No. 615,326. Patented Dec. 6, 1898.

J. F. VOORHEES.

AIR BRAKE FOR RAILWAY TRAINS.

(Application filed Feb. 16, 1897.)

(No Model.)

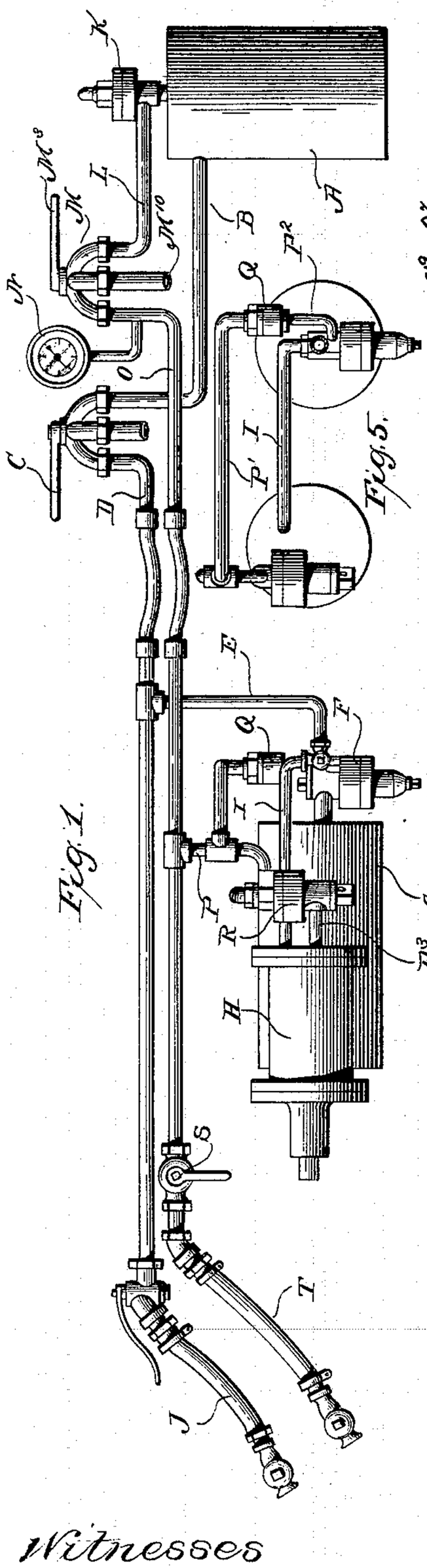

Fig. 1.

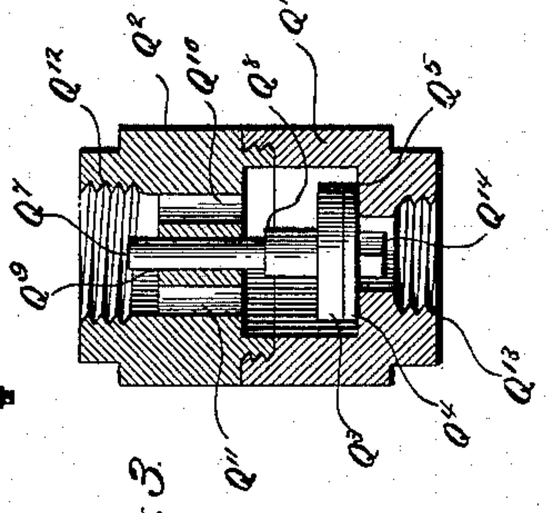

Fig. 3.

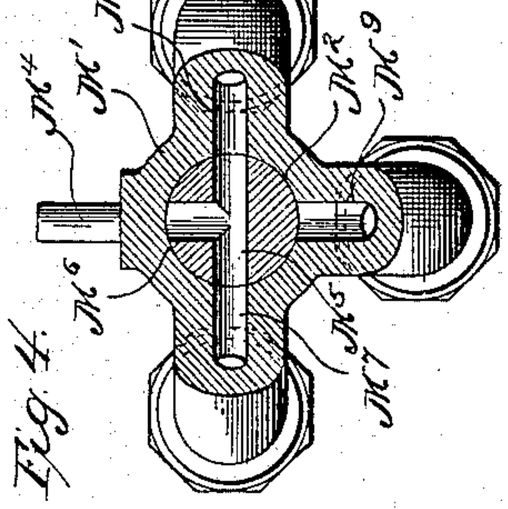

Fig. 4.

