9 is thus reduced sufficiently, brake pipe pressure in chamber 324 at the opposite side of piston 313 shifts said piston in an upwardly direction against spring 327 to close communication between pipes 218 and 325 to thereby cut off the supply of fluid under pressure to the brake pipe, and at the same time the pipe 325 is connected past the lower face of piston 316 to the exhaust port 323, and through this communication fluid under pressure is vented from the brake pipe at an emergency rate for effecting an emergency application of brakes on the train, while on the locomotive such reduction effects operation of the brake controlling valve device 5 to effect an emergency application of the brakes on the locomotive.

Safety control features

As hereinbefore mentioned either the foot valve

device 12 or the brake valve handle 33 in the brake valve device 1 must be held in a depressed condition by the operator at all times when the brakes on the locomotive are released or when applied with a force less than a degree sufficient to insure the safety of the locomotive. When such a degree of application is obtained the cut-off valve device 11 is operated as above described to close communication between pipes 178 and pipe 350 under which condition the engineer may remove manual pressure from the foot valve device 12 and brake valve handle 33 whichever is held depressed.

If at any time the engineer removes his foot from both pedal 365 of the foot valve device 12 and from handle 33 of the brake valve device when the brakes on the locomotive are released or applied with a force less than that just mentioned, a communication is established between the application piston chamber 176 of the train control valve device 7 and the atmosphere through passage 177, pipe 178, through the cut-off valve device 11 to pipe 350 and then past diaphragm 361 in the foot valve device to pipe 363 leading to the brake valve device and then past the valve 42 therein. Through this communication fluid pressure is vented from the application piston chamber 176 and the application piston 170 and slide valve 171 then operates to effect an application of brakes on the locomotive and train either by straight air or automatically through the medium of the brake pipe 50 in the same manner as when an unfavorable traffic condition is encountered, as hereinbefore described. The safety of the train is thus insured in case of incapacity or inattentiveness of the engineer or in case an attempt is made to brake the locomotive and train to a degree less than required to ensure the safety thereof.

Double heading

When a locomotive is used as the second locomotive in double heading or as a pusher at the rear end of a train it is desired that the brakes on the train be controlled only from the leading locomotive except that on the other or non-control locomotive the engineer shall be able to effect an emergency reduction in brake pipe pressure in case of emergency.

In order to condition the equipment shown in the drawing for use on a non-control locomotive the double heading cock 13 is provided and is movable from the normal control position shown in Fig. 1A to a double heading position shown in Fig. 5 and in which the brake pipe 15 is disconnected from the vent valve device 9, train control device 7 and brake valve device 1, and communication between the application piston chamber 176 and the timing valve device 8 and cut-off valve device 11 is closed, and in addition, communication between brake valve device 1 and master switch device 3 through the straight air control pipe 56 is also broken. It will be noted, however, that the brake pipe 15 is connected independently of the double heading cock 13 through pipe 15*a* to the emergency valve (not shown) in the brake valve device. Thus on the non-control locomotive the train control device 7 is rendered non-responsive to changes in traffic conditions and the brake valve device 1 is rendered non-operative to control the brakes on the locomotive and train in any way except in emergency position in which the brake pipe may be vented by way of the brake pipe branch pipe 15*a* just mentioned. The engineer on the non-control locomotive however does, through the independent brake valve device 2, retain independent control of the application and release of brakes on the locomotive in the same manner as before described.

Selector cock 14

As above described, the selector cock 14 in the position shown provides communication through which fluid is supplied to pipe 368 and then to diaphragm chamber 369 in the emergency delay valve device 136 for holding the valve 381 in engagement with the seat rib 382 so that when an emergency application of brakes is effected by operation of the brake controlling valve device 5, the rate of application will be retarded by the choke 478 in order to prevent the harsh running in of slack in a train and consequent possible damage to the train. This cock also connects the suppression reservoir 379 to pipe 378 leading to the train control devices 7, for controlling the operation of the split reduction piston 192 during operation of the train control device 7 and to provide for initial automatic suppression as above described. The cock also connects the timing reservoir 376 to the train control device for operation during automatic suppression.

