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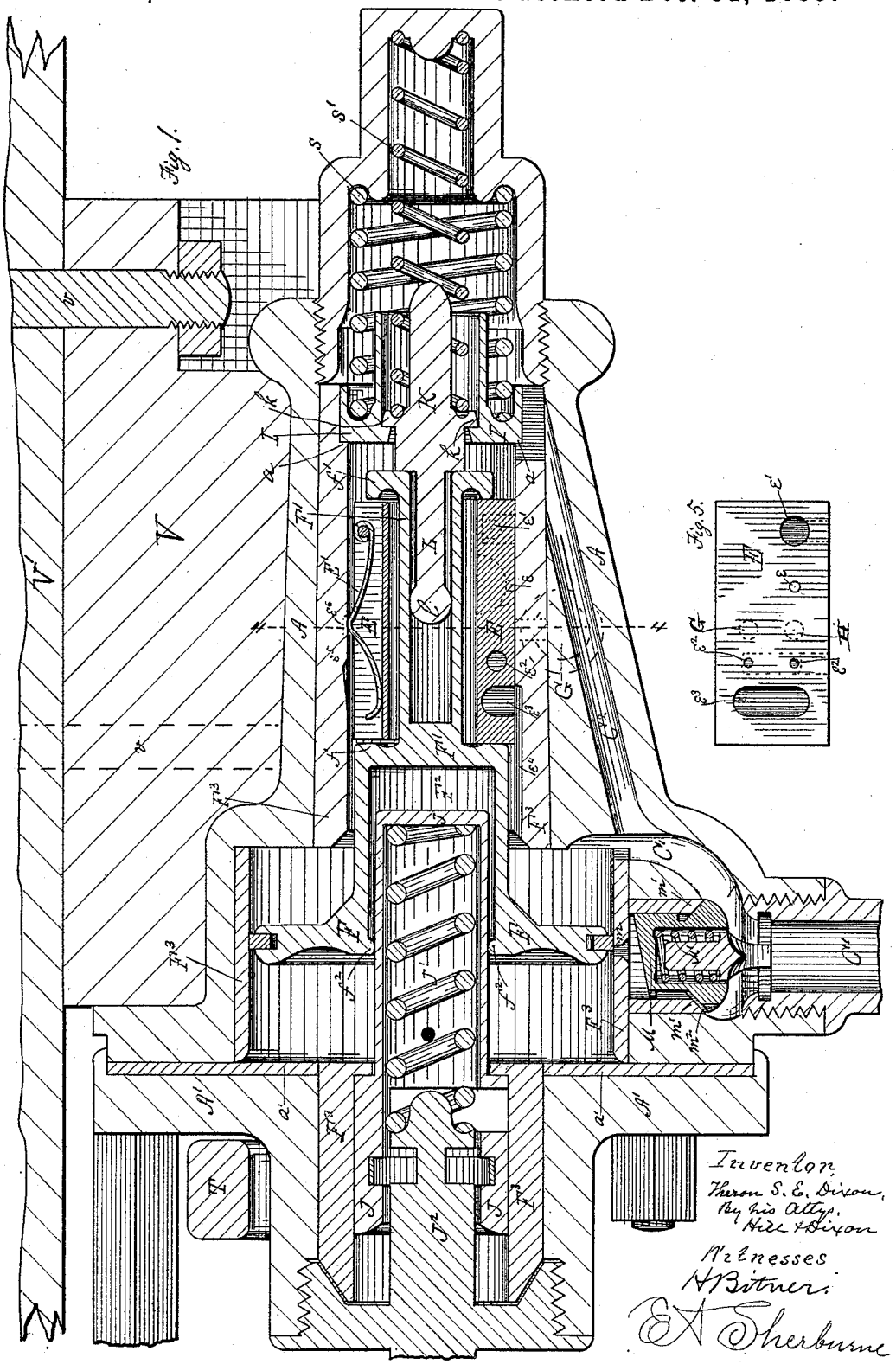
T. S. E. DIXON.