Fig. 5.

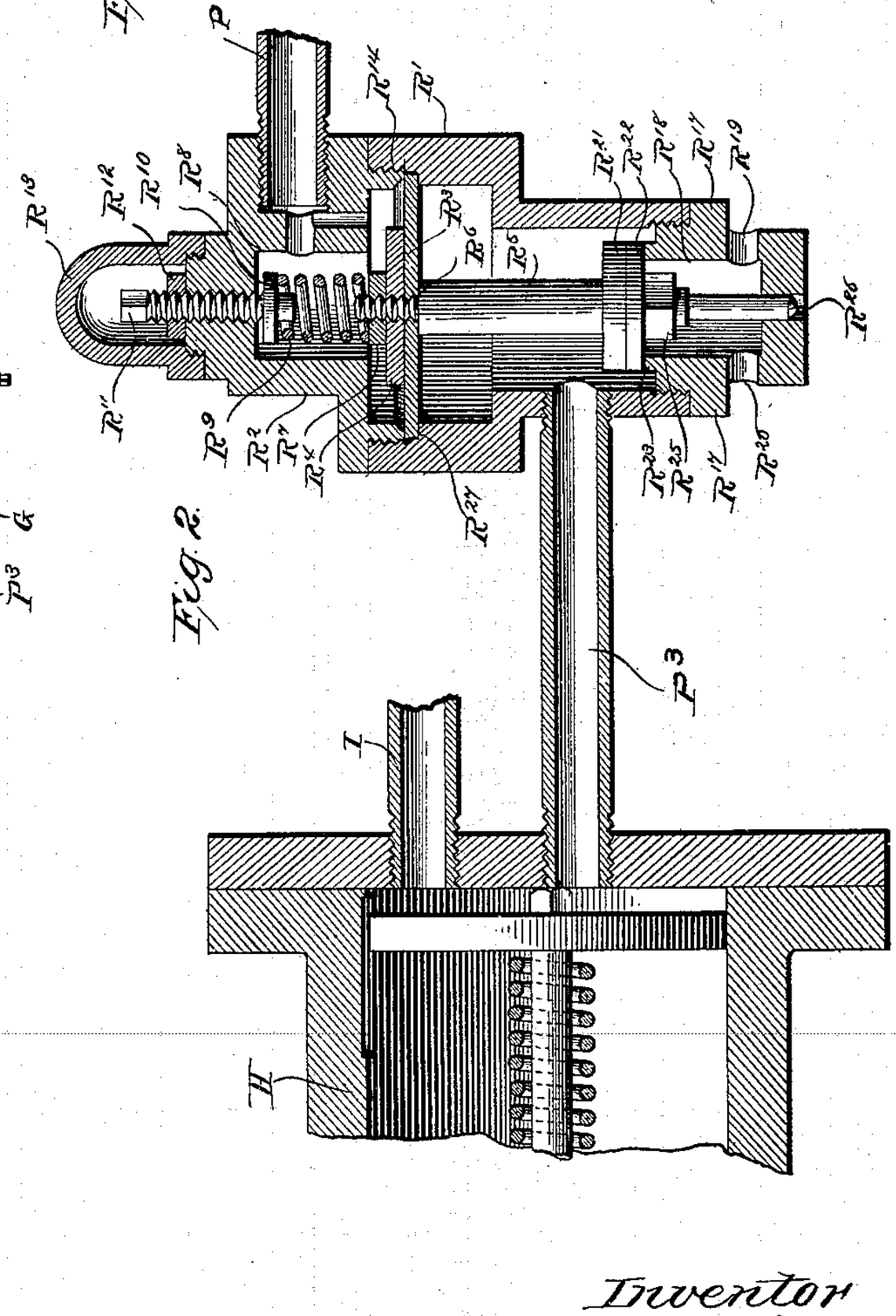

Fig. 2.

