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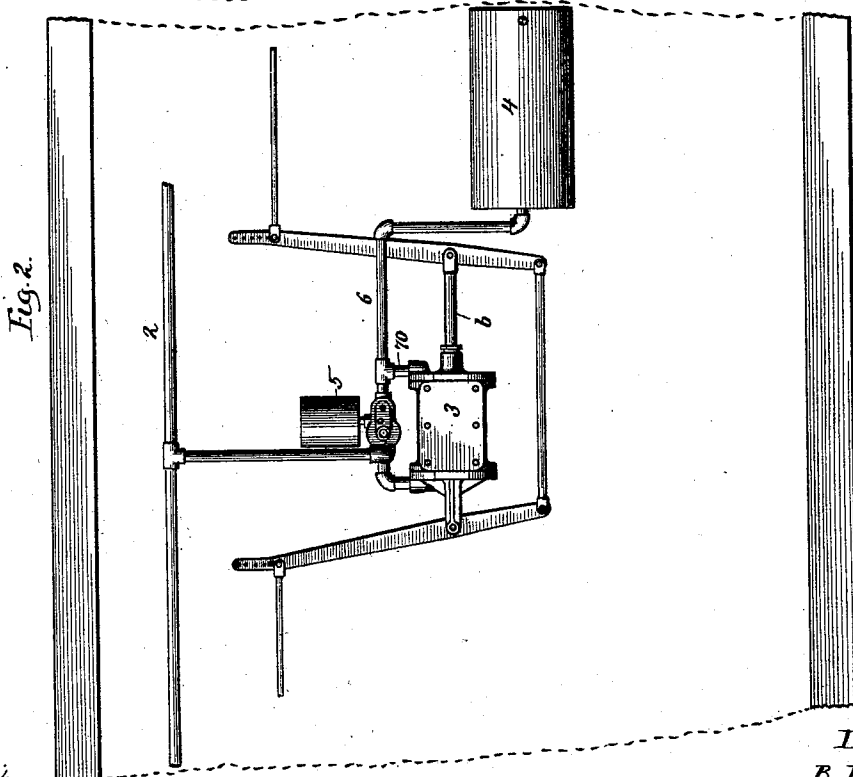
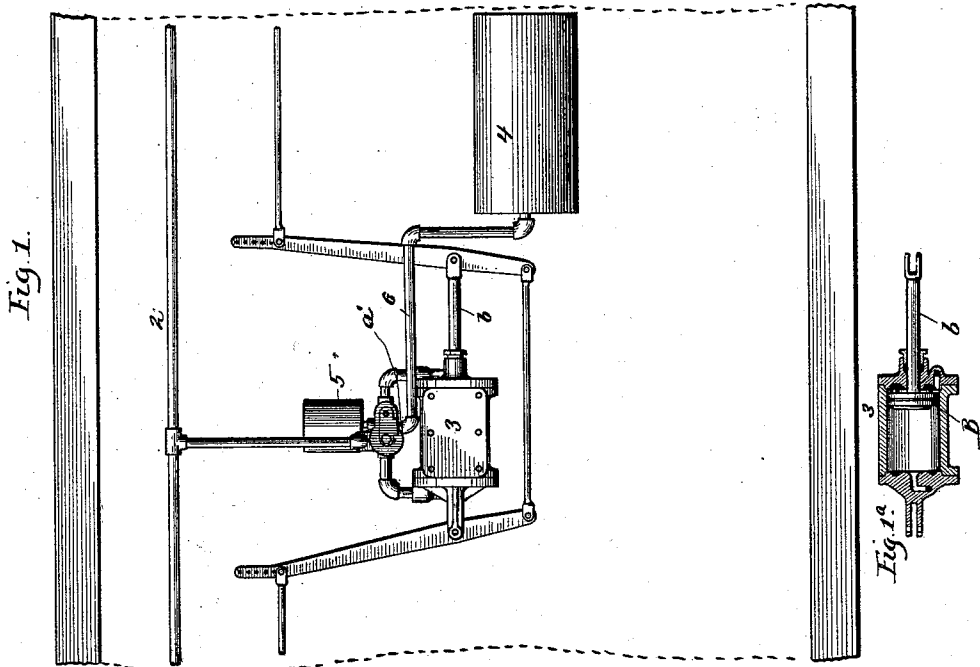
6 Sheets—Sheet 1.

B. F. TEAL.

FLUID PRESSURE BRAKE MECHANISM FOR RAILWAY CARS.

No. 536,107.

Patented Mar. 19, 1895.



Witnesses:
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(No Model.)

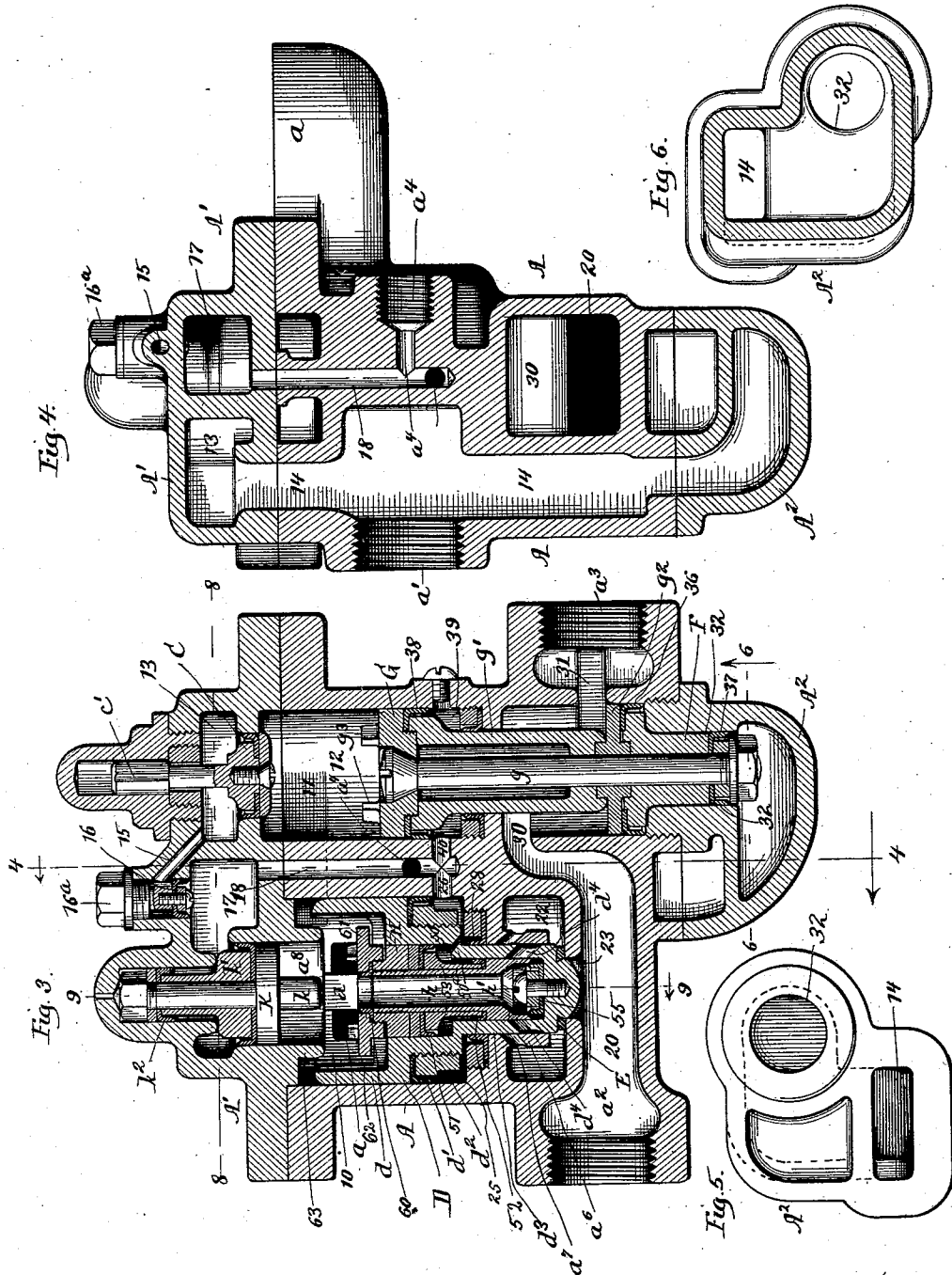
6 Sheets—Sheet 2.