The functioning of the emergency delay valve device 136, split reduction piston 192 and timing reservoir 376 are only required when the locomotive is controlling the brakes on long trains where the problem of controlling slack is of prime importance. On short trains, such as passenger trains, the small amount of slack in the train does not materially affect braking, and an emergency application of brakes can therefore be effected at a desired faster rate, while a service application, in response to operation of the train control device 7, may be a straight away application and not split as above described. To condition the brake equipment for operation with short trains the selector cock handle 372 may therefore be turned from the position shown to the position indicated by the dotted line 373 so as to thereby condition the plug valve 371 to disconnect the timing reservoir 376 and the suppression reservoir 379 from the train control device 7 and to disconnect pipe 368 from pipe 27 and to connect same through the port 367 and a vent 502 directly to the atmosphere. With the selector cock 14 thus conditioned, when the train control apparatus 7 operates to effect an application of brakes on the locomotive and train it will be noted that the split reduction piston 192 and the valve piston 180 will remain in their lower position so that a straight away or continuous reduction in equalizing reservoir pressure into the first and second reduction reservoirs will occur, and as a result a straight away or continuous service reduction in pressure in the brake pipe 15 will be effected and a like application of the brakes on the locomotive and train will be obtained, as will be apparent. Furthermore, in effecting an emergency application of brakes in response to an emergency reduction in pressure in brake pipe 15 the fluid pressure supplied to passage 125 by operation of the brake controlling valve device 5 will flow to the emergency delay valve device 136 and move the valve 381 away from the seat rib 382 and then flow past said seat rib to the relay valve device 6 for applying the brakes, it being noted that with the valve 381 unseated the delay choke 478 is by-passed there-

by providing for the application of brakes on the locomotive at the maximum emergency rate.

Conclusion

It will now be apparent that we have provided an improved locomotive brake equipment embodying automatic train control apparatus controlled by traffic conditions or signal indications which is adapted for use in various types of service such as in the ultra high speed type of service where the brakes on the train are adapted to be controlled either electropneumatically by straight air or on the well known automatic principle or in other conventional types of service wherein the brakes are adapted to be controlled on the usual automatic principle only. The train control device 7 insures the safety of the locomotive and whatever type of train the locomotive is associated with and means are associated with the device whereby the engineer may if he is alert suppress the automatic operation thereof by effecting an application of brakes through either the electropneumatic straight air or automatic control mediums. Furthermore, the locomotive embodies means whereby the brakes on the locomotive may be controlled independently of those on the train at all times and under all conditions.

While only one embodiment of the invention has been described in detail it is not the intention to limit the scope to that embodiment or otherwise than by the terms of the appended claims.

Having now described my invention, what we claim as new and desire to secure by Letters Patent, is:

1. In a fluid pressure equipment, in combination, a straight air pipe adapted to be connected through a train, a brake valve device operative manually to effect a supply of fluid under pressure to said straight air pipe to effect an application of brakes, valve means adapted to operate automatically upon a change in track signals to effect an application of brakes, and means conditionable by the supply of fluid under pressure to said straight air pipe to prevent said operation of said valve means.

2. In a fluid pressure equipment, in combination, a pipe, a brake valve device operative manually to effect a supply of fluid under pressure to said pipe to effect an application of brakes, valve means adapted to operate automatically upon a change in track signals to effect an application of brakes, and means for controlling said valve means independently of said brake cylinder device, said means being operable by the pressure of the fluid pressure supply to said pipe upon operation of said brake valve device for rendering said valve means non-operable to effect an application of brakes upon a change in track signals.

3. In a fluid pressure brake, in combination, a pipe, a brake valve device operable manually to effect a supply of fluid under pressure to said pipe to effect an application of brakes, valve means adapted to move from a normal position to an application position for effecting an application of brakes, track signal controlled means operable upon a change in track signals to effect operation of said valve means, and means subject to the pressure of fluid supply to said pipe and operative substantially upon initiating said supply to said pipe to prevent movement of said valve means from said normal position upon said change in track signals.

