

S. G. NEAL & J. M. CHILDRESS.
 MEANS FOR OPERATING RAILWAY BRAKES.
 APPLICATION FILED JUNE 12, 1908.

961,310.

Patented June 14, 1910.

6 SHEETS—SHEET 1.

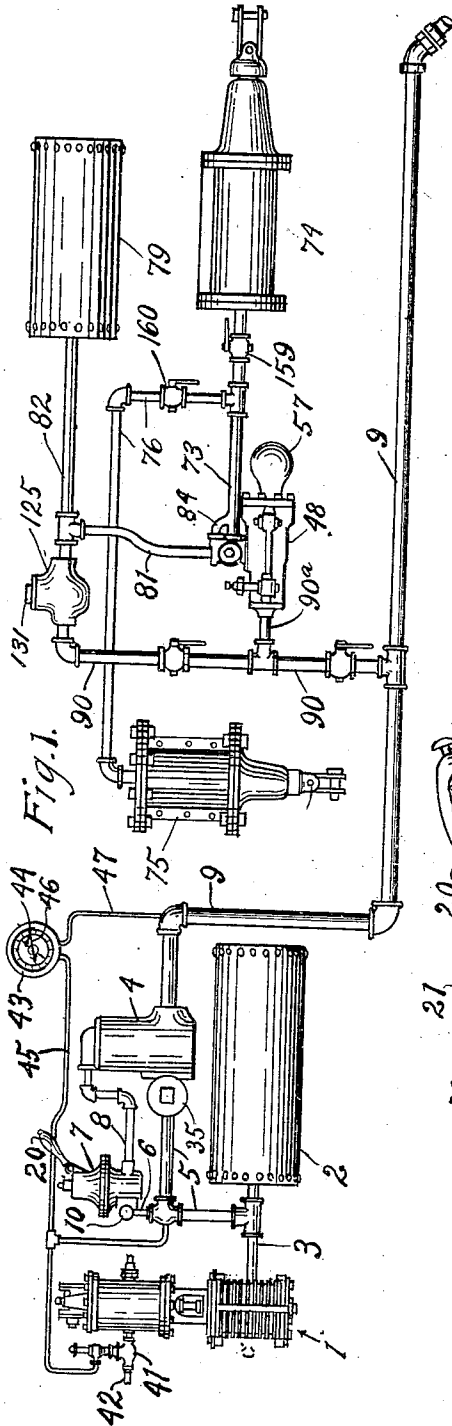


Fig. 1.

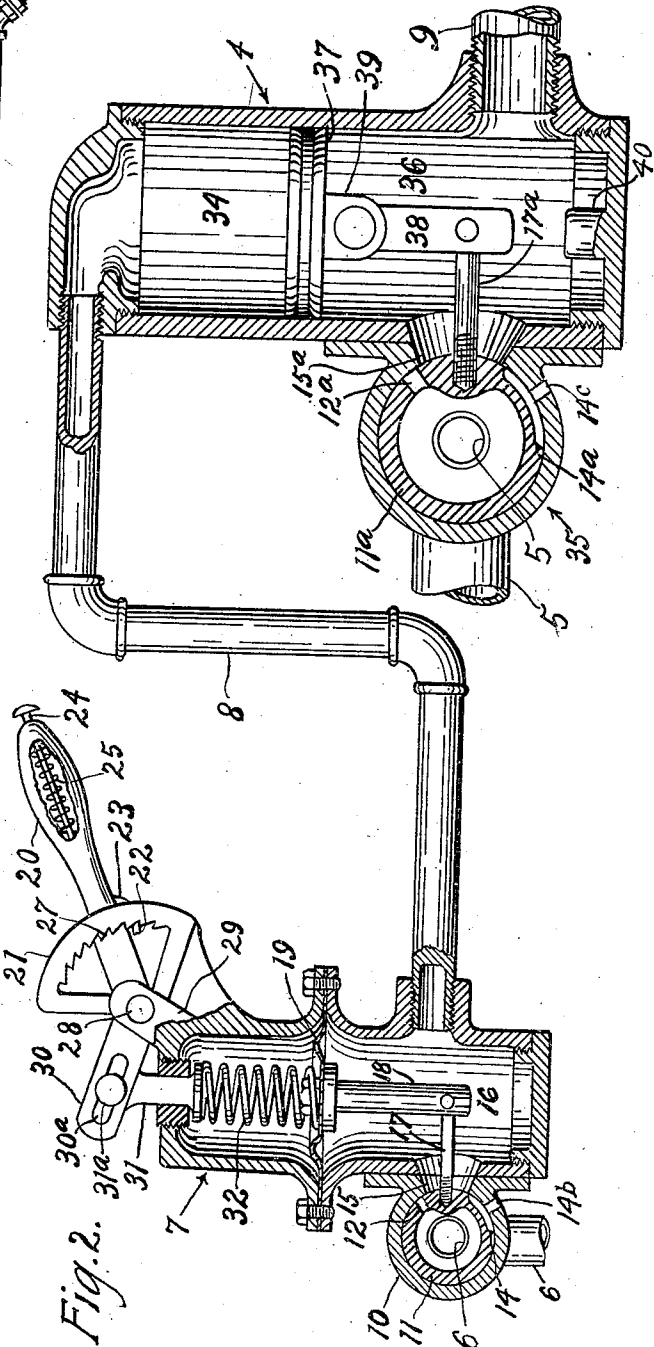


Fig. 2.

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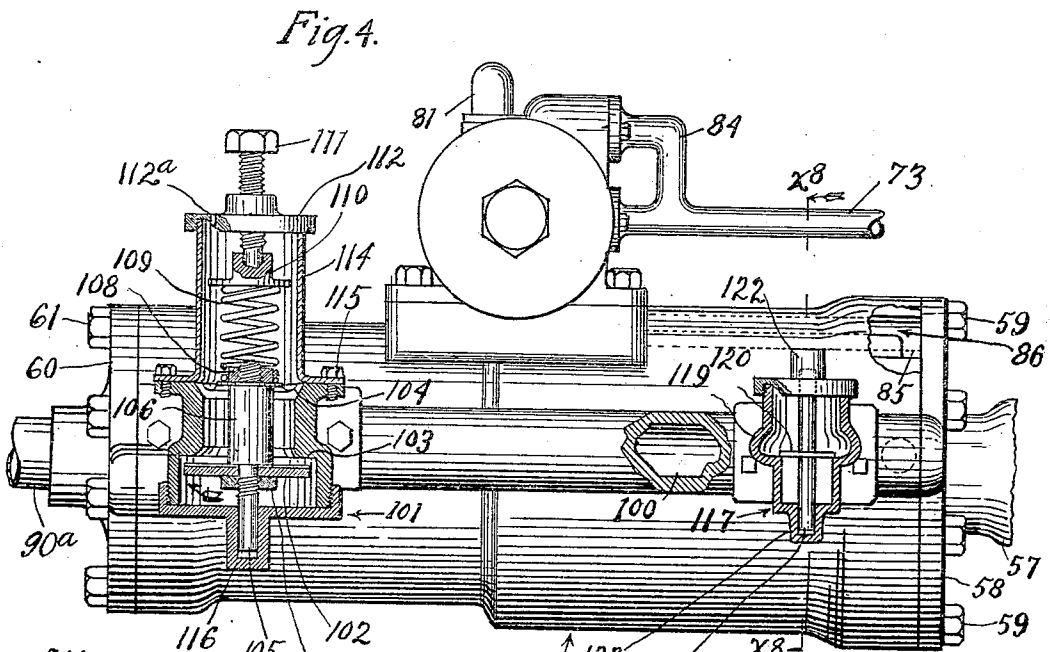
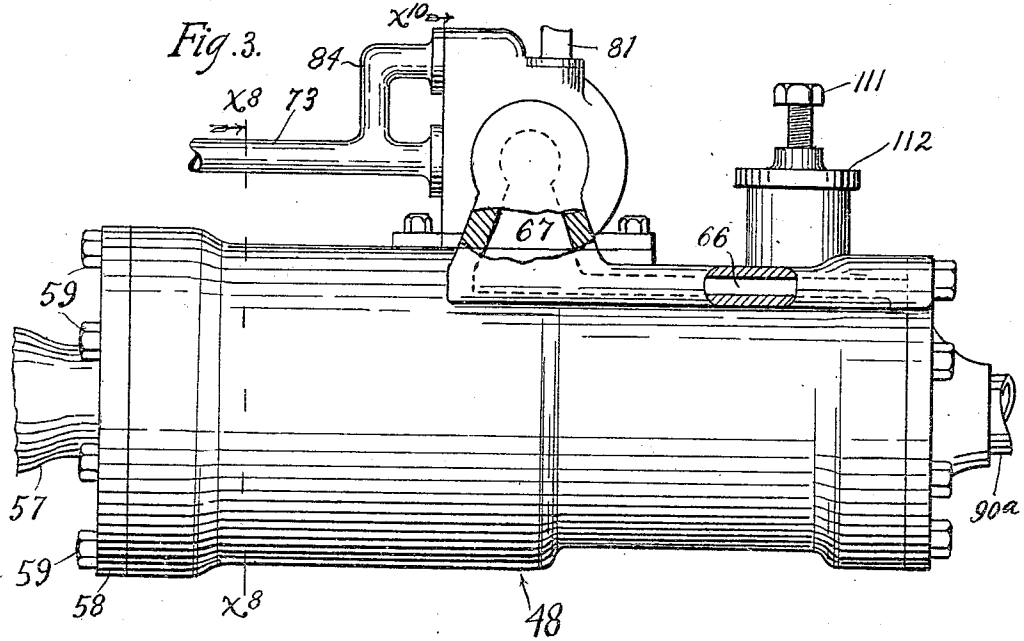
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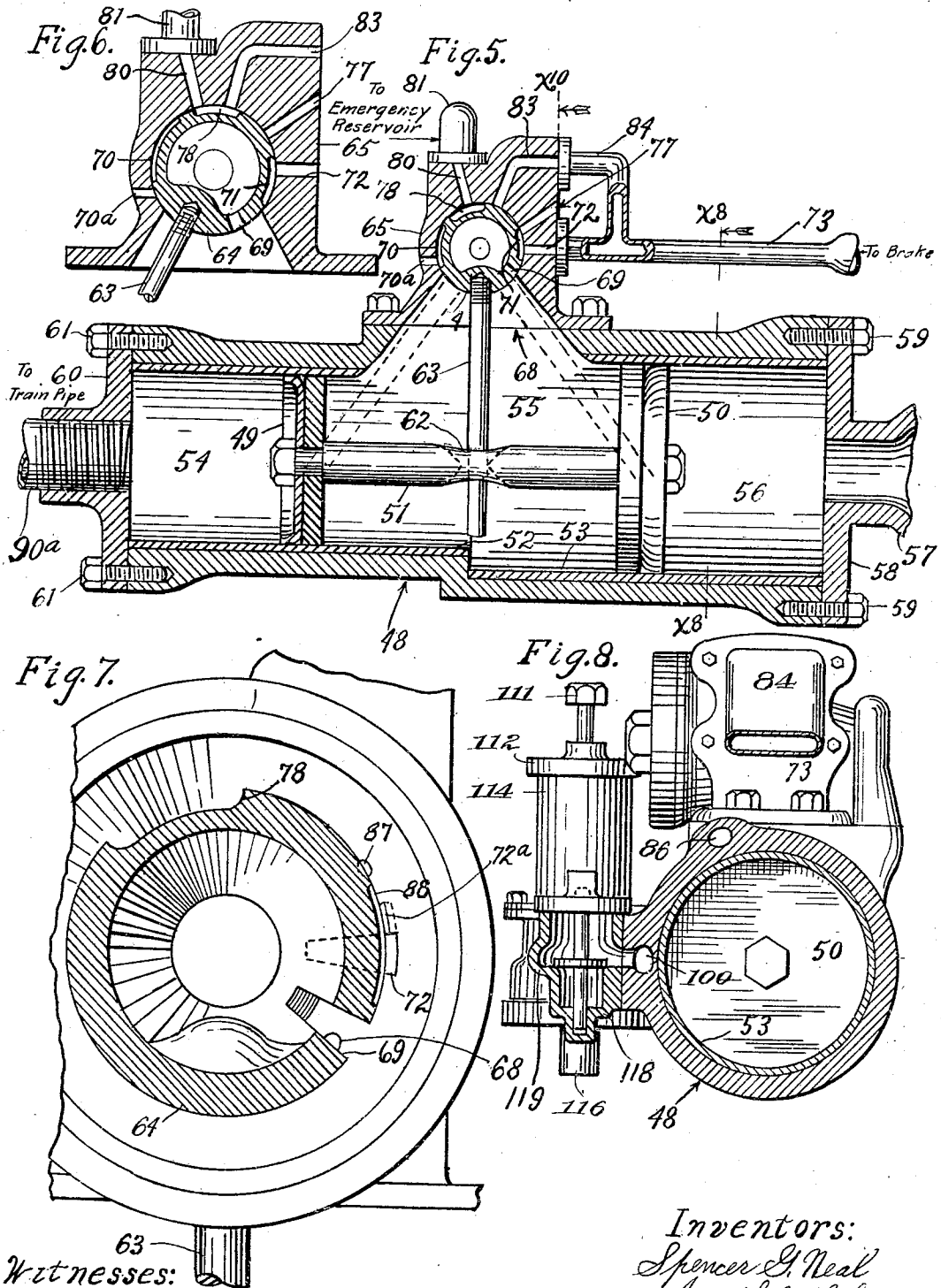
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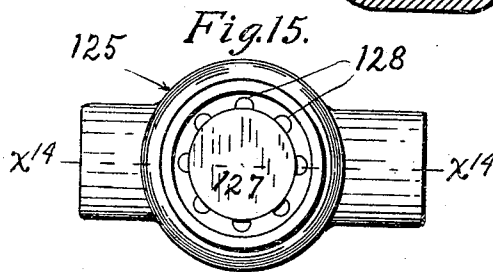
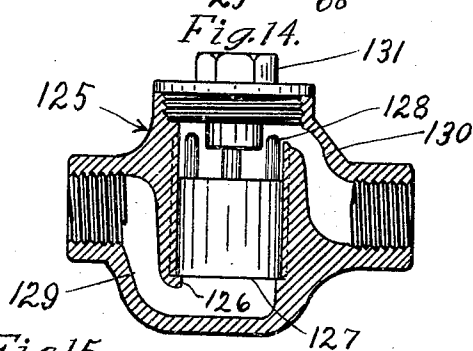
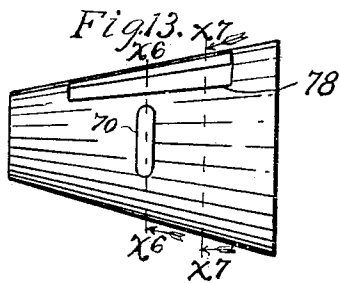
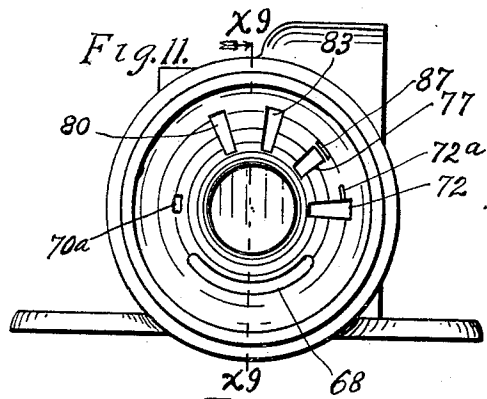
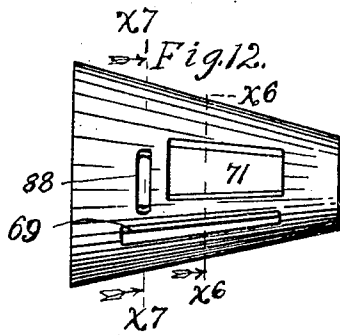
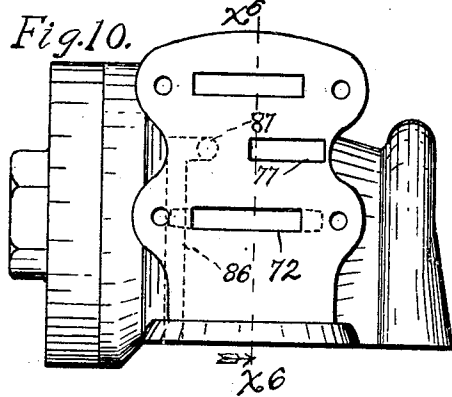
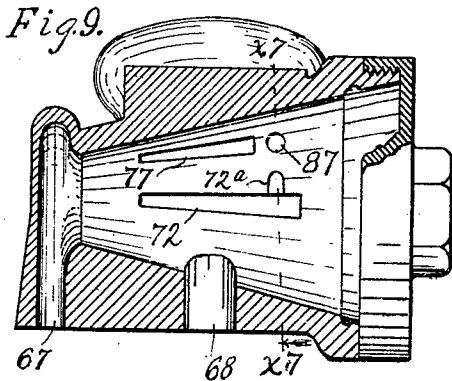
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Fig. 16.