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FLUID PRESSURE BRAKE MECHANISM FOR RAILWAY CARS.

No. 536,107.

Patented Mar. 19, 1895.



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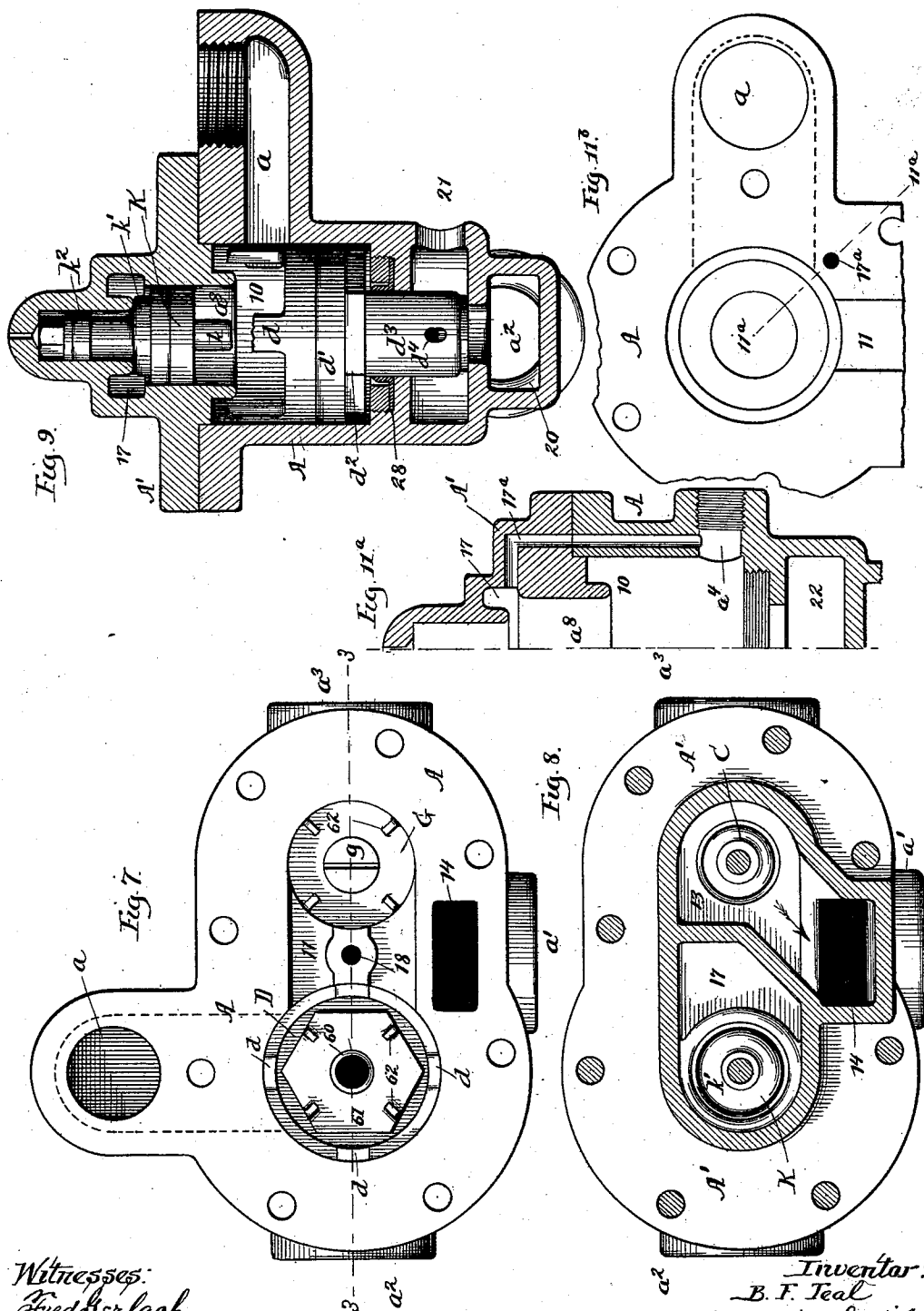
6 Sheets—Sheet 3.

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No. 536,107.

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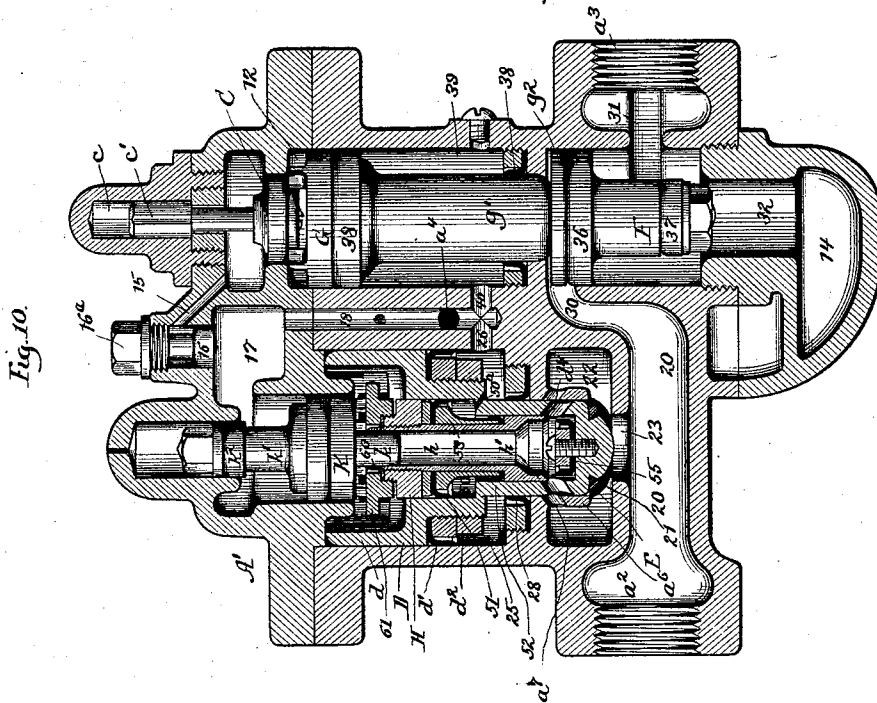
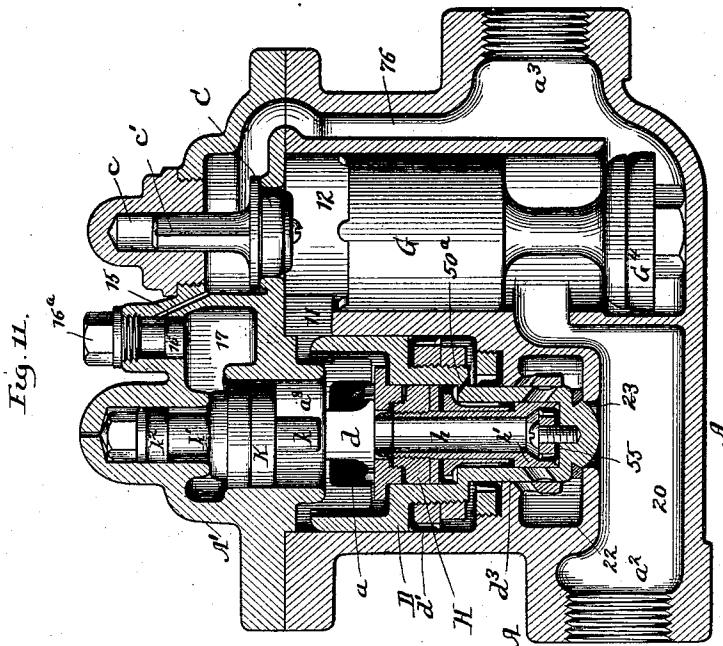
6 Sheets—Sheet 4.