4. In a fluid pressure brake equipment, in combination, a pipe, a brake valve device operative manually to effect a supply of fluid under pressure to said pipe to effect an application of brakes, valve means adapted to operate automatically upon a change in track signals to effect an application of brakes, and means responsive to pressure of fluid in said pipe and connected to said valve means independently of said brake valve device and operable when said pressure is greater than a chosen degree to render said valve means non-responsive to a change in track signals and when less than said chosen degree to render said valve means responsive to a change in track signals.

5. In a fluid pressure brake equipment, in combination, a pipe, a brake valve device operative manually to a position to effect a supply of fluid under pressure to said pipe to effect an application of brakes, valve means operative to effect an application of brakes independently of said brake valve device, means controlled by track signals and operable upon a change therein to effect operation of said valve means, suppression means for rendering said valve means non-responsive to a change in track signals, and means operable with said brake valve device in said position by the pressure of the fluid supply to said pipe for actuating said suppression means.

6. In a brake equipment, in combination, a pipe, a brake valve device operative manually to effect a supply of fluid under pressure to said pipe for effecting an application of the brakes, an application valve device operable upon venting of fluid under pressure from a chamber for effecting an application of brakes, means controlled by traffic conditions and operable upon an unfavorable change therein to vent fluid under pressure from said chamber, valve means controlling communication through which fluid is adapted to be vented from said chamber by the traffic controlled means, and suppression means controlled by the pressure of the fluid supply to said pipe and connected to control said valve means independently of said brake valve device, said suppression means being operable upon the supply of fluid under pressure to said pipe by said brake valve device to operate said valve means to close said communication.

7. In a brake equipment, in combination, a pipe, a brake valve device operative manually to effect a supply of fluid under pressure to said pipe for effecting an application of the brakes, an application valve device operable upon venting of fluid under pressure from a chamber for effecting an application of brakes, means controlled by traffic conditions and operable upon an unfavorable change therein to vent fluid under pressure from said chamber, valve means controlling communication through which fluid is adapted to be vented from said chamber by the traffic controlled means, and suppression means connected to control said valve means independently of said brake valve device and conditionable upon the supply of fluid under pressure to said pipe prior to the venting of fluid under pressure from said chamber for operating said valve means to close said communication, said suppression means being also controlled by said application valve device and being operable to condition said valve means to open said communication upon the venting of fluid under pressure from said chamber prior to the supply of fluid to said straight air pipe.

8. In a brake equipment, in combination, a

straight air pipe, a brake valve device operative manually to effect a supply of fluid under pressure to said straight air pipe for effecting an application of the brakes, an application valve device operable upon venting of fluid under pressure from a chamber for effecting an application of brakes, means controlled by traffic conditions and operable upon an unfavorable change therein to vent fluid under pressure from said chamber, valve means controlling communication through which fluid is adapted to be vented from said chamber by the traffic controlled means, means conditionable upon the supply of fluid under pressure to said straight air pipe for operating said valve means to close said communication, said application valve device being operable upon the venting of fluid under pressure from said chamber by operation of the traffic controlled means to open a vent communication to said chamber which is independent of the communication controlled by said valve means.

9. In a brake equipment, in combination, a straight air pipe, a brake pipe, a brake valve device selectively operative manually to either supply fluid under pressure to said straight air pipe to effect an application of brakes or to vent fluid under pressure from said brake pipe to effect an application of brakes, valve means adapted to respond to a change in track signals to effect an application of brakes, automatic suppression means operative upon the operation of said brake valve device to vent fluid under pressure from said brake pipe, for rendering said valve means non-responsive to a change in track signals, and straight air suppression means operative upon the supply of fluid under pressure to said straight air pipe for rendering said valve means non-responsive to a change in track signals.

10. In a brake equipment, in combination, a straight air pipe, a brake pipe, a brake valve device selectively operative manually to either supply fluid under pressure to said straight air pipe to effect an application of brakes or to vent fluid under pressure from said brake pipe to effect an application of brakes, valve means adapted to respond to a change in track signals to effect an application of brakes, automatic suppression means operative upon the operation of said brake valve device to vent fluid under pressure from said brake pipe, for rendering said valve means non-responsive to a change in track signals, straight air suppression means operative upon the supply of fluid under pressure to said straight air pipe for rendering said valve means non-responsive to a change in track signals, said valve means controlling both of said suppression means and being operative prior to response to a change in track signals to render both said suppression means operable and subsequent to response to a change in track signals to render both of said suppression means non-operable.