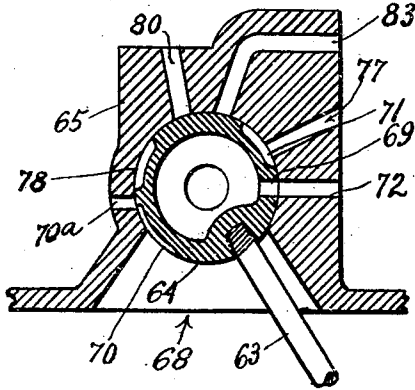


Fig. 18.

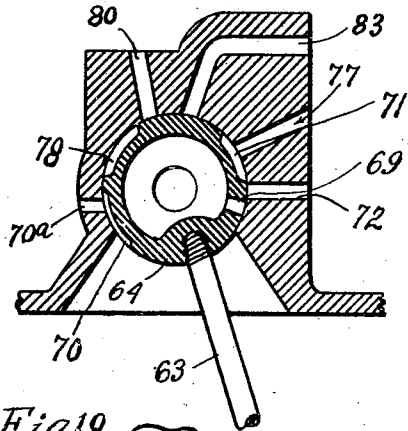


Fig. 17.

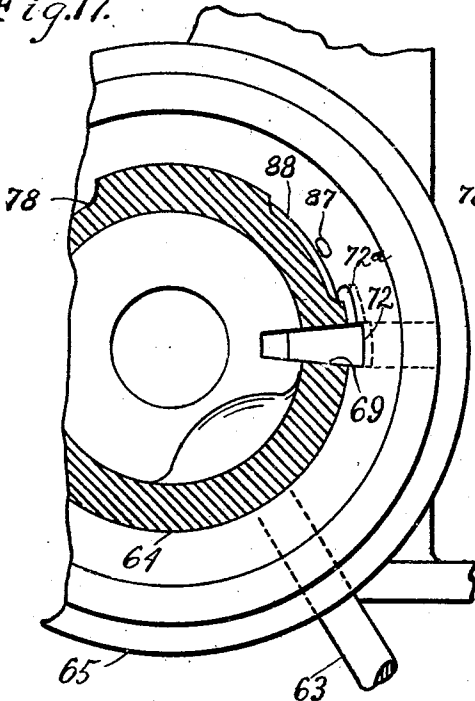
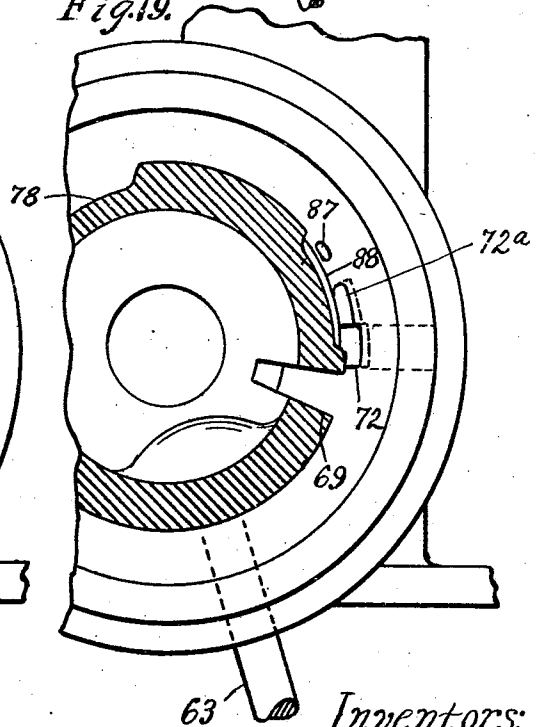


Fig. 19.



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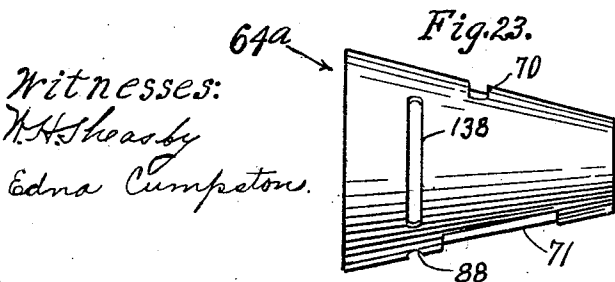
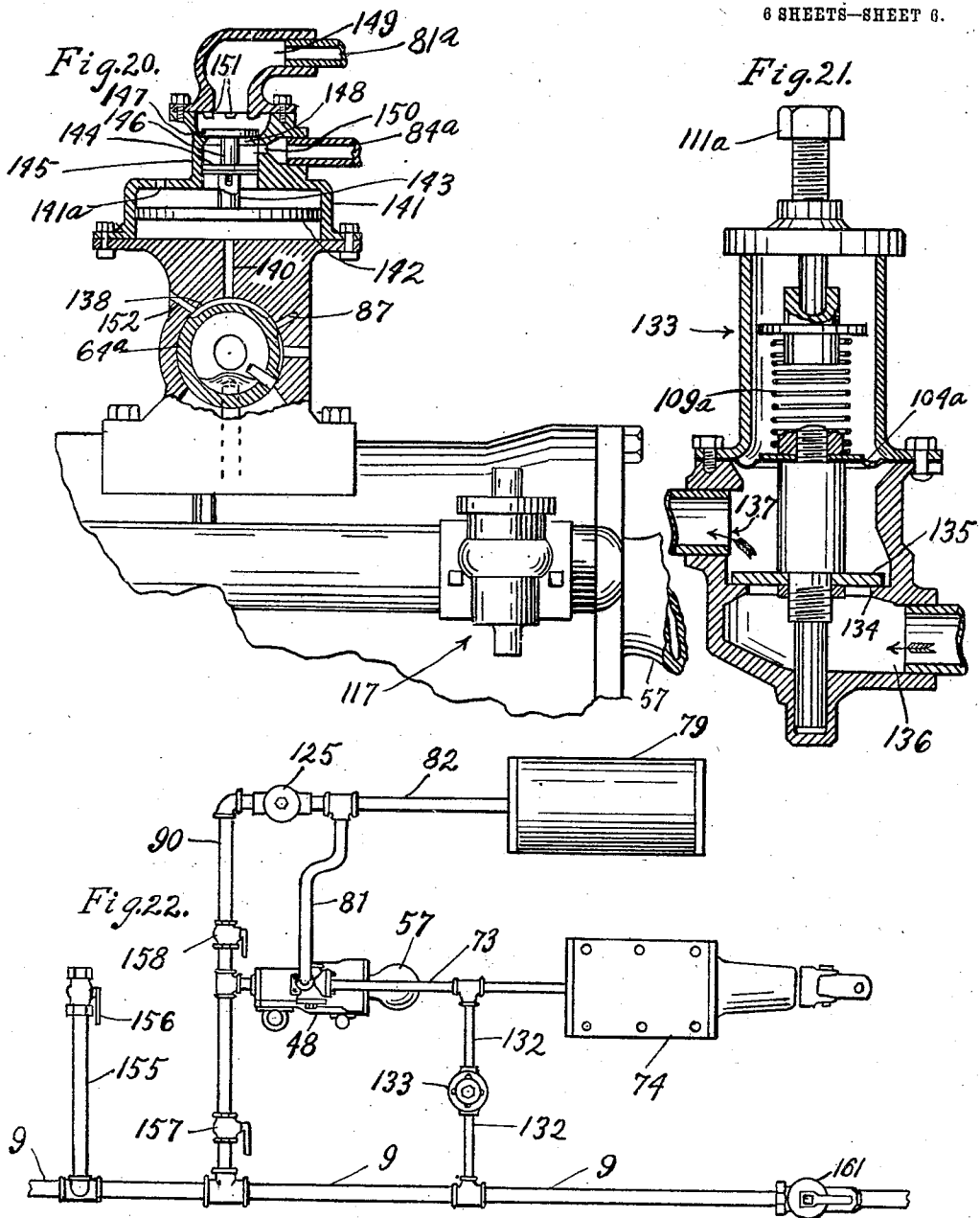
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UNITED STATES PATENT OFFICE.