Witnesses

E. C. Windeman

S. D. Williamson

Inventor

Jeremiah F. Voorhees

by Geo. H. Holgate

Attorney

UNITED STATES PATENT OFFICE.

JEREMIAH F. VOORHEES, OF PHILADELPHIA, PENNSYLVANIA.

AIR-BRAKE FOR RAILWAY-TRAINS.

SPECIFICATION forming part of Letters Patent No. 615,326, dated December 6, 1898.

Application filed February 16, 1897. Serial No. 623,612. (No model.)

To all whom it may concern:

Be it known that I, JEREMIAH F. VOORHEES, a citizen of the United States, residing at Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented a certain new and useful Improvement in Air-Brakes for Railway-Trains, of which the following is a specification.

This invention relates to what is known as "continuous automatic brakes" for railway-trains; and its object is to enable a sufficient amount of available energy to be stored at each car to apply the brakes with the greatest amount of force proportionate to the resistance to their action without a possibility of the said stored energy becoming effective as a braking force exceeding a specific amount unless so determined by an engineer from the locomotive of a train previous to the application of the brakes and then only in conformity with an amount so determined, and also to enable him to effect a reduction in the amount of braking force exceeding said specific amount with sufficient rapidity as to prevent its preponderating to an extent that will cause the car-wheels to slide on the track when the work for which the extra braking force is intended has been accomplished by decreasing a pressure directly under his control.

The rolling surface of a car-wheel resists the retarding action of a brake shoe or block according to the velocity of the car-wheel and the adhesion of the surface of the wheel to the track on which it rolls, and the adhesion is governed by the pressure of the wheels to the track and the frictional resistance of said parts in contact and is subject to considerable variation due to atmospheric conditions affecting the said frictional resistance, and, while the retarding action of the brake-shoe is counteracted to a certain extent by the velocity of the surface of the car-wheel with which it is in contact, it is evident the effectiveness of the brakes to check the speed of the train will depend on the adhesion of the wheels to the track exceeding the retarding action of the brakes, and from the fact that the adhesion is subject to considerable variation not due to the momentum of the train the maximum braking force which can be advantageously employed is subject to variation at a given rate of speed and cannot therefore be applied with regard to the speed of the train only without causing the car-wheels to slide on the track when the adhesion is less than normal.

A car-wheel prevented from revolving by the action of the brake exerts but slight retarding action to the speed of the train by sliding on the track from the fact that the braking force then loses its effective leverage to counteract the momentum of the train, the frictional resistance of the surface of the wheel in contact with the rail exerting but comparatively little retarding action, and from the fact that it requires but comparatively little pressure at the brake-shoe to prevent the wheel from again revolving, on account of the wheel becoming locked by the greater area of the brake-shoe encountering no frictional resistance, it is essential that the braking force must not exceed the resistance thereto, as the braking force must be released before the wheel can again revolve and the brakes again become properly effective to stop the train.

The effectiveness of the braking force to check the speed of the train depends on the adhesion of the wheels to the track exceeding under all conditions the retarding action of the brakes, and it requires a reasonable intelligence to regulate the braking force according to the resistance thereto from the fact that any known mechanical control would be impracticable for the reasons set forth. It therefore requires engineering skill to properly control the braking force, and the mechanism hereinafter described is placed under the control of the engineer of a train for the reason set forth, and the means employed to limit the accumulation of effective braking force must also act to quickly reduce the braking force in conformity with an amount as may be determined by the engineer at the locomotive in order to successfully operate a high-pressure brake system, as herein described. Compressed air being now generally employed to actuate the train-brakes, this invention is shown as applied to an automatic air-brake apparatus, and the type of apparatus shown in the drawings to illustrate the combination is that form in which compressed air from the auxiliary reservoir only enters the brake-cylinder. Several forms of

triple valves are employed that accelerate the serial action of the brakes by locally venting pressure from the train-pipe directly into the brake-cylinders; but as the initial braking force thus applied will not, even with a comparatively high pressure in the train-pipe, exceed an amount determined by the resistance of a spring when adjusted as hereinafter described the results will be the same as far as combination with the present improvement is concerned, and unnecessary complications in the drawings have been avoided.