AIR BRAKE.

No. 418,506. Patented Dec. 31, 1889.



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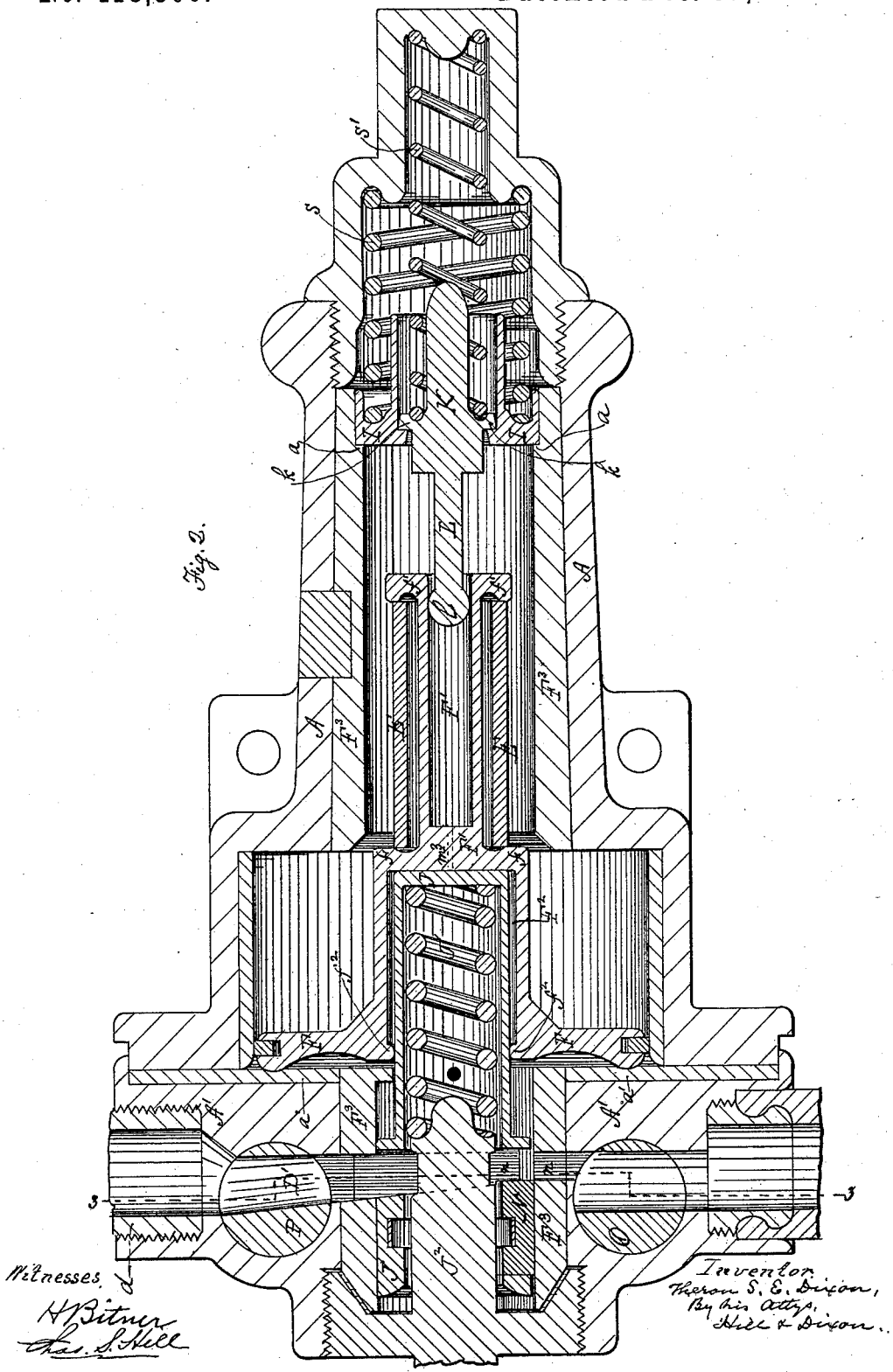

Fig. 2.