SPENCER G. NEAL AND JOSEPH M. CHILDRESS, OF LOS ANGELES, CALIFORNIA, ASSIGNORS TO THE CALIFORNIA VALVE AND AIR BRAKE COMPANY, OF PALMS, CALIFORNIA, A CORPORATION OF CALIFORNIA.

MEANS FOR OPERATING RAILWAY-BRAKES.

961,310.

Specification of Letters Patent. Patented June 14, 1910.

Application filed June 12, 1908. Serial No. 438,197.

To all whom it may concern:

Be it known that we, SPENCER G. NEAL and JOSEPH M. CHILDRESS, both citizens of the United States, and residents of Los Angeles, California, have invented new and useful Means for Operating Railway - Brakes, of which the following is a specification.

This invention relates to a simplified, safe and economical means for effectively controlling the brakes of a train of passenger or freight cars whether drawn by steam or other means.

In air brake equipment now in general use on steam and other railways, it is necessary, in order to maintain efficient means for operating the brakes, that the air pressure in the train line be maintained during the running or full release position of the brakes, at from 75 to 110 pounds per square inch. By this invention an air brake equipment is provided capable of affording efficient operation of the brakes with a train line pressure of 10 to 15 pounds in the running or full release position.

Heretofore, in order to efficiently control long trains of cars equipped with automatic air brakes, it has been necessary to provide on the engine and tender of trains on mountain grades, a straight air equipment, in addition to that portion of the automatic air equipment allotted to the engine. By this invention such additional provision for supplying air to the engine and tender is rendered unnecessary because the entire train is supplied with both automatic and straight air by the use of a single train line.

In automatic braking systems now in general use, no provision is made for automatically maintaining the proper pressure in the various brake cylinders throughout the train for a considerable length of time. That is to say, if a leakage occurs in some brake cylinder of the train, the air is drained from the auxiliary reservoir which supplies such cylinder, thus releasing the brakes of that train unit, destroying its efficiency and bringing about an unequal distribution among the remaining units which lessens the gross braking efficiency. By this invention means are provided for automatically maintaining the required pressure in all the brake cylinders throughout the train during the application of the brakes, thus maintaining the maximum braking efficiency re-

gardless of leakage in the cylinders or train line of any particular train unit.

In braking systems now in general use a high degree of skill on the part of engine men is essential to satisfactory results in handling trains on grades. By this invention the means are so simplified that maximum results are easily secured with but an ordinary degree of intelligence and training on the part of engineers and motormen.

An object of this invention is to provide means whereby the speed of long trains on descending grades may be so nicely calculated and controlled as to eliminate all necessity for auxilliary retaining devices for maintaining control of the train while braking pressure is being restored, and also to entirely eliminate the period of doubtful control on descending grades between the time of exhaustion of braking pressure and its maximum restoration.

By this invention the maximum safety is guaranteed because the regular service or working pressure is secured and maintained independent of the auxiliary pressure, which is held in reserve for use in emergency only, and is under control of the conductor or train men, and is automatically applied in case of train separation or derailment, and may also be used by the engineer in addition to his working supply in the event of threatened collision.

Another object of this invention is to eliminate the trouble arising from the gumming and sticking of triple valve parts, which is often met with, owing to their delicate construction in present systems.

In addition to the advantages above indicated over present braking systems, this invention provides for a simplified arrangement of valves and valve operating means, making it possible to regulate to a nicely the pressure of air in the brake cylinders when either low or high pressure is employed.

The important advantages of this invention over braking systems now in use are secured principally by means of the use of an improved multiple port-valve and novel means for operating said valve wholly by varying the pressure in the train line.

With a view to obtaining the above and other advantages, this invention consists in such features, details of construction, com-

binations and sub-combinations of parts as will be described in connection with the accompanying drawings and more particularly pointed out in the claims.

5 Referring to the accompanying drawings which illustrate the invention, Figure 1 is a side elevation view of a braking equip-
 10 ment, constructed according to the principles of this invention and adapted for mounting on a locomotive, some of the parts being shown out of their true position for
 15 convenience of illustration. Fig. 2 is a mid section view of the engineer's pilot valve and the engineer's main valve. Fig. 3 is a
 20 side elevation of the triple valve and operating cylinder. Fig. 4 is an elevation of said valve and cylinder, looking at the opposite side thereof, parts being shown in
 25 section. Fig. 5 is a longitudinal, vertical, mid section through said valve and cylinder. In said figure, the valve plug and its oper-
 30 ating means are shown in full release position, dotted lines indicating other positions of said arm. Fig. 6 is a similar section of the valve, the same being turned to emer-
 35 gency position. Fig. 7 is an end elevation of the valve shown in Fig. 5, the cap being removed and a portion of the valve plug being sectioned on line X⁷ of Figs. 9 and 12.
 40 The parts are considerably enlarged to show small, interior grooves and openings. The position of the parts is that of full release, as in Fig. 5. Fig. 8 is a cross section on line
 45 X⁸ of Figs. 3, 4 and 5. Fig. 9 is an enlarged, longitudinal, mid section of the valve on line X⁹ of Fig. 11. Fig. 10 is a side elevation of the valve on line X¹⁰ of
 50 Figs. 3 and 5, looking in the direction indicated by the arrows. Fig. 11 is a view of the valve, as it appears when looking into the large end thereof with the cap and plug re-
 55 moved. This view shows the position of the ports leading out through the casing. Fig. 12 is a side elevation of the valve plug, turned to the same angle, as in Fig. 5, look-
 60 ing from right to left. Fig. 13 is a similar view, looking at the reverse side of the plug. Fig. 14 is a sectional detail on line X¹⁴ of Fig. 15 of a check valve used to prevent the
 65 escape of air from the emergency reservoir. Fig. 15 is a plan view of said valve with cap removed and parts of the top broken away. Fig. 16 is a view similar to Fig. 6 showing the valve plug in the full application position. This view is taken on X⁶ of Figs. 10 and 12. Fig. 17 is a view on a larger scale than Fig. 16, showing an end elevation of the valve, the cap being removed and the plug cut away down to line X⁷, Figs. 12 and 13. The position of the parts in this view corresponds to that of Fig. 16. Fig. 18 is a view similar to Fig. 16, except that the plug is shown in the lap position. Fig. 19 is a view similar to Fig. 17, except that the parts are shown in lap position to cor-

respond with Fig. 18. Fig. 20 is a vertical mid section of a modified form of emergency valve. Fig. 21 is a vertical mid section of a high speed braking valve. Fig. 22 is a plan view of the apparatus pertaining to
 70 the engine tender or to one of the cars. This view represents a continuation of the apparatus shown in Fig. 1, but differs from Fig. 1 in that the parts are shown occupying their true positions. Fig. 23 is a top
 75 view of the plug of the modification of the triple valve shown in Fig. 20.

Referring to Fig. 1, which shows a side elevation of the apparatus, well-known levers and means of attachment to the car being
 80 omitted, 1 designates the air pump and 2 the main supply reservoir connected with the discharge of said pump by pipe 3. Main engineer's valve 4 is supplied from pipe 3 through main supply pipe 5. From the
 85 main supply pipe 5 a branch 6 leads to the engineer's pilot valve 7, said pilot valve 7 communicating with the upper portion of main engineer's valve 4 by a pipe 8. From main engineer's valve 4 train pipe 9 sup-
 90 plies the air to the train, under a pressure controlled by the regulating means next described.

Reference is now made to Fig. 2 for an understanding of the operation of engineer's
 95 pilot valve 7 and main engineer's valve 4. Engineer's pilot valve 7 is provided with an auxiliary valve 10, having a hollow plug 11, furnished with a radial port 12 and a segmental groove 14. Branch pipe 6 commu-
 100 nicates with the interior of hollow plug 11 through the end thereof. Auxiliary valve 10 is provided with a combined port and operating slot 15 leading into the chamber 16 of the engineer's pilot valve, said port 15
 105 being elongated to form a suitable slot for the operating arm 17, which is pivotally connected with the pendent stem 18, secured to diaphragm 19. 20 designates an operating arm for the valve, said arm being
 110 provided with any suitable arrangement for maintaining it in the position in which it is placed. Such arrangement may consist of a toothed segment 21, engaged by a dog 22, operated by an extension 23 of rod 24, said
 115 rod 24 tending to move outwardly by reason of the pressure of spring 25 coiled thereabout, as shown through the broken portion of the handle. Pressure upon the knob 26 releases dog 22 from the teeth 27 of the seg-
 120 ment, when it is desired to lower the handle. But when the handle is raised, said dog 22 readily slides over the teeth 27 which are upwardly inclined as shown. Segment 21 is stationary, being mounted on an exten-
 125 sion 29 carried by the upper portion of the casing of valve 7. Arm 20 is pivoted on pin 28 and is provided with an extension 30 for depressing plunger 31 against the opposition of spiral spring 32, which is inter- 130

posed between the head of said plunger and the top of diaphragm 19. Extension 30 has a slot 30^a to provide for slidably pivoting plunger 31 in order that vertical movement may be imparted to said plunger. 31^a designates the pivot of the plunger. Main engineer's valve 4 is provided with an auxiliary valve 35, preferably of the same construction as auxiliary valve 10 of the pilot valve 7. Said valve 35 has a hollow plug 11^a, radial port 12^a, segmental release groove 14^a and radial operating arm 17^a and release port 14^c. Said engineer's valve 4 is desirably provided with a cylindrical chamber, having an upper section 34 and lower section 36, said sections 34 and 36 being separated by a piston head 37 from which depends a stem 38 pivotally supported on a boss 39. Stem 38 is pivoted to radial operating arm 17^a. The main supply pipe 5 of the system communicates with the interior of plug 11^a. When handle 20 is raised, additional downward pressure will be applied to diaphragm 19, depressing said diaphragm against the air pressure therebeneath together with pendent stem 18 and plug arm 17, thereby rotating plug 11 and establishing communication between the interior of said plug and chamber 16 by reason of bringing port 12 into register with port 15. When port 12 is thus brought into register with port 15, air rushes from branch pipe 6 through the interior of plug 11, thence through ports 12, 15, chamber 16, and through pipe 8 into the upper chamber 34 of main engineer's valve 4. If the handle 20 of the engineer's pilot valve be raised, thereby depressing the arm 17 and placing port 12 in communication with port 15, the consequent increase of air pressure in chamber 16 will result in a corresponding increase of pressure in chamber 34 of the main engineer's valve, lowering piston head 37 and arm 17^a, thus admitting air from the pipe 5 to chamber 36 through the ports 12^a and 15^a; while if arm 20 be depressed, the valve operating stem 17 will be raised, thereby allowing air to escape from chamber 16 through groove 14 and discharge port 14^b, thus lessening the pressure in chamber 16 and causing a reduction of pressure in chambers 16 and 34, causing the piston 37 to rise, lifting with it arm 17^a and permitting air to escape from chamber 36 through ports 15^a, groove 14^a and port 14^c. In one case therefore, an increase of pressure in chamber 16 of the engineer's pilot valve is immediately followed by a corresponding increase of pressure in chamber 36 of main engineer's valve, and decrease of pressure in chamber 16 is followed by a corresponding decrease in chamber 36.