It will be understood that the brakes are applied and can be released in the usual manner and that the mechanism herein described acts independent of the means for applying the brakes to automatically prevent an accumulation of pressure in the brake-cylinders from exceeding an amount predetermined by the engineer from the locomotive regardless of the manner in which a reduction of pressure in the main train-pipe is effected or the amount of pressure stored in the auxiliary reservoirs, and also acts quickly to reduce the pressure in the brake-cylinders exceeding a specific amount to correspond to a proportionate reduction in a retaining force controlled by the engineer from the locomotive.

In the drawings, Figure 1 represents an elevation of the parts of an ordinary automatic fluid-pressure brake apparatus for conveying fluid-pressure from the locomotive to the car-brake cylinders, shown in connection with a quick-acting system of automatic relief-valves, controlled by an engineer from a locomotive, I employ for the purpose described. Fig. 2 is a longitudinal section through the relief-valve R, showing also its relation to the brake-cylinder. Fig. 3 is a longitudinal section through a pressure-retaining valve. Fig. 4 is a plan view, partially in section, of the engineer's valve M; and Fig. 5 is an end view of the car-brake appliance, Fig. 1, below the train-pipes.

A represents a storage-reservoir at the locomotive; B, a supply-pipe; C, an engineer's brake-valve; D, the main train-pipe; E, a branch therefrom; F, a triple valve; G, an auxiliary reservoir; H, a brake-cylinder; I, a brake-pipe connecting the triple valve and the brake-cylinder, and J a hose and coupling. These parts are usually provided.

The parts which have been added are a reducing-valve K, conveniently limiting the amount of pressure admitted to a pipe L, connecting the storage-reservoir with a valve M, manipulated by the engineer and regulating a pressure in a retaining-pipe O, extending throughout a train and connected by a hose and coupling T between the cars. A gage N indicates a pressure in the pipe O, and a branch pipe P connects the same with an automatic relief-valve R, joined directly to the brake-cylinder H. A retaining-valve Q is interposed between the exhaust-port of the triple valve F and the retaining-pipe. A stop-cock S closes the pipe O at the end of a train.

The valve M is an ordinary three-way cock. The ports M^5 and M^6 through the plug M^2 are adapted to register with the ports M^7, M^8, and M^9 in the casing M', and the position these ports will assume in relation to each other when the plug is rotated by the handle M^3 can be ascertained from an inspection of Fig. 4. The valve-casing is secured by a projection M^4 and the pipes L O and waste-pipe M^{10} are secured in the usual manner.

The regulating relief-valve R consists of a main body R' in direct communication with the brake-cylinder H through the pipe P^3. A screw-cap R^2, containing a chamber R^8, connected with the valve M by the pipes P and O, forms the other part of the casing. A sensitive diaphragm R^3, interposed between the valve M and the brake-cylinder H, is secured on the offset R^{27} by the annular flange R^{14} of the screw-cap R^2 and is connected with a valve R^{21}, interposed immediately between the brake-cylinder and the atmosphere on the annular valve-seat R^{23}, formed on the screw-cap R^{27}, and a chamber R^{15} therein is in direct communication with the atmosphere through the ports R^{19} and R^{20}, which should be large enough to prevent an accumulation of pressure in the chamber below the valve. The diaphragm is secured on the valve-stem R^5 by a nut R^7, pressing on the plate R^4, and the connected surfaces of the valve and the actuating-diaphragm present differential areas to pressure admitted through the pipe P^3, and the area of the valve R^{21} exposed to the atmosphere determines differential effective areas on opposite sides of the diaphragm R^3, and this differential is maintained when the valve is opened by the plate R^4 coming in contact with the cap R^2, thereby limiting the movement of the valve from its seat. The opening through the valve-seat R^{23} should be large enough to enable the required amount of opening by a slight movement of the valve from its seat, thereby reducing by expansion into the opening within the valve-seat the exhaust fluid to atmospheric pressure without creating any appreciable back pressure on the surface of the valve R^{21} exposed to the atmosphere. The valve-opening should release the pressure from the brake-cylinder at least as rapidly as it can enter the same through the feed-port in the triple valve, so as to prevent an accumulation of pressure therein from exceeding the retaining force.