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FLUID PRESSURE BRAKE MECHANISM FOR RAILWAY CARS.

No. 536,107.

Patented Mar. 19, 1895.



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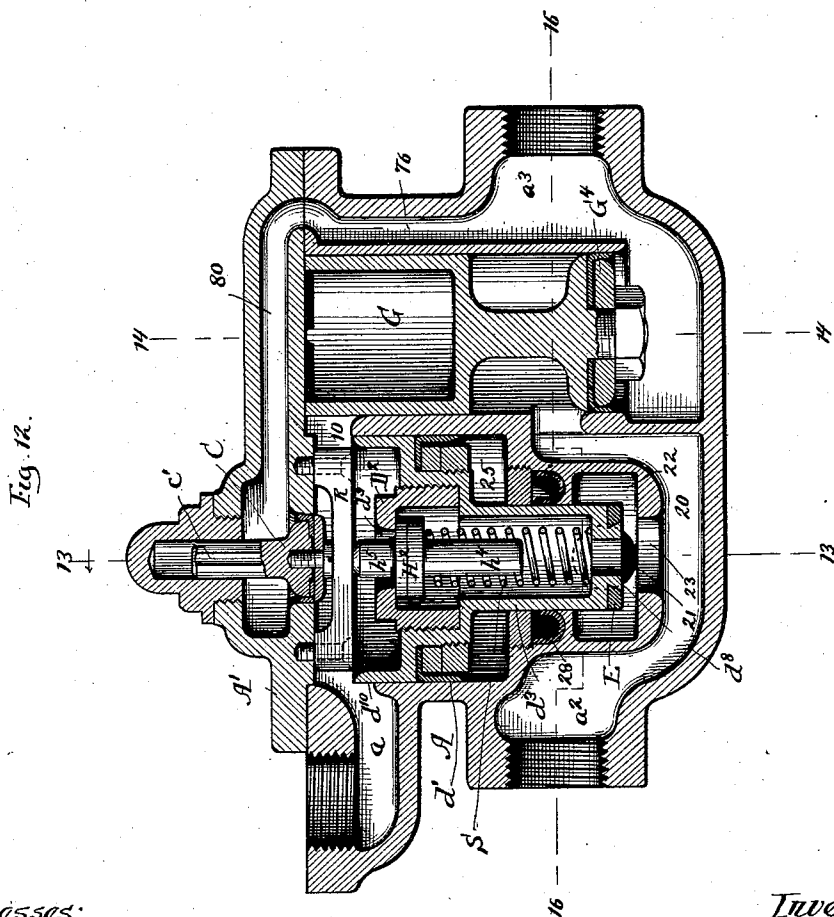
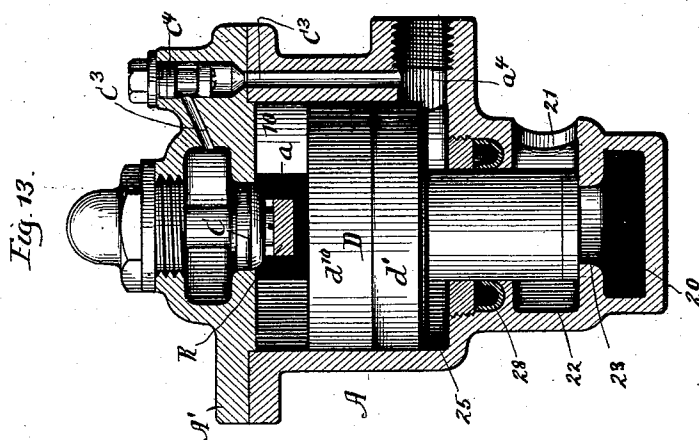
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6 Sheets—Sheet 5.

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FLUID PRESSURE BRAKE MECHANISM FOR RAILWAY CARS.
No. 536,107.

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(No Model.)

6 Sheets—Sheet 6.

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FLUID PRESSURE BRAKE MECHANISM FOR RAILWAY CARS.

No. 536,107.

Patented Mar. 19, 1895.

Fig. 15.

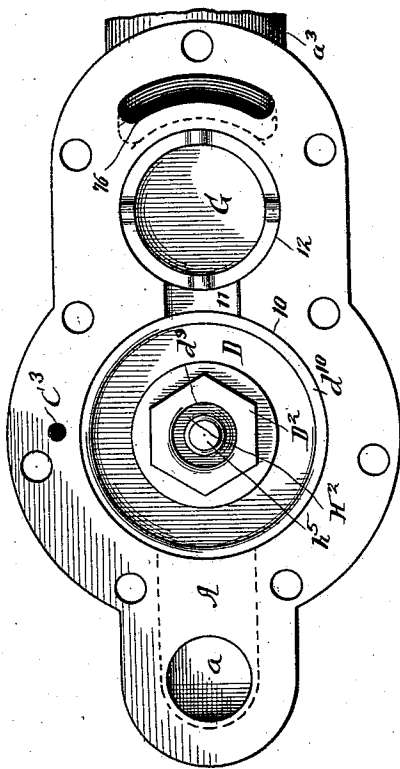


Fig. 16.

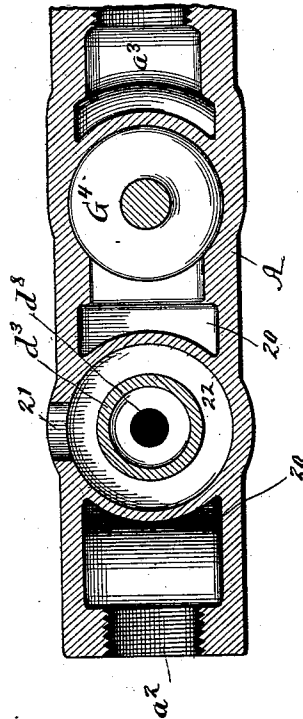
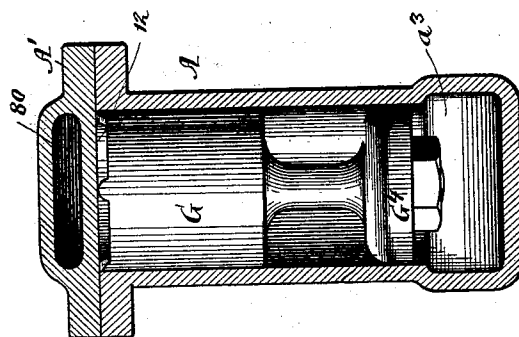


Fig. 14.



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UNITED STATES PATENT OFFICE.

BENJAMIN FRANK. TEAL, OF CHICAGO, ILLINOIS.

FLUID-PRESSURE BRAKE MECHANISM FOR RAILWAY-CARS.

SPECIFICATION forming part of Letters Patent No. 536,107, dated March 19, 1895.

Application filed September 11, 1894. Serial No. 522,720. (No model.)

To all whom it may concern:

Be it known that I, BENJAMIN FRANKLIN TEAL, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Fluid-Pressure Brake Mechanism for Railway-Cars, of which the following is a full, clear, and exact description, reference being had to the drawings forming a part of this specification.

The present invention has relation to that class of fluid pressure railway brakes commonly known as automatic brakes and in which the operation of the brakes is effected under variations of train pipe pressure, by means of fluid pressure stored within reservoirs located beneath the individual cars.