To illustrate the manner in which the apparatus shown in Fig. 2 automatically maintains the desired pressure in the train pipe

line, let it be supposed that the handle 20 of the engineer's pilot valve has been raised sufficiently to allow air from supply pipe 6 to enter chamber 16 and pass therefrom through pipe 8 into chamber 34; and that the piston head 37 is therefore lowered together with the stem 38 until the lower end of said stem 38 strikes against the bumper 40, maintaining the port 12^a of plug 11^a in fully opened position. After the stop 40 limits the downward movement of piston head 37, the pressure is confined against further expansion in chamber 34, and consequently increases in said chamber, and also in chamber 16 of the pilot valve, until said pressure operates with sufficient force against the lower side of diaphragm 19 to cause said diaphragm to yield upwardly against the set compression of spring 32 until the valve plug 11 moves to the lap position, shown in Fig. 2, thus maintaining constant the pressure which exists in chambers 16 and 34. It will be noted that the pressure in chamber 16 is now greater than it was before arm 20 was lifted to a higher position, because the lifting of said arm has further compressed spring 32, thus augmenting the pressure on top of diaphragm 19 so that a greater air pressure under said diaphragm is necessary to bring it back to its original position. While head 37 is depressed and valve 11^a open, the pressure in the train pipe 9 and in chamber 36 will continue to increase until the pressure on the lower side of the piston head 37 begins to exceed that on the upper side thereof. Said piston head 37 will then begin to rise, thus producing a greater pressure under diaphragm 19 and rotating valve plug 11 to a position allowing air to gradually escape from chambers 34 and 16 through groove 14 and port 14^b. Piston head 37 will continue to rise, rotating plug 11^a until said plug is brought to lap position cutting off further supply from main supply pipe 5 and stopping further compression of air in chambers 34 and 16, whereupon valve 11 comes to lap position automatically cutting off further escape from chambers 16 and 34 thus maintaining constant the amount of pressure for which spring 32 is set. The degree of pressure attained in chamber 36 before plug 11^a is brought to lap position, will depend upon the degree of pressure maintained in chambers 16 and 34, being necessarily nearly as high as the pressure in said chambers, the friction of head 37 causing but a slight difference between the pressure thereabove and therebeneath. Therefore, since by lifting arm 20, greater pressure is maintained in chambers 16 and 34, it necessarily follows that such operation of arm 20 results in causing and maintaining a corresponding increase of pressure in chamber 36 and in the train pipe line leading from said cham-

ber 36. Conversely depressing arm 20 will cause a reverse operation of the parts to that just described, resulting in the air escaping from chamber 16 through groove 14 and port 14^b, thus lessening the pressure in chambers 16 and 34, causing piston head 37 to rise and allowing air to escape from chamber 36 through groove 14^a and release port 14^c, thus lessening the pressure in the train pipe line until the pressure in chamber 36 has decreased slightly below that in chamber 34 with the result that the pressure in chamber 34 depresses piston head 37 and brings the valve to the lap position shown in Fig. 2, thus stopping further reduction of the train pipe pressure. It will now be readily understood that a leakage from the train pipe will cause a reverse operation of that just described, automatically causing air to enter chamber 36 through ports 12^a and 15^a until the train pipe line is supplied with a pressure sufficient to lift piston head 37 to cut off further increase of pressure in the train pipe. If there is a steady leak from the train pipe, the port 12^a will remain open wide enough to supply the amount of the leak.

41 designates a governor of well known construction for controlling the action of the pump 1 by regulating the amount of steam admitted to the piston chambers of said pump through the steam supply pipe 42 to maintain the desired pressure in the main reservoir 2.

43 is a gage provided with a hand 44 for indicating the pressure admitted to said gage from main reservoir 2 through pipe 45. 46 is a hand on said gage for indicating the pressure supplied to the gage from the train pipe through pipe 47.

Having now described the means for maintaining the desired pressure in the main train pipe 9, means will next be described for automatically maintaining a proportional equalization between the pressure in the train pipe line and the pressure in the brake cylinders when the brakes are in operation. This is accomplished by providing a triple valve constructed to automatically feed air to the brake cylinders from the main train pipe in such quantities as to maintain, for example, one-half as much air pressure in the brake cylinders as in the train pipe. If desired, the triple valve for this purpose may be provided with operating means so constructed as to maintain one third or other fractional part of pressure in the brake cylinders to that maintained in the train pipe, but in the drawings we have illustrated a valve for maintaining approximately one-half as much pressure in the brake cylinders as exists in the train pipe.

Referring to Figs. 1, 3, 4, 5 and 8, 48 designates the main piston cylinder of the triple

valve, said cylinder containing two piston heads, 49 and 50, fastened together at a distance from each other by a connecting rod 51. As shown in Fig. 5 of the drawings, head 49 is secured to the left end of said rod and the head 50 is secured to the right end thereof. The cylinder 48 is provided with a bore, preferably lined with brass bushings, 52 and 53, bushing 52 being adapted to fit a bore extending throughout substantially the left half of chamber 48 and bushing 53 being formed to fit a larger bore, extending throughout substantially the right half of cylinder 48. The cross sectional area included by bushing 52 is, as shown in Fig. 5, one-half the cross section of the area included by the bushing 53. Piston heads 49 and 50 divide cylinder 48 into three chambers, a train pipe chamber, 54, the central chamber 55 and an equalizing chamber 56. The central chamber 55 occupies the space between heads 49 and 50. Train pipe chamber 54 occupies the space partitioned off at the small end of the cylinder by the small piston head 49. Said train pipe chamber 54 is supplied from the train pipe 9 by supply pipe 90 and inlet pipe 90^a. (See Fig. 1.) Equalizing chamber 56 is partitioned off at the large end of the cylinder by the piston head 50. The capacity of equalizing chamber 56 is desirably augmented by the addition thereto of an enlargement 57 (see Fig. 1). Said enlargement 57 is preferably formed as a part of the cylinder head 58, said head being secured to the cylinder by any suitable means as by the screws 59. 60 designates the small head at the left end of the cylinder, secured thereto by screws 61. Connecting rod 51 for securing together piston heads 49 and 50 is provided with a central slot 62 having a contracted central portion, as indicated by dotted lines in Fig. 5 to receive valve operating arm 63 which extends radially from plug 64. There is a slight play between said arm 63 and the narrowest part of slot 62, in order that said arm 63 may be deflected with relation to rod 51 to an extent indicated by the dotted lines, showing the extent of reciprocation of arm 63.

The operating means of the triple valve having now been described, reference will next be made to the construction of its valvular means proper.

64 designates a hollow, open-ended valve plug within the casing 65. Air is admitted to the small end of said plug from the outer end of train pipe chamber 54 by means of duct 66 (see Fig. 3) which communicates with the end valve casing port 67 leading into the interior of valve plug 64. Valve operating arm 63 reciprocates through slot 68. Radial supply port 69 in valve plug 64 registers with the right end of slot 68, in the position shown in Figs. 5 and 7. Said

port 69 is preferably in the form of an elongated slot, as shown in Fig. 12. Plug 64 is provided on the side thereof nearly opposite to radial port 69 with a segmental groove 70 (see Fig. 13). Said groove 70 registers with the left end of arm slot 68, when the parts are in the positions shown in Figs. 16 and 18 to establish communication between chamber 55 and the outer atmosphere by means of casing port 70^a. Plug 64 is also provided with a main release groove 71, formed as a broad depression in the side of the plug, as shown in Fig. 12. Casing port 72 leads from the valve to pipe 73, said pipe 73 leading to the brake cylinder 74 of that car.

It is to be understood that, ordinarily, the valvular means and operating means therefor now being described, serve to regulate the admission of air to a single brake cylinder, as shown in Fig. 22; but in Fig. 1, which shows the equipment for the driver brakes and truck brakes of an engine, 74 designates the brake cylinder for the truck brakes and 75 the brake cylinder for the driving brakes. In said figure a branch pipe 76 leads from the pipe 73 to the brake cylinder 75 of the driver brakes.

Returning again to the construction of the valve, 77 is a casing port leading to the outer atmosphere. In Fig. 5, the valve plug is in a position to establish communication between the brake cylinder and the outer atmosphere through supply-and-release port 72, release groove 71 and release casing port 77.

For the purpose of applying the brakes quickly in case of an emergency, plug 64 is provided with emergency groove 78. When the plug 64 is in the position shown in Fig. 6, said groove 78 establishes communication between the brake cylinder and emergency reservoir 79. Said reservoir 79 communicates with the casing port 80 through pipe 81, which branches off from emergency-and-supply pipe 82, as shown in Fig. 1. While casing port 80 is in communication with the left end of groove 78, casing port 83 is in communication with the right end of said groove, and said casing port 83 communicates, by way of branch pipe 84 with the brake cylinder pipe 73. The ports and grooves thus far described are all cut through by the section line X^c of Figs. 10 and 12.

For the purpose of establishing communication between equalizing chamber 56 and the brake cylinder during certain positions of the valve, as hereinafter explained, ports and grooves are provided as will next be described.

In passing from equalizing chamber 56 to the brake cylinder 74 air escapes through opening 85 into duct 86, (see Fig. 4) which extends along the side of cylinder 48; thence

through duct 86 (see dotted lines Fig. 10) to equalizing port 87, best shown in Figs. 11, 7, 17 and 19, thence, if the plug is in the position shown in Fig. 19, through equalizing groove 88 to the right end of supply-and-release port 72 (see Fig. 9); thence to pipe 73 leading to the brake cylinder. Supply-and-release port 72 communicates with a short groove 72^a, as shown in Fig. 19, in order that there may still be communication between equalizing groove 88 and supply-and-release port 72, when the plug has further rotated from the position shown in Fig. 19 to that shown in Fig. 17. At all times when it is necessary to have communication between the brake cylinder and equalizing chamber 56, such communication is afforded by reason of equalizing groove 88 establishing communication between equalizing port 87 and supply-and-release port 72 or its grooved extension 72^a.

Supply port 69 is in the form of a long slot through the wall of the plug, as shown in Fig. 12, and supply-and-release port 72 is also elongated, as indicated in Figs. 10 and 11, so that its ends substantially coincide with the ends of port 69. In Fig. 10, the full lines show the size and shape of port 72 in the surface of flange 89 and the dotted lines at the ends of said port indicate its size when it reaches the valve plug. Ports 77, 80 and 83 are also elongated, longitudinally of the plug. It is not absolutely necessary that the various slots be of the length illustrated but such construction is desirable in order that as wide an opening should be provided for as possible with a small circumferential movement of the plug.