A flexible gasket R^{22}, secured to the valve R^{21} by the nut R^{25}, insures an air-tight joint between the valve and its seat. The smaller end of the stem R^5 extends into a hole R^{26}, which acts as a guide for it. A spring R^9, resting on the nut R^7 and subject to compression by the collar R^{10} on the regulating-stem R^{11}, acts to retain the valve on its seat when there is no pressure in the retaining-pipe O. A locking-nut R^{12} and a cap R^{13} are provided for the stem R^{11}. One compartment of the valve R being in constant communication

with the brake-cylinder and the other with the engineer's valve M and the actuating-diaphragm interposed immediately between them and the relief-valve capable of releasing the pressure as rapidly as admitted to the brake-cylinder enables the engineer, according to the pressure he admits into the pipe O through the valve M, to predetermine the maximum force with which the brakes can be automatically applied from the fact that fluid-pressure permitted to enter the brake-cylinders that otherwise cause an accumulation of pressure therein exceeding the desired amount escapes immediately to the atmosphere through the valve-seat R^{23} as rapidly as it can enter the brake-cylinder, and he can from the locomotive limit the force with which the brakes can be applied when he is otherwise deprived of any control of their action, according to the probable resistance to said action, as previously set forth, and he is also enabled to release the braking force exceeding an amount determined by the resistance of the spring R^9 by releasing the retaining-pressure in the pipe O through the valve M with a control similar to that obtained by using the direct-acting system, but with greater rapidity in the reduction of braking force, from the fact that the pressure so released passes immediately to the atmosphere at the valve-seat R^{23}, and also that a specific reduction of pressure in the pipe O releases a proportionately-greater amount of pressure from the brake-cylinder, thereby enabling the extra braking force to be released with sufficient rapidity as to render its employment practicable.

As previously stated, the area of the valve R^{21} exposed to the brake-cylinder pressure determines the effectiveness of similar pressures acting on opposite sides of the actuating-diaphragm R^3. Therefore pressure in the pipe O, acting on the greater effective area of the diaphragm, will retain a greater amount of pressure in the brake-cylinder, and the difference in pressure, as indicated by a gage, at which the effective opposing forces will equalize will be according to the area of valve R^{21} exposed to the brake-cylinder pressure and the limited movement of the valve from its seat, as described, and may be at the option of the constructor, and if the difference in the effectiveness of said pressures, as pointed out, is considerable the action of the valve to release pressure from the brake-cylinder will be accelerated accordingly and a gentle reduction of pressure in the pipe O will secure a more uniform reduction in the braking force throughout the train with sufficient rapidity, as set forth.

While it is impracticable to apply the braking force at all times in proportion to the speed of the train for reasons stated by placing the retaining-pressure described directly under the control of the engineer, a pressure stored at each car is rendered available to apply the brakes with the greatest amount of force that can be advantageously employed without incurring the risks of the brakes being automatically applied thereby with greater force than intended by the engineer, and the increased braking force that can at times be advantageously employed will materially reduce the average distance within which a rapidly-moving train can be stopped.

I am aware of the fact that wheels are injured by sliding on the track when the braking force employed is proportionately less than the weight of the car when stationary; but I have found in such cases the sliding was due to decreased adhesion of the wheels to the track, proof of which is the fact that the same amount of braking force would not cause the wheels to slide on a dry rail. I have also found that after the train has attained a certain speed the resistance to the retarding action of the brakes increases with a ratio greater than the increase in the speed of the train, which clearly demonstrates the practicability of a high-pressure brake intelligently controlled, as herein set forth, to accomplish the desired results.