11. In a brake equipment, in combination, a straight air pipe, a brake pipe, a brake valve device selectively operative manually to either supply fluid under pressure to said straight air pipe to effect an application of brakes or to vent fluid under pressure from said brake pipe to effect an application of brakes, a valve device having a normal position and movable therefrom to an application position upon venting of fluid under pressure from a chamber to effect an application of brakes, automatic means operative upon a change in track signals to vent fluid under pressure from said chamber, a pair of valve means controlling serially the communication through which fluid under pressure is adapted to be vented from said device by said automatic means and operative independently of each other to close said communication for maintaining said valve device in said normal position upon operation of said automatic means, means for actuating one of said valve means to close said communication upon operation of said brake valve device to vent fluid under pressure from said brake pipe, and means operable upon the supply of fluid under pressure to said straight air pipe by operation of said brake valve device to actuate the other of said valve means to close said communication.

12. In a brake equipment, in combination, a straight air pipe, a brake pipe, a brake valve device selectively operative manually to either supply fluid under pressure to said straight air pipe to effect an application of brakes or to vent fluid under pressure from said brake pipe to effect an application of brakes, a valve device having a normal position and movable therefrom to an application position upon venting of fluid under pressure from a chamber to effect an application of brakes, automatic means operative upon a change in track signals to vent fluid under pressure from said chamber, a pair of valve means controlling serially the communication through which fluid under pressure is adapted to be vented from said device by said automatic means and operative independently of each other to close said communication for maintaining said valve device in said normal position upon operation of said automatic means, means for actuating one of said valve means to close said communication upon operation of said brake valve device to vent fluid under pressure from said brake pipe, and means operable upon the supply of fluid under pressure to said straight air pipe by operation of said brake valve device to actuate the other of said valve means to close said communication, said valve device being operative upon movement to said application position to render same non-controllable by either of said pair of valve means.

13. In a fluid pressure brake equipment, in combination, a straight air pipe, valve means operative to supply fluid under pressure to said straight air pipe to effect an application of brakes, a choke in the connection between said valve means and straight air pipe, a brake valve device operative to effect operation of said valve means, an application valve device operative automatically upon a change in track signals to effect an application of brakes, and suppression means connected to said valve means on the valve means side of said choke and operative upon a predetermined increase in the pressure of fluid supplied by said valve means for supply to said straight air pipe, to render said application valve device non-responsive to a change in track signals, said choke being operative upon the operation of said valve means to restrict the flow of fluid supplied thereby to said straight air pipe to thereby provide an increase in pressure on said suppression means ahead of the increase in pressure in said straight air pipe.

14. In a brake equipment, in combination, a brake pipe, an equalizing reservoir, a brake pipe discharge valve device operative upon reduction in pressure in said equalizing reservoir to effect a corresponding reduction in pressure in said

brake pipe, a first reduction reservoir, a second reduction reservoir, valve means providing a normally open communication between said reduction reservoirs, an application valve device having a normal position for effecting charging of said equalizing reservoir and brake pipe with fluid under pressure and for venting said reduction reservoirs and movable therefrom to an application position for cutting off the supply of fluid under pressure to said equalizing reservoir and brake pipe and for connecting said equalizing reservoir to said first reduction reservoir, means operative upon movement of said application valve device to said application position to effect operation of said valve means to close communication between said reduction reservoirs and a predetermined time thereafter to open said communication for thereby providing a two stage reduction in pressure in said equalizing reservoir, and means for controlling the interval of time between the communication closing and opening operation of said valve means.