For the purpose of establishing and cutting off communication between train pipe chamber 54 and equalizing chamber 56 in a manner that will be hereinafter more fully described, main cylinder 48 has formed along the side thereof a full-release duct 100. Passage of air through said duct is controlled by full-release valve 101, whose function is to prevent air from passing from train pipe chamber 54 to equalizing chamber 56 after the air has exceeded a predetermined amount to which the pressure must be raised before the parts are positioned for applying the brakes. For this purpose said valve 101 is provided with a disk 102 which seats on the lower side of an annular valve seat 103. When the disk is in the depressed position shown in Fig. 4, air can enter from the train pipe chamber, as indicated by the arrow, and pass up around the edges of disk 102, but when said disk rises, further entrance of air to the equalizing chamber is shut off. In order to provide means whereby increase of pressure will seat the valve, disk 102 is suspended from diaphragm 104 by means of stem 105, said diaphragm and disk being preferably spaced apart by an

enlarged portion 106 of stem 105, said enlarged portion being interposed between the diaphragm and the disk. The disk is held against the lower end of the enlargement by
 5 nut 107 and the diaphragm is clamped between the upper end of the enlargement and a nut 108. The coil spring 109, under the pressure of a follower 110 and adjusting screw 111, augments the opposition of diaphragm 104 to the tendency of the air there-
 10 under to lift the same, thereby making greater pressure necessary to bring disk 102 to its seat.

112 is a cap for covering the upper portion 15 114 of the valve casing, said cap being screwed on to the casing and provided with a threaded central bore, engaged by the threads of adjusting screw 111. A hole 112^a is desirably provided through cap 112 to
 20 prevent the occurrence of air pressure above the diaphragm in case of air leaking past said diaphragm.

It will be seen that the parts of the valve may be so adjusted that a predetermined
 25 pressure of air beneath diaphragm 104 will seat the valve, such adjustment being accomplished by screwing the adjusting screw 111 down the requisite distance. Such adjustment will ordinarily be to between 10 and
 30 15 pounds pressure per square inch. If valve 101 is so adjusted as to seat at a pressure of 12 pounds beneath the diaphragm, then after said valve has once seated, it will remain seated even though the pressure be-
 35 tween the diaphragm and the disk should be decreased to less than 12 pounds, because when the disk is seated the pressure thereunder will operate to hold the valve closed without the assistance of the diaphragm.
 40 When however, the pressure beneath the disk falls to less than 12 pounds, the spring will open the valve.

The upper portion 114 of the valve casing is clamped down against the top of the edges
 45 of the diaphragm by screws 115. The valve disk is guided in its movements by a hollow downward extension 116 into which the end of stem 105 projects.

In order to prevent air from escaping
 50 from equalizing chamber 56 through duct 100, said duct 100 is provided with a check valve 117 of any desirable construction. In Figs. 4 and 8 said valve is shown mounted in a casing 118 provided with a circumferential
 55 swell 119, said swell forming an annular shoulder at its lower side on which the valve disk 120 seats, when the valve is closed. Disk 120 is mounted on the middle portion of a stem 121, said stem playing at its upper
 60 end in a bore in cap 122 and playing at its lower end in a hollow extension 123.

When the brakes are in full release, there being a pressure of, for example, 10 pounds
 65 in the train pipe line, the position of the ports and piston heads will be that shown

in Figs. 5 and 7. Valve 101 will then be open as shown in Fig. 4. Port 69 will also be open affording communication between central chamber 55 and the interior of valve
 70 plug 64. The pressure will now be the same in chambers 54, 55 and 56 as in the train pipe line. If now, the pressure in the train pipe be raised to, say 15 pounds, such pressure will close valve 101, thereby cutting
 75 off communication between train pipe chamber 54 and equalizing chamber 56. Then if the pressure in the train pipe be increased, pressure will also be increased in train pipe chamber 54 and (through the interior of valve plug 64 and port 69) also in central
 80 chamber 55 but not in equalizing chamber 56. The result will be that piston heads 49 and 50 together with rod 51 and valve arm 63 will be moved to the right, the air in chamber 56 and its enlargement 57 yielding to and being compressed by the in-
 85 crease of pressure to the left of piston head 50. As soon as the piston heads have carried valve arm 63 a short distance to the right, the end of groove 88 is brought into
 90 communication with equalizing port 87 (Fig. 19 shows approximately this position) and immediately following such position of groove 88 and port 87, port 69 is shut off from, and groove 70 is brought into com-
 95 munication with, central chamber 55 (see Fig. 18), thereby cutting off further supply of air from the train pipe to the central chamber and permitting the air to escape from said chamber through the casing port
 100 70^a. Pressure having thus been released from the right of piston head 49 and from both sides of piston head 50, the pressure to the left of piston head 49 moves rod 51 and valve stem 63 quickly to the right until
 105 the valve plug rotates to, or nearly to, the position shown in Figs. 16 and 17. Port 69 is now in register with port 72 and air is therefore permitted to rush from the train pipe through the interior of valve plug 64
 110 out from said plug through ports 69 and 72 to the brake cylinder. When the parts are in this position there is still communication between equalizing ports 87 (to the equalizing chamber) and supply port 72 (to brake
 115 cylinder) because groove 88 still registers with extension groove 72^a of port 72 and said groove 88 is also in communication with equalizing port 87. There will, therefore, at such time be a communication between the
 120 equalizing chamber 56 and the brake cylinder 74, with the result that increase of pressure in the brake cylinder will be accompanied by a corresponding increase of pressure in the equalizing chamber. Therefore,
 125 owing to the area of piston head 50 being twice that of piston head 49, when sufficient air has passed from the train pipe to the brake cylinder to cause the pressure in the equalizing chamber to become slightly more
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than half that in train pipe chamber 54, the piston heads will be moved toward the left, bringing valve plug 64 to lap position shown in Figs. 18 and 19, shutting off port 69 from port 72 and stopping the increase of pressure in the brake cylinder when it becomes half, or slightly more than half that in the train pipe line. While the valve plug is in said lap position, communication still exists between the brake cylinder and equalizing chamber 56 through equalizing groove 88 which is in the position shown in Fig. 19. Therefore leakage from the brake cylinder will reduce the pressure in the equalizing chamber so that it will not be sufficient to oppose the pressure against head 49 in train pipe chamber 54 with the result that the pistons will move toward the right repeating the above described operation of admitting air from the train pipe to the brake cylinder, when the pressure in the equalizing chamber and brake cylinder falls below the proportional amounts corresponding to the different areas of the two piston heads in the operating cylinder. But if there is a steady leak from the brake cylinder, there will be a reduction of pressure in the equalizing chamber corresponding to the reduction in the brake cylinder, which will cause the piston heads to move toward the right and rotate the valve to a position in which port 69 will cause and maintain an opening into casing port 72 equal to the extent of the leak. Air will be supplied to the brake cylinder of each car of the train from the interior of the valve plug of that car in sufficient quantities to maintain the same pressure in the leaky as in the perfect cylinders. The proportion between the pressures in the brake cylinder and the section of the train pipe pertaining to each car is predetermined by the proportional areas adopted for the piston heads 49 and 50 when the apparatus is constructed.

In case it is desired to reduce the pressure in the brake cylinders, a reduction of the pressure is made in the train pipe line, with the result that the pressure on the left side of small piston head 49 is lessened while the pressure on the right side of piston head 50 remains the same. Therefore, piston head 50 moves the piston to the left, rotating the valve plug in a clockwise direction from the position shown in Fig. 18 until release groove 71 registers with casing ports 72 and 77, coming to, or nearly to the position shown in Fig. 5, thus allowing air to escape from the brake cylinder. While air is escaping to the outer atmosphere, from the brake cylinder reducing pressure therein, pressure is also being reduced in the equalization chamber which is, at such times, also in communication with the outer atmosphere, such communication being through duct 86 (see Figs. 4, 8 and 10),

equalizing port 87, equalizing groove 88 of the plug, supply-and-release port 72, release groove 71 and release port 77.

Ordinarily, the reduction made in the train pipe for the purpose of making a partial release of the brakes, will only bring the lower end of release groove 71 partially across supply-and-release port 72, and will not be so great as to bring port 69 into register with port 68 of the central chamber. But if a very great reduction is made, the valve operating arm 63 may move to the position shown in full lines in Fig. 5, thus putting the central chamber momentarily into communication with the train pipe line through the supply port 69. There will, however, immediately follow a movement of the piston to the right, which will again shut off communication between the train pipe and the central chamber, because the pressure momentarily admitted to said chamber will operate more strongly upon the large piston head 50 than upon the small piston head 49; and there is at this time less pressure on the right side of large piston head 50 than upon the left side thereof. This movement will bring the valve back toward its original position, but will not entirely shut off communication between the supply-and-release port 72 and release groove 71 until the proper reduction has been made in the brake cylinder. During the braking operations just described, sufficient pressure is maintained in the train pipe to keep valve 101 (see Fig. 4) seated so that there is no communication between the train pipe chamber and the equalizing chamber by way of duct 100. The differential piston heads 49 and 50 will not continuously remain so far to the left as to maintain port 69 in register with the central chamber 55, until after the parts have been brought to the full release position. To bring the brakes to the full release position, the train pipe pressure is lowered to ten pounds thus allowing full release valve 101 to leave its seat and establish communication between train pipe chamber 54 and equalizing chamber 56 by way of duct 100. The same pressure is now registered in equalizing chamber 56 as in train pipe chamber 54 with the result that, on account of the greater area of piston head 49 (up to this time port 69 is closed from central chamber 55 and exhaust is afforded through groove 70), both piston heads move toward the left until release port 70 is shut off from central chamber 55 and port 69 opens to said chamber, thus putting the train pipe pressure between the piston heads and maintaining the piston heads stationary by reason of balanced pressures. Air can now freely escape from the brake cylinder by way of port 72, groove 71, and port 77.

Provision is made for automatically applying the brakes in case of an emergency, as for example, the parting of the train and the consequent breaking of the train pipe line. In such an event the pressure in the train pipe line will be reduced to zero and the air in the reservoir formed by equalizing chamber 56 and its enlargement 57 (said air being retained by check valve 117) will expand against the right end of piston head 50, throwing the piston to the extreme left hand position, thus bringing the valve plug to the position shown in Fig. 6 and making communication between emergency reservoir 79 and the brake cylinder by reason of emergency groove 78 registering with casing ports 80 and 83. The emergency and supply pipe 82 for supplying air to emergency reservoir 79 is provided with a check valve 125 which prevents air from escaping from the emergency reservoir back to the train pipe through the supply pipe 90. Said check valve 125 may be of any suitable construction, but a desirable form of valve is shown in Figs. 14 and 15. Referring to said figures, 126 designates the annular valve seat and 127 a plunger forming the valve proper. 128 are grooves extending down around the sides of said plunger to points on a level with the seat. When pressure below the valve exceeds that above it, air enters through the inlet 129, raises the plunger from its seat allowing air to pass upwardly around the sides of the plunger through grooves 128 and thence to outlet 130. 131 is a nut screwing into the top of the valve to close the same. When the train is assembled and the train pipe line coupled up, the fluid pressure applied from the engine will pass from the main train pipe 9 through each of the branch pipes 90 past check valves 125 to the emergency reservoirs 79, which are thus usually charged to a pressure of 100 pounds or more. The operation of filling the emergency reservoirs is necessarily accompanied by a setting of the brakes, because the triple valve will go through the operation already described which establishes communication between the train pipe and the brake cylinder, whenever the pressure is raised in the train pipe line sufficiently to seat valve 101 and then further increased. After the brakes have been set, and emergency reservoirs charged as described the train pipe pressure will be lowered thus releasing the brakes. Check valves 125 will then retain the pressure in the emergency reservoirs. In order to throw the parts to emergency position, which has already been described, the engineer will throw his pilot valve 7 wide open to the atmosphere, thus putting the main valve 4 wide open to the atmosphere, causing quick reduction of the air in the train pipe.