My invention relates more particularly to that type of automatic railway brakes in which fluid pressure is employed in both ends of the brake cylinders in order to effect both the application and release of the brakes; but certain features of my invention will be found applicable in other types of fluid pressure railway brakes and I do not wish the invention to be understood therefore as restricted to the particular type of brake mechanism in connection with which it is illustrated and hereinafter described.

One object of my present invention is to so connect the opposite ends of the brake cylinder that the stored pressure used in one end of the cylinder for effecting the application of the brakes may be exhausted thence into the opposite end of the cylinder for effecting the release of the brakes.

A further object of my present invention is to provide an improved construction of valve mechanism primarily designed for controlling the local exhaust of air from the train pipe under emergency conditions although capable of use in other situations.

A still further object of this invention is to provide improved valve mechanism whereby the exhaust of air from the train pipe may be stopped when a reduction of air pressure within the pipe has reached a predetermined limit.

My invention consists in the various features of improvement hereinafter described, illustrated in the accompanying drawings and

particularly pointed out in the claims at the end of this specification.

Figure 1 is a plan view showing the arrangement of the brake cylinder, auxiliary reservoir, supplemental reservoir, actuating valve mechanism and train pipe with their suitable connections beneath the car. Fig. 1^a is a view in longitudinal section through the brake cylinder. Fig. 2 is a view similar to Fig. 1 but showing a modified construction of valve mechanism and modified connection between the brake cylinder and the auxiliary reservoir. Fig. 3 is a view in central vertical section through one form of my improved actuating valve mechanism, the section being taken upon line 3—3 of Fig. 7. Fig. 4 is a view in vertical cross-section on line 4—4 of Fig. 3. Fig. 5 is a detail plan view of the bottom cap at the lower end of the casing. Fig. 6 is a view in horizontal section on line 6—6 of Fig. 3 and looking upward. Fig. 7 is a plan view of the mechanism illustrated in preceding figures, with the cover and parts contained therein removed. Fig. 8 is a view in horizontal section on line 8—8 of Fig. 3. Fig. 9 is a view in vertical cross-section on line 9—9 of Fig. 3, the main piston being shown in elevation. Fig. 10 is a view similar to Fig. 3 but with the parts in different position. Fig. 11 is a view similar to Fig. 3 but showing a different construction of admission valve. Fig. 11^a is a detail view in vertical cross-section of part of the casing shown in Fig. 11 and illustrates the passages connecting with the supplemental reservoir. Fig. 11^b is a plan view of the casing shown in Fig. 11, parts being broken away. Fig. 12 is a view in vertical longitudinal section through one form of valve mechanism, embodying features of my invention. Fig. 13 is a view in vertical section on line 13—13 of Fig. 12, the main piston being shown in elevation and in closed position. Fig. 14 is a view in vertical cross-section on line 14—14 of Fig. 12. Fig. 15 is a plan view of the mechanism shown in Fig. 12 but with the cover removed. Fig. 16 is a view in horizontal section on line 16—16 of Fig. 12.

The casing of the valve mechanism illustrated in Figs. 3 to 10 of the drawings is shown as comprising a body A, a cover A' and a

bottom cap A^2 and this casing is connected with the train pipe 2, the brake cylinder 3, the auxiliary reservoir 4 and the supplemental reservoir 5 as illustrated in Fig. 1 of the drawings; that is to say, the casing A is provided with a port or passage a to which connects a branch pipe leading to the train pipe 2 and is provided with a port a' that connects by the pipe 6 with the reservoir 4 and is provided also with a port a^2 that connects with one end of the brake cylinder and with a port a^3 that connects to the opposite end of the brake cylinder and with a port a^4 that connects to the supplemental reservoir 5.

The brake cylinder 3 is provided with a differential piston B, the stem or trunk b of this piston serving to reduce the surface of the adjacent side of the piston that is exposed to fluid pressure so that when an equal fluid pressure per square inch is delivered to the opposite sides of this differential piston, it will be caused to move outward by reason of the larger area exposed by its inner side or end. Train pipe air is delivered by the port or passage a to the chamber 10 of the casing A and will pass thence by the ports 11 into the piston chamber 12 and lifting the check valve C it will pass into chamber 13. From chamber 13 train pipe air will pass in the direction of the arrow Fig. 8, into the vertical channel 14 and thence by port a' and pipe 6 to the auxiliary reservoir 4. Train pipe air thus delivered to the chamber 13 will also pass by the channel 15 around the stationary check valve 16 into the chamber 17 and from this chamber it will pass by the channel 18 and port a^4 to the supplemental reservoir 5. The check valve 16 is shown as consisting of a cup-leather attached to a stem projecting from a screw-plug 16^a of the cover A' , although manifestly any suitable form of check valve may be used.

From the port a^2 whereby the casing A is connected to the end of the brake cylinder opposite the large area of the piston leads a passage 20 that connects with the exhaust port 21 opening to the atmosphere, and in the preferred form of my invention the exhaust port 21 discharges from the chamber 22, the bottom plate of which is formed with a port 23 that connects the passage 20 with the chamber 22. Within the chamber 10 of the casing A is the main piston D preferably of the construction shown; that is to say, the upper side of this piston is provided with arms or lugs d adapted to contact with the cover A' to limit the upward movement of the piston, and the exterior of the piston is provided with a cup leather packing d' held in place by a threaded ring d^2 in order to prevent the escape around the piston of stored air that is delivered into the chamber 25 beneath the piston D from the supplemental reservoir 5 through port a^4 and branch channel 26. It will thus be seen that one side of the main piston D is at all times exposed to train pipe pressure within

the chamber 10 while the opposite side of the piston D is exposed to a pressure within the chamber 25 in opposition to train pipe pressure. The main piston D has its stem provided at its end with a valve E that serves to normally close the port 23 and thus prevent the escape of air from the brake cylinder through the exhaust port 21. It will thus be seen that while the main piston has train pipe pressure upon one side, its opposite side is exposed not only to pressure within the chamber 25 but also to pressure upon the end of this stem d^3 . The stem d^3 of the main piston D is preferably surrounded by a packing ring 28 to guard against the escape of air from the chamber 25. The end of the brake cylinder 3 opposite the small area of the differential piston, and the port a^3 of the main casing are connected by a supply channel 30 and supply port 31 with the channel 20 and port a^2 that lead to the opposite end of the brake cylinder. The ports 31 and a^3 have air delivered thereto from the auxiliary reservoir by a port 32 that communicates with the bottom of the channel 14 that unites with the port a' leading to the auxiliary reservoir, the bottom of this channel 14 being turned laterally as shown by Figs. 5 and 6 of the drawings, so as to effect communication between the vertical part of the channel 14 and the port 32. This delivery port 32 through which auxiliary reservoir air is supplied to the brake cylinder, is normally closed by a valve F that is operated by the supply piston G within the chamber 12 of the casing A. The valve F is preferably connected with the piston G by means of a through-bolt g , a sleeve g' and a washer g^2 , the washer g^2 serving to hold in place the cup-leather 36 that forms a valve whereby communication may be cut off between the supply port 31 and the passage 30. Preferably also a cup-leather packing 37 is placed beneath the bottom of the valve F and a similar packing 38 is placed at the bottom of the piston G in order to secure an air-tight working of these parts. The under side of the piston G is exposed to pressure within the chamber 39 into which air is admitted by the branch channel 40 from the channel 18 that communicates with the port a^4 and the supplemental reservoir 5, and the stored pressure within the chamber 39 thus acts in opposition to train pipe pressure to which the upper face of the piston G is exposed. By preference the upper face of the piston G has lugs g^3 thereon to limit its upward movement and insure its exposure at all times to train pipe pressure.