15. In a brake equipment, in combination, a brake pipe, an equalizing reservoir, a brake pipe discharge valve device operative upon reduction in pressure in said equalizing reservoir to effect a corresponding reduction in pressure in said brake pipe, a first reduction reservoir, a second reduction reservoir, a valve providing a normally open communication between said reduction reservoirs and operative to close said communication, an application valve device having a normal position for effecting charging of said equalizing reservoir and brake pipe with fluid under pressure and for venting said reduction reservoirs and movable to an application position for cutting off the supply of fluid under pressure to said equalizing reservoir and brake pipe and for connecting said equalizing reservoir to said first reduction reservoir, movable abutment means operable by fluid under pressure to actuate said valve to close communication between said reduction reservoirs, said application valve device being operative in its normal position to supply fluid under pressure to a chamber and in its application position to supply fluid under pressure from said chamber to said movable abutment means for operating same to actuate said valve to close communication between said reduction reservoirs, means providing a restricted vent for the fluid pressure supplied from said chamber to actuate said movable abutment means for gradually reducing the pressure of fluid on said movable abutment means, and means operative when the pressure in said chamber is reduced through said vent to a predetermined low degree to operate said valve to open said communication for thereby providing a second stage of reduction in pressure in said equalizing reservoir.

16. In a brake equipment, in combination, a brake application valve having a normal position and movable therefrom to an application position for effecting an application of brakes, split reduction means associated with said brake application valve and cooperative therewith in the application position thereof upon the supply of fluid under pressure to a chamber and the subsequent release of fluid under pressure therefrom through a restricted vent from said chamber to effect said application of brakes in two successive stages, automatic means responsive to a change in track signals to effect movement of said brake application valve to said application position, a reservoir charged with fluid under pressure in said normal position of said brake application valve and connected to said split reduction means in said application position for controlling the operation of said split reduction means, suppression means operative by fluid under pressure to render said brake application valve non-responsive to operation of said automatic means, and a brake valve device movable to a position to effect an application of brakes, and being operative in said position to establish a communication between said reservoir and the suppression means for effecting operation thereof.

17. In a brake equipment, in combination, a brake application valve having a normal position and movable therefrom to an application position for effecting an application of brakes, split reduction means associated with said brake application valve and cooperative therewith in the application position thereof upon the supply of fluid under pressure to a chamber and the subsequent release of fluid under pressure therefrom through a restricted vent from said chamber to effect said application of brakes in two successive stages, automatic means responsive to a change in track signals to effect movement of said brake application valve to said application position, a reservoir charged with fluid under pressure in said normal position of said brake application valve and connected to said split reduction means in said application position for controlling the operation of said split reduction means, suppression means operative by fluid under pressure to render said brake application valve non-responsive to operation of said automatic means, and a brake valve device movable to a position to effect an application of brakes, and being operative to said position to establish a communication between said reservoir and the suppression means for effecting operation thereof, said brake application valve controlling communication between said reservoir and said brake valve device and being adapted to open same in the normal position thereof and close same in the application position thereof.

18. In a brake equipment, in combination, a brake pipe, a straight air control pipe, a brake valve device connected to both of said pipes and selectively operative manually to either effect a reduction in pressure in said brake pipe or to effect a supply of fluid under pressure to said straight air control pipe for in either case effecting an application of brakes, a brake application valve operative to effect an application of brakes, automatic means operative upon a change in track signals to effect operation of said brake application valve, double heading valve means controlling communication between said pipes and brake valve device and between said brake application valve and automatic means and having a normal position for opening all of the communications and a double heading position for closing all of said communications, and means conditionable manually to position said valve means.

19. In a brake equipment, in combination, a brake pipe, brake controlling valve means operative upon a reduction in brake pipe pressure to supply fluid under pressure for effecting an application of brakes, a delay valve device controlling the rate at which fluid is supplied by said brake controlling valve means for applying the brakes and having a retarding position for providing a relatively slow rate and another posi-

tion for providing a faster rate, a brake application valve responsive to a change in track signals to effect an application of brakes, suppression means operative to render said brake application valve non-responsive to a change in track signals, a brake valve device operative manually to effect a reduction in brake pipe pressure and at the same time to effect operation of said suppression means, and selector valve means having one position for positioning said delay valve device in the retarding position and for rendering said suppression means responsive to operation of said brake valve device and having another position for conditioning said delay valve device for providing said faster rate of brake application and for rendering said suppression means non-responsive to operation of said brake valve device, and means for positioning said selector valve means.