For high speed passenger trains, we provide a straight air emergency as well as automatic emergency. For this purpose a straight air emergency pipe 132, leading from train pipe 9 to each brake cylinder pipe 73, is provided, said pipe 132 passing through a balanced valve 133, as shown in Fig. 22, to prevent air from entering the brake cylinders until it reaches a predetermined pressure in the train pipe. Balanced valve 133 is similar in general construction to full release valve 101 already described (see Fig. 4), except that it seats downwardly instead of upwardly. Said balanced valve is, therefore, not described in detail excepting wherein it differs from valve 101. Referring to Figs. 22 and 21, said balanced valve 133 has an annular seat 134 upon which seats a valve disk 135, there being a space around the edges of said disk so that when the same is raised air escapes from the inlet port 136 up around the edges of said disk 135 and out through the outlet port 137 into the section of pipe 132 which leads by way of pipe 73 to the brake cylinder 74. Adjusting screw 111^a is screwed down sufficiently to put a pressure of upward of 90 pounds upon the disk 135. It will now be seen that by throwing on a heavy pressure in the train pipe line, the disk 135 will be raised against the opposition of spring 109^a and will allow air to pass from the train pipe line directly to the brake cylinder. Owing to valve 133 being a balanced valve, when the valve once opens under a pressure of, say 100 pounds in the train pipe line, said valve will be thrown to a wide open position and will remain wide open, quickly admitting an inrush of air from the train pipe directly to the brake cylinder. The valve is maintained wide open by reason of the pressure acting upon the lower side of diaphragm 104^a after disk 135 has been raised from its seat.

Valve 133 for use in making straight air emergency application of the brakes is not shown in Fig. 1 because said figure only includes the braking appliances for the wheels of the portion of the engine forward of the tender. The straight air emergency should not be employed in connection with the driver wheels of the locomotive as it would be more apt to injure the tires of such wheels than it would be to injure the wheels of the cars. It is a rule in railroading to apply brakes to the wheels of the engine as seldom as possible so as to avoid danger of overheating and loosening the tires of the driver wheels thus disabling the engine. This invention overcomes a defect in braking systems now in general use by providing means for continuously applying the brakes of the cars during the descent of long grades making it unnecessary to apply the engine brakes at intervals to help hold back the train

while the auxiliary reservoirs are being recharged. Although there is about 10 pounds pressure in the train pipe when full release valve 101 closes, there is at such time only
 5 five pounds pressure in the brake cylinders so that the brakes are but lightly applied when the ports approach the full release position. Another advantage of having a ratio of pressure between the train pipe and
 10 the brake cylinder with the smaller amount of pressure in the brake cylinders is that such an arrangement makes it possible to regulate more accurately the pressure in the brake cylinders as will be evident when it is
 15 noted that an increase of pressure of 10 pounds, for example, in the train pipe line will cause an increase of only 5 pounds in the brake cylinders when the piston heads are proportioned to each other as shown in
 20 the drawings. It is evident that with an arrangement whereby a relatively large amount of air is admitted from the supply to the train pipe to increase the pressure in the brake cylinders 1 pound the engineer is not
 25 so apt to throw on an excessive pressure as he would be if the admission of a smaller additional amount of air to the train pipe raised the pressure in the brake cylinders 1 pound. Conversely, the pressure may be
 30 lowered in the brake cylinders in a more gradual and satisfactory manner by the means for maintaining the proportional pressures if there is a less pressure in the brake cylinder.

35 In Fig. 20 is shown a modified form of valvular means for automatic emergency. In this figure the valvular means comprises two members, a primary valve member similar in general construction to that shown in
 40 Fig. 5, but having a somewhat different plug designated as 64^a in Fig. 20; and a secondary valve member operatively connected with the primary member as hereinafter described. 138 is a narrow segmental plug
 45 groove (see Fig. 23) for affording communication, when in its right hand position between equalizing port 87 which leads to the equalizing chamber, and port 140 which is in communication with a cylinder 141 of the
 50 secondary valve member. In said cylinder 141, is a large piston head 142 having a short upwardly projecting stem 143 carrying a small upper piston head 144, working in a small extension 145 of cylinder 141. Stem
 55 143 is extended by an upright extension 146, said extension carrying at its upper end a valve disk 147 seating downwardly on an annular valve seat 148. One advantage obtained by using the valvular means illustrated in Fig. 20 for controlling the currents of air is that the plug 64^a is of the nature of a pilot valve and therefore the groove 138 can be made comparatively narrow causing
 60 less pressure upon said plug and less friction than is caused by a larger groove such as

must be provided if the plug directly controls the admission of air to the brake cylinders. 149 is the port communicating with the emergency reservoir, and 150 the port communicating with the brake cylinder.
 70 151 designates a series of downwardly extending lugs ranged around the mouth of port 149 to provide air spaces above valve disk 147 when said disk is in its uppermost position, so that air can pass down around the disk when the valve is fully open.
 75 When plug 64^a is rotated to the emergency position, communication is established between the equalizing chamber and the cylinder 141 by way of equalizing port 87, groove 138 and port 140. Air from the equalizing chamber will then raise piston head 142 and unseat valve disk 147, allowing
 80 air to pass from the emergency reservoir through pipe 81^a, ports 149 and 150 and pipe 84^a, to the brake cylinder. Whenever the valve plug 64^a is not in emergency position, the groove 138 is in the release position shown in Fig. 20 or farther to the left of that position.
 85 When the plug is in a release position, air may escape from cylinder 142 by way of port 140, groove 138 and discharge port 152. A release position is maintained throughout all positions of valve arm 63 to the right of that shown in full lines in Fig. 5, thus eliminating all danger of communication between the emergency reservoir and the brake cylinder caused by leakage from plug 64^a to cylinder 141. 141^a is relief port to maintain atmospheric pressure above piston head 142 at all times.
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For the purpose of enabling conductors on passenger trains to apply the brakes in case of emergency, each car may be furnished with means communicating with an intermediate portion of the train pipe to release
 105 pressure therefrom. Such means may consist of a conductor's pipe 155, having a conductor's emergency valve 156. When the conductor wishes to apply the brakes in case
 110 of an emergency he opens said valve 156 and thereby empties the train pipe, thus applying the brakes in the same manner as they would be applied by the train parting and the train pipe breaking, as has already
 115 been described. On freight trains the conductor's pipe and release valve will be provided on the caboose only. If the train parts while the apparatus is not in the emergency position, the reduction of the
 120 pressure to, or nearly to, zero causes the piston heads to move to the extreme left position and applies the air from the emergency reservoirs to set the brakes as already explained. If, however, the conductor, in order
 125 to prevent threatened collision or for some other reasons wishes to stop the train suddenly, he will fully open the conductor's valve 156, thereby reducing the pressure in the train pipe line to zero or nearly
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zero so as to apply the brakes in the same manner as if the train line had parted. But as soon as he has applied the brakes in this manner he may again close valve 156, thus
 5 allowing pressure in the train pipe to be restored to what it was before. If the pressure in the train pipe, when restored, is that required for the running position, the brakes will not be released until the engineer raises
 10 the pressure in the train pipe sufficiently to close full release valve 101, thus throwing the parts to a position that would apply the brakes, (if they were not already applied) and also recharging the emergency reser-
 15 voirs through branch pipes 90 and 82 through check valve 125, thereby restoring the air to the emergency reservoirs which were exhausted when the conductor operated the valve. Thus it will be seen that the parts
 20 are constructed to operate in such a manner that it will be practically impossible for the train crew to start the train after it has been stopped in case of emergency without first charging the emergency reservoirs.

25 For the purpose of shutting off communication between the train pipe and the braking equipment of a car in case of an accident to the brake rigging (not shown), a stop cock 157 is provided on branch pipe 90
 30 near the train pipe. In order to cut off communication between the train pipe and emergency reservoir 79 only, in case of accident to said reservoir or its piping, stop cock 158 may be provided, as shown, in Figs. 1 and
 35 22. When said stop cock 158 is added to the apparatus, it makes it possible to cut off the emergency reservoir without interfering with the regular braking of the train by the application of straight air. In the latter
 40 case stop cock 157 will be left open, while stop cock 158 is closed. In Fig. 22, 161 designates one of the train line stop cocks. Engine brake cylinder 74 may be cut off from communication with the rest of the
 45 apparatus by a stop cock 159. The driver brake cylinder 75 of the engine may also be isolated from the rest of the apparatus by a stop cock 160 on pipe 76, as shown in Fig. 1.

50 It is to be understood that various forms of valvular means may be operated by the piston heads 49 and 50 and that the invention is not limited to the particular kind of valves shown for controlling the passage of
 55 air from the train pipe line to the brake cylinder, or for controlling the passage of air from the emergency reservoir to the brake cylinder. Neither do we limit ourselves to the particular arrangement of piston heads
 60 49 and 50 illustrated in the drawings, because the invention relates broadly to a construction employing piston heads of different areas constructed and arranged to be operated by pressure from the train pipe

line and brake cylinders to actuate the valve 65 or valves employed to control the air currents.

We claim:

1. An air brake apparatus comprising a single train pipe, a brake cylinder, an auto- 70 matic pressure controlled means actuated by an increase of train pipe pressure to admit air to the brake cylinder and also actuated by the brake cylinder pressure alone to close communication between the train pipe and 75 the brake cylinder when the brake cylinder pressure reaches a predetermined point below the train pipe pressure.

2. In combination, a single train pipe, supply means for said pipe, a brake cylinder, 80 a valve to control the supply from said pipe to said cylinder to apply the brakes by an increase in train pipe pressure, and means adapted to automatically open said valve when the pressure in said pipe exceeds a 85 predetermined constant proportion to that in said cylinder.

3. In combination, a train pipe, supply means for said pipe, a brake cylinder, means for supplying said cylinder from said pipe, 90 and automatic means operated by brake cylinder pressure for lessening the pressure in said cylinder during a reduction of pressure in said pipe, said automatic means being adapted to maintain in said cylinder a pres- 95 sure below the pressure in the train pipe and having a fixed ratio to the pressure in said pipe.

4. In combination, a train pipe, supply means for said pipe, a brake cylinder, means 100 for supplying said cylinder from said pipe, and automatic means for increasing the pressure in said cylinder during an increase of pressure in said pipe, said automatic means being operated by brake cylinder pressure 105 and adapted to maintain in said cylinder a pressure below the pressure in the train pipe and having a fixed ratio to the pressure in said pipe.

5. In combination, a fluid supply, a train 110 pipe fed therefrom, a brake cylinder, valvular means to control the supply of fluid from said pipe to said cylinder, an operating cylinder, a piston therein, means operatively connecting said piston to said valvular 115 means, and means automatically regulating the pressure upon said piston to operate said valvular means, said pressure regulating means being actuated by a difference in pressure between the fluid in the train pipe and 120 in the brake cylinder.

6. In combination, fluid supply, a train 125 pipe fed therefrom, a brake cylinder communicating with said train pipe, valvular means to control the communication between said train pipe and said brake cylinder, a piston cylinder having sections of different diameter, a piston having a head fitting each

of said sections and a rod connecting said heads, means operatively connecting said piston with said valvular means to operate the same, means for automatically supplying and cutting off communication between the train pipe line and both sides of the large piston head, and means for admitting pressure from the train pipe to the outer side of the small piston head.

10 7. In combination, a fluid supply, a train pipe fed therefrom, a brake cylinder, valvular means operated by train pipe pressure to control the supply of fluid from said pipe to said cylinder, an operating cylinder, a
15 piston in said operating cylinder and means operatively connecting said piston to said valvular means, said piston having heads of different areas, one of said pistons being subject to train pipe pressure and one being
20 subject to brake cylinder pressure, whereby brake cylinder pressure will overcome the train pipe pressure when the predetermined relative pressures in the train pipe and brake cylinder are secured.

25 8. In combination, a fluid supply, a train pipe fed therefrom, a brake cylinder communicating with said train pipe, an emergency reservoir communicating with said
30 brake cylinder, a piston cylinder communicating with said train pipe, a piston in said piston cylinder, valvular means adapted to establish and cut off communication between said train pipe and said brake cylinder and
35 between said emergency reservoir and said brake cylinder, and means operatively connecting said piston with said valvular means, said valvular means including a hollow plug, the interior of which is in communication with the train pipe, said plug having a port
40 adapted to establish and cut off communication between the interior thereof and said piston chamber.