From the foregoing description it will be seen that when the valve F is in the closed position shown in Fig. 3, the two ends of the brake cylinder will be in free communication, and when the valve F is raised to the position seen in Fig. 10 communication between the two ends of the brake cylinder will be closed and communication will be established through ports 32, 31 and a^3 of the casing be-

tween the auxiliary reservoir and the end of the brake cylinder opposite the small area of the differential piston.

The main piston D and stem d^3 are chambered as shown, the upper chamber of this piston forming a cylinder to receive the supplemental or emergency valve piston H and to form the chamber 50 wherein the under side of this supplemental or emergency valve piston will be exposed to a pressure in opposition to train pipe pressure to which the opposite side of the emergency piston is exposed. The chamber 50 receives air from the supplemental reservoir 5 through ports 50^a that communicate with the chamber 25, which in turn communicates with the supplemental reservoir as above defined. The stem h of the supplemental piston H is tubular and around this stem is held an upper cup leather packing ring 51 and a lower cup leather packing ring 52 to guard against the escape of air from the chamber 50, and these cup leather packing rings 51 and 52 are preferably held in place by means of a sleeve 53. The piston H being united to its stem h by a threaded joint securely retains the packing rings in place, and by preference the lower part of the piston stem h is provided with an annular shoulder against which the lower packing ring 52 will be held. The tubular stem h serves as a passage through which the exhaust of train pipe air from the chamber 10 of the casing A is effected and the lower end of this stem h is provided with an annular valve h' adapted to close the exhaust ports d^4 that are formed in the wall of the stem d^3 and the main piston D, and this valve h' when used in the connection illustrated constitutes an emergency valve for controlling the local exhaust of air from the train pipe. In order to insure a tight closing of the valve h' I prefer to provide a cup leather packing 55 within the chamber of the piston stem d^3 . If desired also the main casing A may be provided with lugs a^6 constituting a check adapted to close the ports d^4 until the main piston in its upward movement has brought these ports opposite the ports a^7 of the lugs.

In order to check the exhaust of air from the train pipe when a sufficient reduction of train pipe pressure has been made, I provide the exhaust stop valve mechanism next to be described. Within the cover A' of the main casing is formed a cylinder a^8 in which moves the stop valve piston K that carries upon its lower face the stop valve k . The upper face of the stop valve K is exposed to pressure within the chamber 17 (see Figs. 3 and 8), to which chamber air is admitted from the supplemental reservoir by the channel 18 and port a^4 . From the upper side of the piston K extends a sleeve k' that encircles the piston stem and at the top of this stem is held a packing ring k^2 that is held upon the threaded end of the piston stem by a suitable nut and washer and serves to guard against the escape of air from the chamber 17. The exhaust stop

valve k , in the form of my invention above described, is of proper size to enter within a packing ring 60 at the mouth of the tubular stem h of the emergency valve piston H, this packing ring being held in place preferably by a threaded ring 61 that engages a corresponding threaded part of the piston H and is provided with lugs 62 to contact with the depending flange 63 of the main casing and limit the upward movement of the piston H. When the exhaust stop valve k is within the tubular stem h it will serve to prevent the passage of train pipe air through said stem from the chamber 10.

From the foregoing description the operation of the parts will be seen to be as follows, it being assumed that all parts are in the position shown by Fig. 3, which is the position occupied when the brakes are off, with the exception that the emergency valve h' is shown as partially raised for the purpose of better illustration. Train pipe air is now free to pass from the chamber 10, by channel 11 and chamber 12 into chamber 13 and thence by chamber 14 (see Fig. 8) and port a' to the auxiliary reservoir. The check valve C which prevents the back flow of air from the auxiliary reservoir when train pipe pressure is reduced within the chamber 12 is shown as closed for the reason that this valve has its entire upper surface and as well also the upper end of its stem exposed to pressure and will consequently close by gravity as soon as pressure within the train pipe and auxiliary reservoir has equalized. It is to insure the balancing of this check valve C that its stem c is provided with a groove c' whereby pressure from the chamber 13 is allowed to act upon the upper end of the stem. If now it is desired to set the brakes for service application train pipe pressure will be reduced slightly. The first effect of this reduction will be to cause the check valve C to close and thus prevent back flow of air from the auxiliary reservoir, if this valve has not already assumed a closed position. Inasmuch however, as the valve C is balanced under an equilibrium of pressure in the train pipe and the auxiliary reservoir, its weight will cause it to normally occupy the closed position shown in the drawings. Under this slight initial reduction of train pipe pressure, the pressure from the supplemental reservoir 5 acting upon the under side of the piston G, plus the pressure from the auxiliary reservoir 4 acting upon the bottom of the valve F, will cause the piston G to move upward until the valve 36 passes the supply port 31 and cuts off communication through the passage that connects the ends of the brake cylinder. As soon as communication is thus cut off, the further movement of the piston G under the initial reduction of train pipe pressure upon the upper side of this piston will withdraw the valve F from the port 32 and will thus establish communication between the channel 14 that leads to the auxiliary reservoir and the

supply port 31 and port a^3 that connects with the end of the brake cylinder opposite the small area of its piston. The initial slight reduction of train pipe pressure above mentioned, while serving to effect the operations above described, does not release the pressure from the end of the brake cylinder opposite the large area of this piston, but a further slight reduction of train pipe pressure is necessary to this end. When this additional reduction of train pipe pressure is had, the pressure of air from the supplemental reservoir 5, acting upon the under side of the piston D, plus the pressure of air from the end of the brake cylinder opposite the large area of the piston upon the end of the piston-stem d^3 , will force this piston upward thereby permitting air to escape from the end of the brake cylinder opposite the large area of the piston through the port a^2 , channel 20, port 23, chamber 22 and escape port 21 to the atmosphere. As soon however, as sufficient air has been thus allowed to escape, the pressure upon the end of the piston-stem d^3 is partially relieved, so that the piston D is held in raised position almost entirely by the pressure of stored air within the chamber 25 acting upon the under face of this piston. As this supplemental reservoir pressure is however, insufficient of itself to retain the piston in raised position under the reduction of train pipe pressure above mentioned, the piston D will descend and again close the exhaust port 23, thereby shutting off the escape of air from the end of the brake cylinder opposite the large area of its piston. The braking effect incident to this reduction of train pipe pressure will be that due to the difference between pressure from the auxiliary reservoir 4 acting upon the small area of the brake cylinder piston and the resistance of the reduced pressure upon the large area of this piston. If now a greater degree of brake action is desired the engineer will further reduce train pipe pressure and the operation above defined will be repeated until the desired brake action has been obtained. When it is required to set the brakes under emergency conditions, the engineer will reduce the train pipe pressure to the extreme extent necessary for this purpose. The effect of this extreme reduction will be the operation of the piston G in the manner hereinbefore defined, and also the upward movement of the piston D as above defined, and in addition to this the pressure from the supplemental reservoir 5 acting upon the under face of the supplemental or emergency piston H will cause this piston to move upward until the valve h' at the lower end disengages from the cup packing 55 and uncovers the ports d^4 , thereby permitting train pipe air to escape from the chamber 10 through the hollow stem h and thence to the atmosphere, by way of the port a^7 in the plate a^6 (if these plates are employed), the chamber 22 and exhaust port 21. When the emergency piston H has been thus