The retaining-valve Q, connected to the exhaust-port of the triple valve by the pipe P^2 and with the pipe P by the pipe P′, is provided for the purpose of retaining pressure in the brake-cylinder H while recharging the auxiliary reservoir from the main train-pipe by pressure in the same pipe employed for conveying the retaining-pressure to the valve R, and consists of a main body Q′, forming a seat Q^5 for a valve Q^3, which when seated presents differential areas to pressure acting on opposite sides of the same. A flexible gasket Q^4, secured to the valve by a nut Q^{14}, forms an air-tight joint between the valve and its seat. A screw-cap Q^2, having ports Q^{10} and Q^{11} through it, completes the valve-casing, and a stem Q^7, extending into a hole Q^9, acts as a guide for the valve, and the shoulder Q^8 on the stem by coming in contact with the cap limits the movement of the valve from its seat.

The valve Q^3 when seated presents a greater exposed area to pressure from the pipe O, and it will require but slight pressure therein to retain the full amount of pressure released through the triple valve when recharging the auxiliary reservoir from the main train-pipe, and when the pressure in the pipe O is reduced to a minimum the pressure released from the brake-cylinder through the triple valve will be enabled to unseat the valve Q^3 and equalize with the pressure in the pipe O and will be somewhat reduced by expansion therein before it is released to the atmosphere, and as the pressure thus created in the pipe O acts as a retaining force at the valve R the full amount of pressure should not be retained in the brake-cylinder until the auxiliary reservoir was fully recharged unless an amount of braking force so determined can be advantageously employed.

The retaining-valve is intended for use on

mountain grades and may be omitted at the option of the constructor, as it is not necessary to operate a high-pressure brake, as previously described. Its use is rendered permissible by the action of the valve R in preventing an excessive accumulation of pressure in the brake-cylinder.

Equivalent means may be substituted for those herein shown to illustrate the combination set forth to control a high-pressure brake system in a manner substantially as described. I therefore consider all known substitutes and equivalents as within the scope of my invention as set forth in the above specification.

I claim as my invention and desire to secure by Letters Patent—

1. In an automatic fluid-pressure brake apparatus, the combination of a brake-cylinder, a quick-acting relief-valve connected directly to a brake-cylinder, and means for enabling an engineer from a locomotive to regulate the maximum load of said relief-valve substantially as and for the purpose specified.

2. In combination with a fluid-pressure brake apparatus, a storage-reservoir, an auxiliary engineer's valve, a retaining-pipe, a quick-acting system of relief-valves adapted to automatically release fluid-pressure from each brake-cylinder in excess of an amount determined by a pressure controlled by an engineman from a locomotive, and acting in conjunction with a spring at each relief-valve to regulate the pressure in said brake-cylinder, immediately to the atmosphere as rapidly as it can enter each brake-cylinder, whereby the accumulation of pressure therein is automatically limited to conform to an amount determined by an engineer through said auxiliary engineer's valve from a locomotive previous to the application of the brakes, regardless of the amount of pressure stored in the auxiliary reservoirs, or its free admission to the brake-cylinders, substantially as set forth.

3. The combination of a brake-cylinder, a quick-acting relief-valve connected directly thereto, a retaining-pipe, an auxiliary engineer's valve, means whereby the load of said relief-valve can be regulated by an engineman from a locomotive, thereby enabling the maximum accumulation of pressure in said brake-cylinder to be determined by the engineer previous to the application of the brakes, and according to the probable resistance to their action, regardless of the free admission of pressure to said brake-cylinder substantially as specified.

4. The combination with an automatic fluid-pressure brake system, of a storage-reservoir, a line of pipe connected with a storage-reservoir, or with the atmosphere through a valve controlled by an engineman at a locomotive, and with a valve-casing interposed immediately between a brake-cylinder and said line of pipe, said casing containing an actuating diaphragm or piston interposed immediately between a brake-cylinder and an engineer's valve, and connected with a valve controlling a port opening immediately to the atmosphere from the interior of the valve-casing subject to fluid-pressure acting simultaneously on the piston in the brake-cylinder to apply the brakes and on the said interposed diaphragm or piston to open the relief-valve against the resistance of a spring acting in conjunction with a fluid-pressure admitted into the connecting-pipe through said engineer's valve to act on the interposed diaphragm or piston in direction to retain the valve on its seat, whereby the accumulation of pressure in a brake-cylinder exceeding an amount determined by the resistance of a spring is automatically regulated to conform to an amount determined by a pressure controlled by an engineman from a locomotive for the purpose substantially as specified.