9. In combination, a fluid supply, a train pipe fed therefrom, a brake cylinder communicating with said train pipe, an emergency reservoir communicating with said
45 brake cylinder, a piston cylinder communicating with said train pipe, a piston in said piston cylinder, valvular means adapted to establish and cut off communication between
50 said train pipe and said brake cylinder and between said emergency reservoir and said brake cylinder, and means operatively connecting said piston with said valvular means, said valvular means including a hollow plug, the interior of which is in communication with the train pipe, said plug having a port
55 adapted to establish and cut off communication between the interior thereof and said piston chamber and a segmental exterior groove adapted to establish and cut off communication between said piston cylinder and the outer atmosphere.

10. In combination, a fluid supply, a train

pipe fed therefrom, a brake cylinder, an
65 emergency reservoir communicating with said brake cylinder, a piston cylinder communicating with said train pipe, a piston in said piston cylinder, valvular means adapted to establish and cut off communication between
70 said emergency reservoir and said brake cylinder, said valvular means comprising two members operatively connected, and means operatively connecting one of said members with said piston, the other
75 member being adapted to establish and cut off communication between said emergency reservoir and said brake cylinder.

11. In combination, a fluid supply, a train pipe fed therefrom, a brake cylinder, an
80 emergency reservoir communicating with said brake cylinder, a piston cylinder communicating with said train pipe, a piston in said piston cylinder, valvular means adapted to establish and cut off communication between
85 said emergency reservoir and said brake cylinder, said valvular means comprising a primary valve and a secondary valve, pressure-operating means controlled by said primary valve to operate said secondary
90 valve, and means operatively connecting said piston with said primary valve, said secondary valve being adapted to establish and cut off communication between said emergency reservoir and said brake cylinder.
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12. In combination, a fluid supply, a train pipe fed therefrom, a brake cylinder, an emergency reservoir communicating with
100 said brake cylinder, a piston cylinder communicating with said train pipe, a piston in said piston cylinder, valvular means adapted to establish and cut off communication between said emergency reservoir and said brake cylinder, said valvular means comprising
105 a primary valve and a secondary valve, a piston cylinder for said secondary valve, a secondary valve piston in said cylinder, means controlled by said primary valve for supplying and cutting off pressure from said secondary valve piston, and means operatively
110 connecting said primary valve with the first named piston, said secondary valve being adapted to establish and cut off communication between said emergency reservoir and said brake cylinder.
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13. In combination, a fluid supply, a train pipe fed therefrom, a brake cylinder, an emergency reservoir communicating with
120 said brake cylinder, a piston cylinder communicating with said train pipe, a piston in said piston cylinder, valvular means adapted to establish and cut off communication between said emergency reservoir and said brake cylinder, said valvular means comprising
125 a primary valve and a secondary valve, a piston cylinder for said secondary valve, a large piston head in said last named piston cylinder, a stem projecting from one side

of said large piston head, a smaller piston head carried by said stem, the piston cylinder being provided with a contracted extension wherein said smaller piston head operates, an extension projecting from the side of said smaller piston head opposite said large piston head, a valve disk, said extension being operatively connected with said valve disk to operate said secondary valve for controlling communication between said emergency reservoir and said brake cylinder, and means operatively connecting said primary valve with the first named piston.

14. In combination, a fluid supply, a train pipe fed therefrom, a brake cylinder communicating with said train pipe, valvular means to control the communication between said pipe and brake cylinder, a piston cylinder, two piston heads of different areas in said cylinder, a rod fastening said heads together at a distance from each other, an arm operatively connecting said rod with said valvular means, said piston heads dividing said piston cylinder into a central chamber between the piston heads, an equalizing chamber outside the large piston head, and a train pipe chamber outside the small piston head, a conduit affording communication between said train pipe chamber and said equalizing chamber, a conduit leading from said plug to said brake cylinder, and a train pipe conduit affording communication between said valvular means and said train pipe, said valvular means being adapted to establish and cut off communication between said train pipe conduit and said brake cylinder conduit.

15. In combination, a fluid supply, a train pipe fed therefrom, a brake cylinder communicating with said train pipe, valvular means to control the communication between said pipe and brake cylinder, a piston cylinder, two piston heads of different areas in said cylinder, a rod fastening said heads together at a distance from each other, said piston heads dividing said piston cylinder into a central chamber between the piston heads, an equalizing chamber outside the large piston head, and a train pipe chamber outside the small piston head, a conduit affording communication between said train pipe chamber and said equalizing chamber, a check valve in said conduit to prevent return of fluid from said equalizing chamber to said train pipe chamber, a full release valve closing said conduit when pressure therein exceeds a predetermined amount, an emergency reservoir, means for supplying fluid to said reservoir from the train pipe line, a conduit leading from said emergency reservoir to said valvular means, a conduit leading from said valvular means to said brake cylinder, said valvular means being adapted to establish and cut off communi-

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tion between said emergency reservoir conduit and said brake cylinder conduit, and a conduit leading from said equalizing chamber to said valvular means, said valvular means being adapted to control communication between said equalizing chamber conduit and said brake cylinder conduit, said valvular means being also adapted to control communication between said central chamber and the train pipe and between said central chamber and the outer atmosphere.

16. In combination, a train pipe, a supply reservoir to supply fluid under pressure to said train pipe, regulating means for supplying said train pipe from said reservoir, said regulating means being capable of adjustment to maintain different pressures in said train pipe, a brake cylinder, and automatic means positively moved in one direction by train pipe pressure and in opposition to train pipe pressure by the resulting brake cylinder pressure and adapted to maintain in said brake cylinder pressure below the pressure in the train pipe and having a fixed ratio to the pressure in said train pipe.

17. In combination, a train pipe, a supply reservoir to supply fluid under pressure to said train pipe, regulating means for supplying said train pipe from said reservoir, said regulating means being capable of adjustment to maintain different pressures in said train pipe, a brake cylinder, and means to supply fluid from said train pipe to said brake cylinder, said means being positively moved in one direction by train pipe pressure and in opposition to train pipe pressure by the resulting brake cylinder pressure and being adapted to automatically admit fluid to said brake cylinder in quantities to maintain in said cylinder pressure below the pressure in the train pipe and having a fixed ratio to that in said train pipe.

18. In combination, a fluid supply, a train pipe terminating thereat and fed therefrom, a plurality of brake cylinders, a plurality of valvular means to control the supply of fluid from said train pipe to said brake cylinders, an operating cylinder for each valvular means, a piston in each of said operating cylinders, means operatively connecting each operating piston to its valvular means, an emergency reservoir communicating with each brake cylinder, said valvular means being adapted to establish communication between said emergency reservoirs and said brake cylinders when said train pipe is emptied of its fluid pressure, means at the aforementioned terminus of the train pipe for releasing pressure therefrom, and means communicating with an intermediate portion of said train pipe for releasing pressure therefrom.

19. The combination with a train pipe line, brake cylinder, emergency reservoir, and conduits thereof, of a hollow valve plug, and operating means therefor, said plug
5 having a port affording communication between the interior thereof and the train pipe, a radial port adapted to establish and cut off communication between the train pipe and the brake cylinder, and a segmental
10 groove adjacent said radial port adapted to establish and cut off communication between the brake cylinder and the outer atmosphere.

20. The combination with the train pipe line, brake cylinder, emergency reservoir, and conduits thereof, of a hollow valve
15 plug, an operating cylinder therefor, pistons having heads of different areas in said cylinder, means operatively connecting said pistons with said valve plug to rotate the same,
20 said pistons dividing said operating cylinder into three chambers, a train pipe chamber outside the smaller piston head, an equalizing chamber outside the larger piston head and a central chamber between said piston
25 heads, said plug having a port affording communication between the interior thereof and the train pipe and a radial port adapted to establish communication in an intermediate position between the interior of
30 said plug and said central chamber and to establish communication between the interior of said plug and said brake cylinder when said piston has moved from said intermediate position toward the end of the piston
35 chamber occupied by the larger piston head.

21. In combination, a fluid supply, a train pipe fed therefrom, a brake cylinder communicating with said train pipe, valvular
40 means to control the communication between said brake cylinder and train pipe, piston heads, and means operatively connecting said piston heads with said valvular means, said piston heads being impelled
45 in one direction by pressure from said train pipe and also in the opposite direction by the resultant pressure alone from said brake cylinder lower than the train pipe pressure and having a fixed ratio to said train pipe
50 pressure.

22. In combination, a fluid supply, a train pipe fed therefrom, a brake cylinder communicating with said train pipe, valvular
55 means to control the communication between said brake cylinder and train pipe, piston heads of different areas, and means operatively connecting said piston heads with said valvular means, said piston heads being actuated in one direction by pressure
60 from said train pipe and in the opposite direction by pressure from said brake cylinder, the smaller piston head being actuated by pressure from said train pipe.

23. In combination, a train pipe, a brake cylinder communicating therewith, an emer-

gency reservoir communicating therewith, 65
valvular means to control the communication between said train pipe and said brake cylinder and between said train pipe and said emergency reservoir and between the
70 said emergency reservoir and said brake cylinder, piston heads, and means operatively connecting said piston heads with said valvular means, said piston heads being impelled by pressure from said train pipe and
75 also by pressure from said brake cylinder.

24. The combination of a train pipe, a brake cylinder connected therewith, a valve to control communication between said train pipe and said brake cylinder, and means
80 operated by train pipe pressure to move said valve in one direction to place the train pipe in communication with the brake cylinder, and means operated by brake cylinder pressure alone lower than the train
85 pipe pressure but at a fixed ratio thereto to move the valve and close communication between the train pipe and the brake cylinder.

25. In an air brake apparatus the combination of a main storage reservoir, a train
90 pipe, a pressure-actuated valve controlling communication between the train pipe and the main reservoir said valve being closed by train pipe pressure, means for admitting storage tank pressure to open said valve,
95 and an automatically-operating means connected to said valve to admit a predetermined pressure from the storage tank to actuate the train pipe controlling valve.

26. In an air brake apparatus the combination of a main storage reservoir, a train
100 pipe, a pressure-actuated valve controlling communication between the train pipe and the main reservoir, said valve being adapted to be closed by train pipe pressure, a valve
105 for permitting storage tank pressure to open said train pipe controlling valve, automatically-operating pressure-controlled means to close communication between the main reservoir and the train pipe controlling
110 valve when a predetermined pressure is reached in the train pipe, and means for varying the degree of pressure required to close said valves.

27. In an air brake apparatus the combination of a main storage reservoir, a train
115 pipe, a train pipe controlling valve controlling communication between the train pipe and the reservoir and adapted to be moved in one direction by train pipe pressure and
120 in the other direction by storage tank pressure, and a pilot valve adapted to admit a predetermined amount of pressure from the storage reservoir to the train pipe-controlling valve to open said valve.
125

28. In an air brake apparatus the combination of a main storage reservoir, a train
pipe, a train pipe-controlling valve control-

ling communication between the train pipe and the reservoir and adapted to be moved in one direction by train pipe pressure and in the other direction by storage tank pressure, a pilot valve adapted to admit a predetermined amount of pressure from the storage reservoir to the train pipe-controlling valve to open said valve, and means whereby the pilot valve will be closed when the desired pressure has been admitted to the train pipe-controlling valve.

29. In an air brake apparatus the combination of a main storage reservoir, a train pipe, a train pipe-controlling valve controlling communication between the train pipe and the reservoir and adapted to be moved in one direction by train pipe pressure and in the other direction by storage tank pressure, a pilot valve adapted to admit a predetermined amount of pressure from the storage reservoir to the train pipe-controlling valve to open said valve, means whereby the pilot valve will be closed when the desired pressure has been admitted to the train pipe-controlling valve, and means for varying the amount of pressure required to close the pilot valve, whereby the train pipe pressure will equal the amount of pressure required to close the pilot valve.