raised until its lugs 62 check against the depending flange 63 above them, so as to permit the escape of sufficient train pipe air to give the required emergency brake action, the pressure from the supplemental reservoir 5 acting within the chamber 17 upon the upper surface of the exhaust stop valve piston K will cause this piston to descend, thereby forcing the stop valve k to enter the upper end of the tubular stem H and thus check the further reduction of train pipe pressure. This entrance of the valve k into the end of the tubular stem h also serves to diminish by the extent of the valve the area of the piston K exposed to train pipe pressure. Consequently the piston K will remain in this depressed position until train pipe pressure has been restored not only to the degree at which the piston K descended, but to a higher degree on account of the reduction in effective area made by the entrance of the valve k into the stem h . Consequently, the piston D will descend and cause the emergency valve h' to blank the escape ports d^4 before the valve k passes from out the upper end of the tubular stem h of the emergency valve; and hence when the train pipe pressure within the chamber 10 is increased to such extent as to raise the piston K and the valve k to normal position, the ports d^4 are closed, and consequently further reduction of train pipe pressure is thereby avoided. The necessity of thus closing the emergency valve before the exhaust stop valve is restored to its normal position is obvious, since if air could pass freely through the tubular stem h when the stop valve k was released therefrom, a further reduction of the train pipe pressure in chamber 10 would occur at the very time when it was sought to restore such pressure. When train pipe pressure is restored within chamber 10 to release the brakes, the main piston D is caused to descend thereby closing the escape port 23, and cutting off communication between the atmosphere and the brake cylinder. Immediately after this the further increase of train pipe pressure will cause the piston G to descend until the valve F closes communication between the channel 14 that leads to the auxiliary reservoir, and the ports 31 and a^3 that connect with the end of the brake cylinder opposite the small area of this piston; and as the piston G continues to descend under the increase of train pipe pressure the valve 36 will pass below the port 31, thereby permitting the stored air within the end of the brake cylinder opposite the small area of the piston (this being the air that has been used to apply the brakes), to pass by the ports a^3 , 31, channels 30, 20 and port a^2 to the end of the brake cylinder opposite the large area of the piston. By thus placing the two ends of the brake cylinder in communication the effect is to balance the air pressure per square inch upon the opposite sides of the differential piston within said cylinder so that that the greater total pressure upon the larger

area of the piston will cause the reverse movement of the piston necessary to effect the release of the brakes. This effecting of the release of the brakes by the same air that has been used to effect the application of the brakes, is important in that it insures a most economical use of the reservoir air.

It is obvious that in order to insure the operation of the several valves and pistons in the manner above defined, the relative areas exposed by these pistons to train pipe pressure and to stored pressure from the supplemental reservoir 5 must be properly proportioned. The pistons are differential, but I have not deemed it necessary to state the exact areas of their opposite sides, as these may be varied according to the points of train pipe reduction at which it may be desired to effect the operation of the several valves and pistons. Recognizing the mechanical equivalency in air brake mechanism of flexible diaphragms and pistons, I have not deemed it necessary to illustrate any of the familiar ways in which flexible diaphragms might be employed instead of pistons in the above described structure, but I wish the term "piston" as herein used to be understood as synonymous with the words "movable abutment" as commonly employed in describing mechanism of this character.

It is manifest that the details of construction above defined may be varied without departing from my invention and that certain features of the actuating valve mechanism above described may be employed without the adoption of the mechanism as an entirety. Thus for example, in Figs. 11 to 16 of the drawings I have shown modifications of the structure which will next be described. In Fig. 11 the main casing A has a cover A' and at the left-hand side of this casing there is shown a main piston D, an emergency valve piston H, and an exhaust stop valve piston K, these several parts and the parts wherewith they cooperate being the same as in the form of my invention hereinbefore described, and bearing the same characters of reference. In this form of the invention I have shown a modified construction of admission piston G within the chamber 12 of the casing and the check valve C above this chamber is also somewhat modified in construction, being provided with an annular flange that bears upon the top of the check valve seat in such way as not to alter the area of the valve but simply arrests its downward movement. The valve casing when constructed as shown in Fig. 11 and when provided with an admission valve piston G and an admission valve G⁴ as shown in such figure, will be connected with a train pipe, the brake cylinder, the auxiliary reservoir and the supplemental reservoir, as illustrated in Fig. 2, Sheet 1 of the drawings; that is to say, the casing will be connected to the train pipe 2 by a port a as in the construction hereinbefore described and will be connected by the port a^2 with the end of the brake cylinder op-

posite the large area of this differential piston, but in this embodiment of the invention the opposite end of the brake cylinder is in constant communication by branch pipe 70 and pipe 6 with the auxiliary reservoir 4, and the port a^2 of the casing is directly connected and in constant communication with the pipe 6 that leads to the auxiliary reservoir. In the structure shown in Fig. 11 the supplemental reservoir 5 is connected with the chamber 17 as shown more particularly in Fig. 11^a of the drawings, that is to say, from the chamber 17 leads a channel 17^a to the port a^4 to which the supplemental reservoir 5 is connected and it will thus be seen that air from the supplemental reservoir will be delivered to the several chambers in which the main piston, the emergency valve piston and the exhaust stop valve piston are exposed.

The admission valve G⁴ in the structure shown in Fig. 11 simply serves to cut off communication between the auxiliary reservoir and the passage 20 through which air is exhausted from the end of the brake cylinder opposite the large area of the differential piston. Inasmuch however, as the construction and arrangement of admission piston and the manner of connecting a casing provided with such type of piston with the auxiliary reservoir and brake cylinder form the subject matter of another application filed by me of even date herewith, I have not deemed it necessary to more fully illustrate the same in this application, my purpose in showing herein this form of supply piston and valve being merely to illustrate how it may be employed in connection with the main piston and the emergency valve and stop valve mechanism hereinbefore described. By referring to Figs. 2 and 11 of the drawings, it will be seen that the auxiliary reservoir 4 is in constant communication with the end of the brake cylinder opposite the small area of its piston and when the parts are in the position for release as shown in Fig. 11 auxiliary reservoir air will pass freely by the port a^3 , above the admission valve G⁴ and through ports 20 and a^2 to the end of the brake cylinder opposite the large area of its differential piston and will consequently retain the brakes in released position. If now it is desired to set the brakes, train pipe pressure will be reduced by the engineer and the effect of this initial reduction will be to close the check valve C if said valve has not already closed and thus prevent the back flow of air from the auxiliary reservoir through the channel 76. The supply piston G under this reduction of train pipe pressure within the chamber 12 will rise causing the valve G⁴ to cut off communication between the auxiliary reservoir and the channel 20 and thereafter the piston D will rise causing the opening of the release port 23, so as to permit the escape of air from the end of the brake cylinder opposite the large area of the differential piston. The operation of the emergency valve and its piston and of

the stop valve and its piston will be the same as in the form of my invention hereinbefore described. When it is desired to again release the brakes, train pipe pressure will be increased within the chambers 10 and 12, the main piston D will be caused to descend in the manner above described, the emergency valve and its piston, and the exhaust stop valve and its piston will be operated as above set forth and the supply valve G⁴ and its piston G will be returned to the position shown in Fig. 11 of the drawings.

In the modified form of my invention illustrated in Figs. 12 to 16 of the drawings, the casing A is provided with a cover A' having a channel 80 that communicates with the channel 76 and port a³ leading to the auxiliary reservoir and with the chamber 10 in which is the main piston D and from which chamber 10 a port or channel a leads to the train pipe. The back flow of reservoir air through the channel 80 is guarded against by a balanced check valve C, this check valve being provided with the groove c' to admit reservoir air to the end of this stem and the downward movement of this check valve C will be limited by a stop bar R that is bolted to the under side of the cover A'. The casing A shown in Fig. 12 is connected to the auxiliary reservoir, to the brake cylinder and to the train pipe as shown in Fig. 2 of the drawings, and when such form of casing is used the auxiliary reservoir is in constant communication with one end of the main cylinder as shown in Fig. 2. The supply piston G and the supply valve G⁴ are the same in construction as illustrated in Fig. 11 of the drawings and this valve and piston serve in like manner to control the passage of air from the port a³ that connects with the auxiliary reservoir to the channel 20 that connects by the port a² with the end of the brake cylinder opposite the large area of the piston. In this last form of the invention as in that illustrated in Fig. 3, the exhaust from the end of the cylinder opposite the large area of the piston will occur through the port a², the channel 20, the port 23, the chamber 22 and the main exhaust port 21, and the exhaust from the cylinder will be controlled by a valve E that is fixed to the end of the stem d³ of the main piston D. The main piston D is provided with a cup leather packing d' and about the stem of this piston is fitted a packing ring corresponding to the ring 28 shown in Fig. 11 and in like manner is held in place by a retaining ring, the purpose of this packing ring being to tightly close the chamber 25 into which air is admitted from the supplemental reservoir 5 by the port a⁴. The supplemental reservoir receives its supply of air by a passage C³ (see Fig. 13) leading from the chamber above the check valve C and connecting with the port a⁴. In this passage C³ is interposed a check valve C⁴ consisting of a cup leather attached to the stem of the plug-cap at the top of the passage, the cup