20. In a brake equipment in combination, a brake pipe, brake controlling valve means operative upon either a service or an emergency reduction in brake pipe pressure to supply fluid under pressure for effecting either a service or an emergency rate of application of the brakes, respectively, a delay valve device for controlling the rate at which fluid is supplied by said brake controlling valve device in effecting an emergency application of the brakes and having a retarding position for providing a relatively slow rate of supply and another position to provide for a faster rate of supply, a brake application valve responsive to a change in track signals to effect an application of the brakes, suppression means operative to render said brake application valve non-responsive to a change in track signals, a brake valve device operative manually to effect either a service reduction in brake pipe pressure and operation of said suppression means or to effect an emergency reduction in brake pipe pressure, selector valve means having a position for positioning said delay valve device in the retarding position and for rendering said suppression means operable upon operation of said brake valve device and having another position for positioning said delay valve device in the said other position to provide said faster rate and for rendering said suppression means non-responsive to operation of said brake valve device, and means for positioning said selector valve means.

21. In a brake equipment in combination, a brake application valve controlled by track signals, split reduction means cooperative with said brake application valve upon response thereof to a change in track signals for effecting an application of brakes in two successive stages, suppression means operative to render said brake application valve non-responsive to a change in track signals, a brake pipe, a brake valve device operative manually to effect a reduction in brake pipe pressure for effecting an application of the brakes and at the same time to effect operation of said suppression means, and selector valve means having one position for rendering said suppression means responsive to operation of the brake valve device and for conditioning said split reduction means to cooperate with said brake application valve and having another position for rendering said suppression means and split reduction means inoperable, and means for positioning said selector valve means.

22. In a brake equipment in combination, a brake pipe, brake controlling valve means controlled by brake pipe pressure and operative upon a reduction in brake pipe pressure to supply fluid under pressure for effecting an application of brakes, a delay valve device for controlling the rate at which fluid is supplied by said brake controlling valve means and having a retarding position for providing a relatively slow rate and another position for providing a faster rate, a brake application valve controlled by track signals, split reduction means cooperative with said brake application valve upon response thereof to a change in track signals for effecting an application of brakes in two successive stages, suppression means operative to render said brake application valve non-responsive to a change in track signals, a brake valve device operative manually to effect a reduction in brake pipe pressure and at the same time to effect operation of said suppression means, selector valve means having one position for positioning said delay valve device in the retarding position and for rendering said suppression means responsive to operation of said brake valve device and for also rendering said split reduction means cooperative with said brake application valve, said selector valve means being movable to another position for conditioning said delay valve device to provide said faster rate of brake application and for rendering said suppression means non-responsive to operation of said brake valve device and for rendering said split reduction means non-operable, and means for positioning said selector valve means.

23. In a locomotive brake equipment, in combination, brake application valve means operative automatically upon a change in track signals to effect a supply of fluid under pressure to apply the brakes on the locomotive, valve means providing a communication through which said fluid under pressure is supplied for applying the brakes on the locomotive and movable to a position for closing said communication to prevent the application of locomotive brakes, and an engineer's brake valve device having a normal position for conditioning said valve means to open said communication and movable to another position for effecting operation of said valve means to close said communication.

24. In a locomotive brake equipment, in combination, brake application valve means operative automatically upon a change in track signals to effect a supply of fluid under pressure to apply the brakes on the locomotive, valve means operative to release the application of brakes on the locomotive effected by the operation of said brake application valve means, and an engineer's independent brake valve device operative to effect the operation of said valve means.

25. In a locomotive brake equipment, in combination, a train pipe on the locomotive, a brake application valve means operative upon a change in track signals to effect a supply of fluid under pressure to said pipe, means on the locomotive operative by pressure of fluid supplied to said train pipe for effecting an application of the locomotive brakes, valve means conditionable to release the application of brakes on the locomotive independently of the pressure of fluid in said train pipe, and an engineer's independent brake valve device on the locomotive operative to so condition said valve means.