5. The combination of a valve-casing, a diaphragm or piston fitted therein, and connected with a valve controlling a connection between the interior of said casing subject to pressure from a brake-cylinder or connection thereto and the atmosphere, a seat for the valve situated in a manner that pressure within the valve-casing acts on the surface of the valve connected with its actuating piston or diaphragm while the surface of the valve within an opening through the valve-seat is exposed to the atmosphere, and the proportion of the area so exposed, to that of the actuating diaphragm or piston, determines differential effective areas on opposite sides of said diaphragm, and the difference in effectiveness of similar pressures acting on opposite sides thereof, is maintained when the valve is open, by a stop limiting the movement of the said valve from its seat thereby reducing the pressure of the exhaust fluid by expansion into the opening within the valve-seat, a port or pipe for admitting fluid-pressure to act on the larger effective area of said actuating piston or diaphragm to control the action of said valve, for regulating a fluid-pressure within a brake-cylinder by a proportionate, less amount of controlling-pressure, substantially as specified.

6. The combination of a valve-casing an actuating diaphragm or piston fitted therein and connected with a valve controlling an opening from the interior of said casing immediately to the atmosphere, a seat for said valve so formed that the area of the valve within an opening through the valve-seat, is exposed to the atmosphere, a stop acting to limit the movement of the valve from its seat, whereby fluid-pressure released from the valve-casing through the restricted valve-opening is reduced by expansion into the opening through the valve-seat, thereby preventing appreciable back pressure on the valve exposed to the atmosphere, and maintaining at all times a difference in effectiveness of similar pressures acting on opposite sides of said actuating diaphragm or piston,

according to the area of the release-valve exposed to the atmosphere, means whereby a pressure can be controlled to act on the greater effective area of said diaphragm or piston in direction to close the valve-opening, for enabling a specific reduction in said controlling-pressure to release a proportionately greater amount of pressure, acting on the opposite side of said diaphragm to open the valve, thereby accelerating the action of the valve to automatically release fluid-pressure in conformity with a reduction in a retaining-pressure, substantially as specified.

7. The combination with a fluid-pressure brake apparatus, of a valve-casing connected with a brake-cylinder through a pipe or port, and with an engineer's valve through a system of pipes and containing a valve interposed immediately between a brake-cylinder and the atmosphere, and actuated by a diaphragm or piston interposed between said brake-cylinder and engineer's valve, a seat for the valve having a sufficiently large opening through it to release fluid-pressure from a brake-cylinder as rapidly as it can enter the same, by a slight movement of the valve from its seat, thereby reducing by expansion into the chamber within the valve-seat, the exhaust fluid to atmospheric pressure without causing appreciable back pressure on the surface of the valve within the opening through the valve-seat, a spring acting in conjunction with a fluid-pressure admitted into the connecting-pipes through said engineer's valve to act on the greater effective area of said actuating-diaphragm, as determined by the area of the said interposed valve exposed to the atmosphere, to determine the maximum pressure that can accumulate in said brake-cylinder, and to quickly release pressure therefrom by a reduction of controlling-pressure as, and for the purpose substantially as specified.

8. In a fluid-pressure brake apparatus, the combination of an auxiliary reservoir, a triple valve, a brake-cylinder an automatic relief-valve connected to said brake-cylinder, a retaining-pipe, an auxiliary engineer's valve, and means whereby a pressure controlled by the engineer can act in conjunction with a spring to regulate the maximum load of said relief-valve, whereby a pressure in said auxiliary reservoir sufficient to furnish a braking force in the brake-cylinder connected thereto, proportionately greater than the weight of the car is rendered ineffectual to apply the brakes with greater force than determined by the engineer previous to the application of the brakes, and without an undue loss of pressure in said brake-cylinder in case of the train parting.