leather serving to prevent the back flow of air from the supplemental reservoir. The main piston D is chambered and at the lower end of the stem is formed with a port d³ that opens into the chamber 22, and the upper end of the piston chamber is provided with a screw-threaded cap D² that is provided with a port d³ that is normally closed by the emergency valve H². In this form of my invention the emergency valve H² is held normally closed against train pipe pressure by a coil spring S that bears upon the underside of the valve and encircles a stem h⁴ and the upper face of the valve H² is provided with a stem h⁵ which, when the main piston D has been moved upward under an emergency reduction of air within the train pipe, will contact with the cross-bar R, thereby causing the valve H² to be unseated against the force of the graduating spring S.

From the foregoing description it will be seen that when train pipe pressure has been reduced slightly, the pressure of the auxiliary reservoir acting upon the under side of the supply valve G⁴ and the piston G will cause this piston and valve to rise to the position shown in Fig. 12, after which the reduction of train pipe pressure will permit the stored pressure within the chamber 25, together with the pressure from the brake cylinder within the channel 20 to lift the main piston D until the stem h⁵ of the emergency valve H² contacts with the cross-bar R. This lifting of the main piston D will open the port so as to permit the escape of air from the end of the brake cylinder opposite the large area of the differential piston, but the spring S will arrest any further movement of the main piston D under the slight reduction of train pipe pressure necessary to service applications of the brakes, and as soon as a sufficient escape of air has occurred from the brake cylinder to considerably reduce the pressure upon the end of the stem d³ and upon the under side of the valve H², the valve E will close the port 23 because the slight reduction of train pipe pressure above mentioned will not be sufficient to allow the pressure within the chamber 25 alone to hold the piston D and the valve E in raised position after such considerable reduction of pressure has been had in the brake cylinder. In making service applications of the brakes or for the purpose of merely slacking the speed of the train, the engineer will repeat the operation last above defined until the desired degree of brake pressure has been attained. When however, it is desired to apply the brakes under emergency conditions the engineer will, by means of his engineer's valve, effect a sudden and greater reduction of train pipe pressure and this sudden and greater reduction of pressure will cause the main piston D to rise not only to the position shown in Fig. 12 of the drawings, but to a higher point, thereby causing the valve H² to be arrested in its upward movement by contact of its stem h⁵ with the

cross bar R while the main piston D continues to move upward until its rim d^{10} contacts with the under side of the cover A'. This arrest of the emergency valve H² opens the port d^9 thereby allowing train pipe air to exhaust freely through the port d^9 and thence through the chamber of the main piston and its stem, through the port d^8 into the chamber 22 and by the port 21 to the atmosphere. By thus locally exhausting the train pipe air beneath each car a quick application of the brakes with full force will be effected since the main piston D will remain thus arrested and the emergency valve H² will remain open until the pressure within the train pipe is restored for the purpose of effecting the release of the brakes. When train pipe pressure is thus restored the piston D will be forced to descend thereby causing the emergency valve H² to close the port d^9 and thereafter causing the valve E to close the port 23 and arrest the exhaust from the end of the brake cylinder opposite the larger area of the piston. As the train pipe pressure is thus restored the admission piston G will be caused to descend until the valve G⁴ so far descends as to permit a free passage of air from the auxiliary reservoir by the port a^3 , channel 20 and port a^2 into the end of the brake cylinder opposite the large area of the differential piston and so effect the release of the brakes.

Certain features of the valve mechanism hereinbefore described and illustrated in the accompanying drawings are described and claimed in an application, Serial No. 522,719, filed by me in the Patent Office September 11, 1894, and I do not wish to be understood as claiming in this application any features of invention described herein but specifically made the subject-matter of the claims of said companion application, Serial No. 522,719.

What I claim as new, and desire to secure by Letters Patent, is—

1. In an automatic fluid pressure brake system the combination of a train pipe, an auxiliary reservoir and a brake cylinder, said auxiliary reservoir supplying the air used in both ends of said brake cylinder, a differential piston in said brake cylinder, an air passage connecting the opposite ends of said brake cylinder and closed against admission of train pipe air and suitable valve mechanism for controlling said passage, whereby when communication is established between opposite ends of said cylinder said differential piston will be shifted, substantially as described.

2. In an automatic fluid pressure brake system, the combination of a train pipe, an auxiliary reservoir and a brake cylinder, having closed ends said auxiliary reservoir supplying the air used in both ends of said brake cylinder, a differential piston in said brake cylinder, an air passage connecting the opposite ends of said brake cylinder, and closed against admission of train pipe air and valve mechanism for controlling the release of air from the end of said brake cylinder opposite the

large area of its piston and for controlling the passage, whereby air is delivered from one end of said brake cylinder to the other to effect the operation of said differential piston.

3. In an automatic fluid pressure brake system, the combination of a brake cylinder, an auxiliary reservoir connected with and supplying the air used in both ends of said cylinder, a train pipe and an actuating valve mechanism suitably connected with said train pipe, said reservoir and said brake cylinder; said valve mechanism comprising a casing having a channel extending therethrough for passage of air between opposite ends of the brake cylinder whereby stored air that has been used in one end of said cylinder to shift its piston in one direction may be exhausted into the opposite end of said cylinder in order to shift its piston in the opposite direction and comprising a valve interposed in said channel to cut off passage of air between the opposite ends of the brake cylinder, and to cut off passage of air between the auxiliary reservoir and said channel when said channel is open, and a valve controlling an opening leading from said channel to the exterior of said casing and pistons for said valves exposed on one side to train pipe pressure and upon the other side to pressure in opposition to said train pipe pressure, substantially as described.

4. In an automatic fluid pressure brake system, the combination of a train pipe, a brake cylinder, an auxiliary reservoir and an actuating valve mechanism suitably connected with said train pipe, said brake cylinder and said reservoir, said actuating valve mechanism comprising a passage-way connecting the opposite ends of said brake cylinder and having an exhaust port for the escape of air from one end of said brake cylinder and having a separate valve controlled passage leading to the auxiliary reservoir, said valve mechanism comprising also a valve adapted to control said exhaust port and having connected thereto a differential piston exposed on one side to train pipe pressure and upon its opposite side to pressure of stored air within a chamber of said valve mechanism, a valve for controlling the flow of air between opposite ends of the brake cylinder and having connected thereto, a piston exposed on one side to train pipe pressure and upon its other side to stored air pressure in opposition to said train pipe pressure, substantially as described.

5. In an automatic fluid pressure brake system the combination with the brake cylinder having a differential piston therein, an auxiliary reservoir supplying the air used in both ends of said cylinder whereby both the application and release of the brakes are effected by stored pressure, a train pipe closed against communication with said brake cylinder and an actuating valve mechanism suitably connected with said train pipe, with said reservoir and with said brake cylinder; said actuating valve mechanism being provided with

an exhaust port by which air is released from the end of said brake cylinder opposite the larger area of its piston and being provided also with a valve for controlling said exhaust port, and with a passage connecting the opposite ends of said brake cylinder, and valve mechanism for controlling communication between the opposite ends of said brake cylinder, whereby when communication is established between opposite ends of the brake cylinder the differential piston is caused to shift, substantially as described.