26. In a locomotive brake equipment, in combination, a brake pipe, a brake application valve means operative automatically upon a change in track signals to effect a reduction in pressure in said brake pipe, valve means on the locomotive responsive to said reduction in brake pipe pressure for effecting an application of the brakes on

the locomotive, means for effecting a release of the brakes on the locomotive effected by operation of said valve means and independently of the fluid pressure in the brake pipe, and an engineer's independent brake valve device having one position for conditioning said means to provide for the application of brakes by said valve means and movable to another position for conditioning said means to effect a release of the brakes on the locomotive.

27. In a locomotive brake equipment, in combination, a train pipe, brake application valve means operative automatically upon a change in track signals to effect a variation in pressure in said train pipe, valve means on the locomotive responsive to said variation in train pipe pressure adapted to effect an application of brakes on the locomotive, selector valve means having one position for preventing an application of brakes on the locomotive by the operation of said valve means and having another position providing for the brakes on the locomotive being applied upon operation of said valve means, and an engineer's independent brake valve device for controlling said selector valve means and having a normal position providing for movement of said selector valve means to its last named position, said independent brake valve device having another position to effect movement of said selector valve means to its first named position.

28. In a locomotive brake equipment in combination, a brake pipe, an equalizing reservoir, a reduction reservoir, a brake pipe, a discharge valve mechanism operative upon a reduction in equalizing reservoir pressure to effect a reduction in brake pipe pressure, a brake valve device having a service position for connecting said reservoirs to provide for a reduction in equalizing reservoir pressure by equalizing into said reduction reservoir, said brake valve device having a release position for charging said brake pipe and equalizing reservoir and for venting fluid under pressure from said reduction reservoir, and an application valve device having a normal position and movable automatically upon a change in track signals from said normal position to an application position for connecting said reservoirs to provide for equalization of the pressures therein, communication between said brake valve device and reduction reservoir being controlled by said application valve device and open when said application valve device is in its normal position and closed in its application position.

29. In a locomotive brake equipment in combination, a brake pipe, an equalizing reservoir, a reduction reservoir, a brake pipe, a discharge valve mechanism operative upon a reduction in equalizing reservoir pressure to effect a reduction in brake pipe pressure, a brake valve device having a first service position for connecting said reservoirs to provide for a reduction in equalizing reservoir pressure by equalization into said reduction reservoir and movable therefrom to another service position to effect a further reduction in equalizing reservoir pressure, said brake valve device also having a lap position for bottling the fluid pressure in said equalizing reservoir and for venting fluid under pressure from said reduction reservoir, said brake valve device further having a release position for charging said brake pipe and equalizing reservoir and also for venting fluid under pressure from said reduction reservoir, said brake valve device being movable successively first to one and then the other of the lap and release positions for effecting successive increases in brake pipe pressure and in said lap and release positions venting said reduction reservoir preparatory to effecting a further reduction in equalizing reservoir pressure upon movement of said brake valve device to said first service position.

30. In a locomotive brake equipment in combination, a brake pipe, an equalizing reservoir, a reduction reservoir, a brake pipe, a discharge valve mechanism operative upon a reduction in equalizing reservoir pressure to effect a reduction in brake pipe pressure, a brake valve device having a first service position for connecting said reservoirs to provide for a reduction in equalizing reservoir pressure by equalization into said reduction reservoir and movable therefrom to another service position to effect a further reduction in equalizing reservoir pressure, said brake valve device also having a lap position for bottling the fluid pressure in said equalizing reservoir and for venting fluid under pressure from said reduction reservoir, said brake valve device further having a release position for charging said brake pipe and equalizing reservoir and also for venting fluid under pressure from said reduction reservoir, said brake valve device being movable successively first to one and then the other of the lap and release positions for effecting successive increases in brake pipe pressure and in said lap and release positions venting said reduction reservoir preparatory to effecting a further reduction in equalizing reservoir pressure upon movement of said brake valve device to said first service position, and a brake application valve device having a normal position and movable automatically to an application position upon a change in track signals to connect said reservoirs for effecting a reduction in equalizing reservoir pressure, said brake application valve device controlling communication between said reduction reservoir and brake valve device and being operative to open said communication in the normal position thereof and to close said communication in the application position thereof.