30. An air brake apparatus comprising a train pipe, a brake cylinder, means actuated by train pipe pressure to admit air to the brake cylinder, and means actuated by brake cylinder pressure and operating against the train pipe pressure and at a lower degree of pressure to close communication between the train pipe and the brake cylinder when the brake cylinder pressure reaches a certain degree of pressure below the pressure in the train pipe.

31. In an air brake apparatus the combination of a main storage reservoir, a train pipe, a train pipe-controlling valve controlling communication between the train pipe and the reservoir and adapted to be moved in one direction by train pipe pressure and in the other direction by storage tank pressure, a pilot valve adapted to admit a predetermined amount of pressure from the storage reservoir to the train pipe-controlling valve to open said valve, means normally tending to open the pilot valve, means for varying the force exerted by the pilot valve opening means whereby the degree of pressure admitted to the train pipe-controlling valve may be varied.

32. In combination, a train pipe, means to vary pressure therein, a brake cylinder, and automatic means operated by brake cylinder pressure to maintain in said brake cylinder pressure less in amount and having a fixed ratio to the pressure in said train pipe.

33. In combination, a train pipe, means to vary pressure therein, a brake cylinder, and

automatic means to maintain in said brake cylinder pressure less in amount and having a predetermined proportion to the pressure in said pipe, said automatic means operating to put said brake cylinder into communication with the outer atmosphere upon the pressure in the train pipe being lowered below a predetermined point.

34. In combination, a train pipe, means to vary pressure therein, a brake cylinder, means providing a passage between said pipe and brake cylinder, automatic means controlling the flow of fluid through said passage to maintain in said brake cylinder pressure less in amount and having a predetermined proportion to the pressure in said train pipe, means for providing another passage from said train pipe to said brake cylinder, and a balanced valve to automatically put the train pipe into communication with said brake cylinder through said last named passage upon the pressure in the train pipe being raised above a predetermined point.

35. In combination, a train pipe, means to vary pressure therein, a brake cylinder, means providing a passage between said train pipe and brake cylinder, automatic means controlling the flow of fluid through said passage to maintain in said brake cylinder pressure less in amount and having a predetermined proportion to the pressure in said train pipe, means for providing another passage from said train pipe to said brake cylinder, and means operated by a rise of pressure in the train pipe to automatically put the train pipe into communication with said brake cylinder through said last named passage upon the pressure in the train pipe being raised above a predetermined point.

36. An air brake apparatus comprising a train pipe, a brake cylinder, means actuated by an increase of train pipe pressure to admit air to the brake cylinder, and means actuated by the brake cylinder pressure and working against the train pipe pressure to close communication between the train pipe and the brake cylinder when the brake cylinder pressure equals a certain percentage of the train pipe pressure, whereby the pressure acting to cut off the train pipe from the brake cylinder will vary in direct proportion to the variations of pressure in the train pipe.

37. An air brake apparatus comprising a train pipe, a brake cylinder, means to admit air from the train pipe to the brake cylinder for a service application of the brakes by a gradual increase in train pipe pressure, means connecting the train pipe to the brake cylinder to apply the brakes for an emergency application by a sudden and excessive increase in train pipe pressure, a supplemental reservoir, means connecting the supplemental reservoir to the

train pipe and means whereby the supplemental reservoir will be placed in communication with the brake cylinder by a sudden and excessive reduction in train pipe pressure.

38. An air brake apparatus comprising a single train pipe, a brake cylinder, a valve operated by an increase of train pipe pressure to admit a portion of train pipe pressure to the brake cylinder, a pipe connecting the train pipe to the brake cylinder, a valve in said pipe adapted to open and place the train pipe in direct communication with the brake cylinder to admit full train pipe pressure to the brake cylinder when the train pipe pressure exceeds a predetermined amount.

39. An air brake apparatus comprising a train pipe, a brake cylinder, a valve operated by an increase of train pipe pressure to admit a predetermined amount of train pipe pressure to the brake cylinder, pipe connecting the train pipe to the brake cylinder, a valve in said pipe adapted to open and place the train pipe in direct communication with the brake cylinder when the train pipe pressure exceeds a predetermined amount, an auxiliary reservoir connected to the train pipe and to the brake cylinder, and means whereby an excessive reduction of train pipe pressure will place the auxiliary reservoir in communication with the brake cylinder for an emergency application of the brakes.

40. An air brake apparatus comprising a train pipe, a brake cylinder, a valve, controlling communication between the brake cylinder and the train pipe, and operating under an increase of train pipe pressure to admit air at a reduced pressure to the brake cylinder, a pipe connecting the train pipe to the brake cylinder, a valve in said pipe adapted to open under a predetermined pressure to establish direct communication between the train pipe and the brake cylinder upon an increase of train pipe pressure to a predetermined amount.

41. An air brake apparatus comprising a train pipe, a brake cylinder, a valve, controlling communication between the brake cylinder and the train pipe, and operating under an increase of train pipe pressure to admit air at a reduced pressure to the brake cylinder, a pipe connecting the train pipe to the brake cylinder, a valve in said pipe adapted to open under a predetermined pressure to establish direct communication between the train pipe and the brake cylinder, an auxiliary reservoir, means connecting the auxiliary reservoir to the train pipe, and means connecting the auxiliary reservoir to the brake cylinder whereby upon an excessive reduction in train pipe pressure the auxiliary reservoir will be placed in direct

communication with the brake cylinder for an emergency application of the brakes.

42. An air brake apparatus comprising a train pipe, a brake cylinder, means controlled by train pipe pressure for admitting air to the brake cylinder, an equalizing chamber, means whereby said chamber will be simultaneously charged with the brake cylinder and at the same pressure, and means controlled by pressure in the equalizing chamber for cutting off communication with the brake cylinder and to said chamber when the pressure in the brake cylinder reaches a certain proportion to the pressure in the train pipe.

43. An air brake apparatus comprising a train pipe, a brake cylinder, pressure-actuated means for controlling communication between the train pipe and the brake cylinder, an equalizing chamber, means for simultaneously charging the brake cylinder and equalizing chamber and means actuated by pressure in the equalizing chamber and operating against train pipe pressure to close communication between the train pipe and the brake cylinder.

44. An air brake apparatus comprising a train pipe, a brake cylinder, an equalizing chamber, means actuated by pressure in the equalizing chamber and operating against train pipe pressure to control communication between the train pipe and the brake cylinder, and means for simultaneously charging the brake cylinder and the equalizing chamber.

45. An air brake apparatus comprising a train pipe, a brake cylinder, and automatic means actuated by fluid pressure from the train pipe and the brake cylinder to maintain in the brake cylinder a pressure below the pressure in the train pipe and having a fixed direct ratio to the pressure in the train pipe.

46. An air brake apparatus comprising a train pipe, a brake cylinder, and automatic means actuated by fluid pressure from the train pipe and the brake cylinder to maintain in the brake cylinder a fluid pressure less in amount and having a fixed ratio to the pressure in said train pipe.

47. An air brake apparatus comprising a train pipe, a brake cylinder, and automatic means adapted to be operated by an increase of fluid pressure in the train pipe to put the train pipe in communication with the brake cylinder for an application of the brakes, means adapted to be operated by fluid pressure lower than the train pipe pressure for cutting off communication between the train pipe and the brake cylinder and means for supplying fluid pressure to this latter device from the train pipe.

48. An air brake apparatus comprising a train pipe, a brake cylinder, means actuated

by an increase of fluid pressure in the train pipe to place said pipe in communication with the brake cylinder, an equalizing chamber, means for charging the equalizing chamber from the train pipe and at the same pressure as the brake cylinder and means actuated by fluid pressure in said equalizing chamber to cut off communication between the brake cylinder and the train pipe when the pressure in said chamber reaches a certain proportion to the pressure in the train pipe, said means also placing the brake cylinder to exhaust upon a reduction in train pipe pressure to release the brakes.

49. An air brake apparatus comprising a train pipe, a brake cylinder, an auxiliary reservoir, means actuated by an increase of fluid pressure in the train pipe to place said pipe in communication with the brake cylinder, an equalizing chamber, means for charging the equalizing chamber from the train pipe and at the same pressure as the brake cylinder and means actuated by fluid pressure in said equalizing chamber to cut off communication between the brake cylinder and the train pipe when the pressure in said chamber reaches a certain proportion to the pressure in the train pipe, said means also placing the brake cylinder to exhaust upon a reduction in train pipe pressure to release the brakes, and upon a further reduction in train pipe pressure to place the auxiliary reservoir in communication with the brake cylinder for an emergency application of the brakes.

50. An air brake apparatus comprising a train pipe, a brake cylinder, means actuated by train pipe pressure to open communication between the train pipe and the brake cylinder, means actuated by brake cylinder pressure to close communication between the train pipe and the brake cylinder, this latter means acting against the train pipe pressure and at a lower degree of pressure, whereby when the brake cylinder pressure equals a certain percentage of the train pipe pressure communication between the train pipe and the brake cylinder will be interrupted and whereby the brake cylinder pressure will be maintained equal to a certain predetermined percentage of the train pipe pressure.

51. An air brake apparatus comprising a train pipe, a brake cylinder, a rotatable valve, a train pipe chamber in communication with the train pipe, an equalizing chamber, means whereby the train pipe chamber and the equalizing chamber will be placed in communication with the brake cylinder through the rotatable valve, the train pipe chamber and the equalizing chamber being in direct communication with each other

through a suitable passage, a valve in said passage normally tending to open against train pipe pressure and arranged to be closed when said train pipe pressure exceeds a predetermined amount, a check valve in said passage to prevent the return of air from the equalizing chamber to the train pipe chamber, and means in the train pipe chamber and the equalizing chamber adapted to be moved by air pressure to operate the rotatable valve.

52. An air brake apparatus comprising a train pipe, a brake cylinder, a rotatable valve, a pair of pistons operatively connected to said valve and adapted to be moved by air pressure, one of said pistons being larger than the other, means for simultaneously supplying air under pressure to said pistons, said air pressure working in opposite directions whereby the pistons will oppose each other and whereby a lower degree of pressure on the larger piston will overcome the higher pressure on the smaller piston, and means whereby the rotatable valve will control communication between the train pipe and the brake cylinder and the chambers containing the pistons.

53. An air brake apparatus comprising a train pipe, a brake cylinder, a hollow rotatable valve controlling communication between the train pipe and the brake cylinder, and means adapted to be operated by variations in air pressure to oscillate the rotatable valve and thereby control communication between the train pipe and the brake cylinder and the atmosphere.

54. An air brake apparatus comprising a train pipe, a brake cylinder, an auxiliary reservoir, a hollow rotatable valve, and means operated by variations in air pressure in the train pipe to oscillate said valve and thereby control communication between the train pipe, brake cylinder and auxiliary reservoir and between the brake cylinder and the atmosphere.

55. An air brake apparatus comprising a train pipe, a brake cylinder, a hollow rotatable valve, a pair of differential pistons operatively connected to said valve to oscillate it and to thereby control communication between the train pipe and the brake cylinder and the atmosphere, whereby the rotatable valve will be held in its normal or lap position by differential pressures on the pistons.

56. An air brake apparatus comprising a train pipe, a brake cylinder, a triple valve, a train pipe chamber in communication with the train pipe, an equalizing chamber, means whereby the train pipe chamber and the equalizing chamber will be placed in communication with the brake cylinder through

the triple valve, the train pipe chamber and the equalizing chamber being in direct communication with each other through a suitable passage, a valve in said passage normally tending to open against train pipe pressure and arranged to be closed when said train pipe pressure exceeds a predetermined amount, a check valve in said passage to prevent the return of air from the equalizing chamber to the train pipe chamber, and means in the train pipe chamber and the

equalizing chamber adapted to be moved by air pressure to operate the triple valve.

In testimony whereof we have hereunto signed our names in the presence of two subscribing witnesses at Los Angeles, California, this 6th day of June, 1908.

SPENCER G. NEAL.

JOSEPH M. CHILDRESS.

Witnesses:

ALBERT H. MERRILL,

W. H. SHEASBY.