9. The combination of the brake-cylinder H, the quick-acting relief-valve R, engineer's valve M, the pipe O and branch pipe P connecting the valve R with the valve M, the actuating-diaphragm R^3 interposed between the valve M and the brake-cylinder H, and connected with the valve R^{21} interposed immediately between the brake-cylinder H and the atmosphere, the annular valve-seat R^{23}, the adjustable spring R^9 acting in conjunction with a pressure as may be determined by an engineman at the valve M, to regulate the accumulation, and retention of pressure in the brake-cylinder H in manner, and for the purpose substantially as specified.

10. The combination of the brake-cylinder H, the valve R, consisting of a main body R′ in direct communication with the brake-cylinder H, the valve-seat R^{23}, and the valve R^{21} connected with the actuating-diaphragm R^3, means for limiting the movement of the valve R^{21} from the seat R^{23}, for maintaining differential effective areas on opposite sides of the actuating-diaphragm R^3 according to the area of the valve R^{21} exposed to the atmosphere, the pipe O and branch pipe P connecting the cap R^2 with the engineer's valve M, whereby a pressure as may be determined by the engineer at the valve M, acts on the larger effective area of the diaphragm R^3 and in conjunction with the spring R^9 retains a greater pressure in the brake-cylinder H, and the reduction of pressure therein accelerated, when the pressure in the pipe O is reduced according to the amount of said differential effective areas, substantially as described.

11. The combination of a storage-reservoir, an engineer's valve, a brake-cylinder, a spring-pressed diaphragm or piston interposed between a brake-cylinder and an engineer's valve, and connected with a valve controlling a port opening immediately to the atmosphere from the interior of the valve-casing subject to pressure from said brake-cylinder, the amount of valve opening being sufficient to release said pressure as rapidly as admitted to the brake-cylinder, the actuating diaphragm or piston being subject to pressure from a brake-cylinder or connection thereto to open the valve against the resistance of said spring acting in conjunction with a pressure as may be determined by an engineer from a locomotive to regulate the accumulation of pressure in said brake-cylinder, thereby enabling an engineer to determine from a locomotive, independent of the means for applying the brakes, and according to the probable resistance to their action, the maximum force with which the brakes can be automatically applied by pressure stored at each car, without an undue loss of pressure from the brake-cylinders in case of the train parting.

12. The combination with a brake-cylinder, of a separate valve for venting the brake-cylinder directly to the atmosphere at each car, acting independent of the triple-valve mechanism, and consisting of a main body R′, a cap R^2 having an annular flange R^{14} for securing a diaphragm-plate R^3 on the offset R^{27}, a valve R^{21} connected to the diaphragm by a stem R^5, nut R^7, and plate R^4, a regulating-stem R^{11}, a spring R^9 for retaining the valve on its seat R^{23}, a pipe P for admitting

fluid-pressure controlled by an engineer from a locomotive, to act on the diaphragm R^3 to counteract pressure from the brake-cylinder H, acting on the opposite side of the plate R^3 to raise the valve and establish a direct communication between the cylinder H and the atmosphere, for the purpose substantially as specified.

13. The combination of a brake-cylinder H, triple valve F, pipe O, relief-valve R, branch pipes P, P′, and P^2 and a retaining-valve Q, for retaining pressure in the cylinder H, by a very low pressure in the pipe O, acting simultaneously at the valve R to regulate the accumulation of pressure in the brake-cylinder, in a manner substantially as specified.

14. The combination of a brake-cylinder H, triple valve F, pipe O, relief-valve R, branch pipes P, P′, and P^2, and retaining-valve Q, for retaining a pressure in the cylinder H, without creating a similar pressure in the pipe O, and when the valve Q^8 is unseated by pressure from the cylinder H, the said pressure being reduced by expansion into the comparatively vacant pipe, thereby preventing too much pressure acting on the diaphragm R^3 to increase the accumulation of pressure in the brake-cylinder in case of the brakes being reapplied, substantially as set forth.

In testimony whereof I have hereunto affixed my signature in the presence of two subscribing witnesses.

JEREMIAH F. VOORHEES.

Witnesses:
S. S. WILLIAMSON,
ALLISON W. MCCURDY.