31. In a fluid pressure brake equipment in combination, a straight air pipe adapted to extend through a train, a brake valve device operative manually to effect a supply of fluid under pressure to said pipe to effect an application of brakes, valve means adapted to respond to a change in track signals to effect an application of brakes, and means subject to the pressure of the fluid supply to said pipe and operative when said pressure exceeds a chosen degree to render said valve means non-responsive to change in track signals.

32. In a fluid pressure brake equipment in combination, a straight air pipe adapted to extend through a train, a brake valve device operative manually to effect a supply of fluid under pressure to said pipe to effect an application of brakes, valve means adapted to respond to a change in track signals to effect an application of brakes and means subject to the pressure of the fluid supply to said pipe and operative upon initiating the supply of fluid under pressure to said pipe and during a subsequent increase therein to render said valve means non-responsive to a change in track signals and upon obtaining a chosen pressure in said pipe to maintain said valve means non-responsive.

33. In a fluid pressure brake equipment, in combination, a straight air control pipe, a brake valve device operative to effect an increase in

pressure in said control pipe, a straight air train pipe adapted to be connected through a train an increase in pressure in which is adapted to effect an application of brakes, a relay device controlled by the opposing pressures in said pipes and operative in accordance with the increase in pressure in said control pipe to provide a corresponding pressure in said train pipe, valve means adapted to respond automatically to a change in track signals to effect an application of brakes, and means controlled from said train pipe and operative upon a chosen increase in pressure in said train pipe to render said valve means non-responsive to a change in track signals.

34. In a fluid pressure brake equipment, in combination, a straight air control pipe, a brake valve device operative to effect an increase in pressure in said control pipe, a straight air train pipe adapted to be connected through a train an increase in pressure in which is adapted to effect an application of brakes, a relay device controlled by the opposing pressures in said pipes and operative in accordance with the increase in pressure in said control pipe to provide a corresponding pressure in said train pipe, valve means adapted to respond automatically to a change in track signals to effect an application of brakes, and means controlled from said train pipe and operative upon a chosen increase in pressure in said train pipe to render said valve means non-responsive to a change in track signals, the control of said valve means by said means being independent of said brake valve device.

35. In a fluid pressure brake equipment, in combination, a straight air control pipe, a brake valve device operative to effect an increase in pressure in said control pipe, a straight air train pipe adapted to be connected through a train an increase in pressure in which is adapted to effect an application of brakes, a relay device controlled by the opposing pressures in said pipes and operative in accordance with the increase in pressure in said control pipe to provide a corresponding pressure in said train pipe, valve means adapted to respond automatically to a change in track signals to effect an application of brakes, and means controlled from said train pipe and operative upon initiating the supply of fluid under pressure to said train pipe and during a subsequent continued increase therein to render said valve means non-responsive to a change in track signals, said means being operative upon obtaining a chosen degree of pressure in said train pipe to maintain said valve means non-responsive.

36. In a fluid pressure brake equipment, in combination, a straight air pipe an increase in pressure in which is adapted to effect an application of brakes, a brake valve device operative to effect a supply of fluid under pressure to said straight air pipe, valve means adapted to respond automatically to a change in track signals to effect an application of brakes, means conditionable when a chamber is vented to render said valve means responsive to a change in track signals and when said chamber is supplied with fluid under pressure non-responsive to a change in track signals, and a valve subject to fluid pressure in said straight air pipe and operative to vent said chamber when said straight air pipe is vented and operative by fluid pressure supplied to said straight air pipe upon operation of said brake valve device to supply fluid under pressure to said chamber.

37. In a fluid pressure brake equipment, in combination, a straight air pipe an increase in pressure in which is adapted to effect an application of brakes, a brake valve device operative to effect a supply of fluid under pressure to said straight air pipe, valve means adapted to respond automatically to a change in track signals to effect an application of brakes, and means conditionable upon the supply of fluid under pressure to said straight air pipe to render, independently of said brake valve device, said valve means non-responsive to a change in track signals.

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