6. In an automatic fluid pressure brake system, the combination with a brake cylinder having a differential piston therein, an auxiliary reservoir supplying the air used in both ends of said cylinder whereby both the application and release of the brakes are effected by stored pressure, a train pipe and an actuating valve mechanism suitably connected with said train pipe, with said reservoir and with said brake cylinder, said actuating valve mechanism being provided with an exhaust port by which air is released from the end of the brake cylinder opposite the larger area of its piston, a valve for controlling said exhaust port, a piston exposed to train pipe pressure for operating said valve, a passage connecting the opposite ends of said brake cylinder and closed against admission of train pipe air and an independent valve and piston for controlling the passage of fluid from the end of the brake cylinder opposite the smaller area of the piston to the end of said cylinder opposite the larger area of the piston, substantially as described.

7. In an automatic fluid pressure brake system, the combination of a train pipe, an auxiliary reservoir and a brake cylinder, said auxiliary reservoir supplying the air used in both ends of said brake cylinder, a differential piston in said brake cylinder, an air passage connecting the opposite ends of said brake cylinder independently of said auxiliary reservoir, and suitable valve mechanism for controlling said passage whereby when communication is established between opposite ends of said brake cylinder the stored air pressure that has been used in the end of said cylinder opposite the smaller area of the piston may be exhausted thence into the opposite end of the cylinder.

8. In an automatic fluid pressure brake system, the combination of a train pipe, an auxiliary reservoir and a brake cylinder, said auxiliary reservoir supplying the air used in both ends of said brake cylinder, a differential piston in said brake cylinder, an air passage connecting the opposite ends of said brake cylinder, and suitable valve mechanism exposed to train pipe pressure for controlling said passage between the opposite ends of the brake cylinder and for controlling communication between one end of said brake cylinder and the auxiliary reservoir whereby communication may be established between opposite ends of said brake cylinder and com-

munication may at the same time be cut off between the brake cylinder and the auxiliary reservoir.

9. In an automatic fluid pressure brake system the combination with a brake cylinder having a differential piston therein, an auxiliary reservoir supplying air used in both ends of said cylinder, whereby both the application and release of the brakes are effected by a stored pressure, a train pipe, and an actuating valve mechanism suitably connected with said train pipe, with said reservoir and with said brake cylinder; said actuating valve mechanism having an exhaust port by which air is released from the end of the brake cylinder opposite the larger area of its piston, a passage connecting the opposite ends of the brake cylinder and connecting also with the auxiliary reservoir, valvular appliances for controlling the passage of air from the auxiliary reservoir to the end of the brake cylinder opposite the smaller area of the piston and for controlling the communication between the two ends of the brake cylinder, whereby air may be exhausted from the end of the brake cylinder opposite the smaller area of its piston to the opposite end of said brake cylinder to release the brakes, and whereby communication may be cut off between the opposite ends of the brake cylinder and may be established and cut off between the auxiliary reservoir and the end of said brake cylinder opposite the smaller area of its piston to apply the brakes, substantially as described.

10. In an automatic fluid pressure brake system, the combination with a brake cylinder, an auxiliary reservoir and a train pipe suitably connected together; of valve mechanism provided with a local exhaust port whereby air is vented from the train pipe, an emergency valve for controlling said local exhaust port, a supplemental piston for operating said emergency valve operated independently of the main piston and exposed upon one side to train pipe pressure and upon its other side to a pressure in opposition to said train pipe pressure, and a main piston whereby said emergency valve and its piston are carried, said emergency valve being arranged to effect a reduction of train pipe pressure beyond that necessary for service application of the brakes, substantially as described.

11. In an automatic fluid pressure brake system the combination of a main piston exposed on one side to train pipe pressure and having a passage therethrough whereby air may be vented from the train pipe, a valve carried by said piston for controlling the exhaust of train pipe air therethrough, and a supplemental piston for operating said valve, said supplemental piston being carried by said main piston and being exposed on one side to train pipe pressure and upon its opposite side to pressure within a chamber of said main piston, substantially as described.

12. In an automatic fluid pressure brake system the combination of a main piston ex-

posed on one side to train pipe pressure and on its other side to pressure in opposition to said train pipe pressure and having a passage therethrough whereby air may be vented from the train pipe, a valve carried by said main piston for controlling the exhaust of train pipe air therethrough, and a supplemental piston for operating said valve, said supplemental piston being exposed on one side to train pipe pressure and being provided with a passage therethrough for the escape of train pipe air, substantially as described.

13. In an automatic fluid pressure brake system, an actuating valve mechanism comprising a casing having an exhaust port therein connected with the brake cylinder, a main piston provided with a valve for controlling said exhaust port and exposed on one side to train pipe pressure and provided with a passage therethrough for locally venting air from the train pipe, a valve for controlling said passage, and a supplemental perforated piston for operating said valve exposed on one side to train pipe pressure and having a tubular stem passing through said main piston and by which stem air may escape from the train pipe, substantially as described.

14. In an automatic fluid pressure brake system, an actuating valve mechanism comprising a casing having an exhaust port therein connected with the brake cylinder, a chambered main piston provided at its end with a valve for controlling the exhaust from the brake cylinder and provided with a passage in the side of its stem for escape of train pipe air, a valve within the hollow stem of said main piston for controlling said escape passage, and a perforated supplemental piston for operating said valve exposed on one side to train pipe pressure and provided with a tubular stem through which train pipe air will pass to the escape passage in the side of the main piston stem, substantially as described.

15. In an automatic fluid pressure brake system, an actuating valve mechanism comprising a main piston exposed on one side to train pipe pressure and on its other side to pressure in opposition to said train pipe pressure and having a passage whereby air may be vented from the train pipe, an emergency valve and a supplemental piston for controlling said passage in the main piston and carried by said main piston, said supplemental piston being exposed to train pipe pressure, and a check for preventing the escape of train pipe air through the passage of the main piston until said piston has been shifted by a reduction

of train pipe pressure, substantially as described.

16. In an automatic fluid pressure brake mechanism, the combination of a main piston exposed on one side to train pipe pressure and on its other side to pressure in opposition to said train pipe pressure, an exhaust passage whereby air is vented from the train pipe, a valve and supplemental piston carried by said main piston for controlling said exhaust passage, an exhaust stop valve for closing said exhaust passage and an independent piston for controlling said exhaust stop valve and exposed on one side to train pipe pressure, substantially as described.

17. In an automatic fluid pressure brake system, the combination of a main piston exposed on one side to train pipe pressure and on its other side to pressure in opposition to said train pipe pressure and having a passage therethrough whereby air may be vented from the train pipe, a valve carried by said main piston for controlling the exhaust of train pipe air therethrough, a supplemental piston for operating said valve, said supplemental piston being exposed on one side to train pipe pressure and being provided with a passage therethrough for the escape of train pipe air, an exhaust stop valve for controlling the passage of air through said supplemental piston and a piston exposed to train pipe pressure for operating said exhaust stop valve, substantially as described.

18. In an automatic fluid pressure brake mechanism, the combination of a main piston, a casing having a chamber to which train pipe pressure is admitted and wherein said main piston is exposed to said pressure, an exhaust passage leading from said chamber and whereby air may be vented from the train pipe, an emergency valve and its operating piston carried by said main piston and serving to control the escape of air through said exhaust passage, an exhaust stop valve for cutting off the flow of train pipe air through said passage and an independent piston for operating said exhaust stop valve, said independent piston having one side exposed to train pipe pressure in said chamber of the casing to which train pipe air is admitted and having its other side exposed to a pressure acting in opposition to said train pipe pressure, substantially as described.

B. FRANK. TEAL

Witnesses:

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FRED GERLACH.