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Fig. 3.

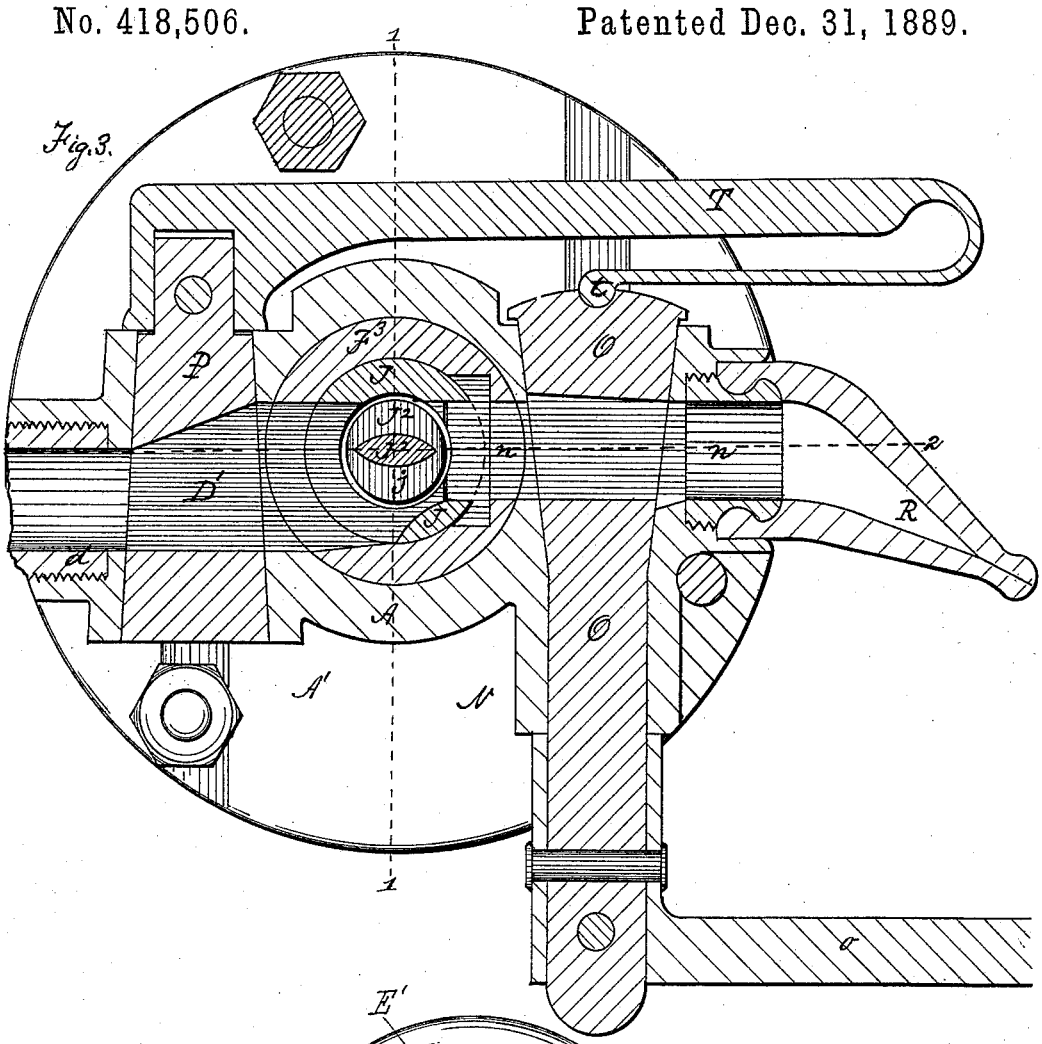
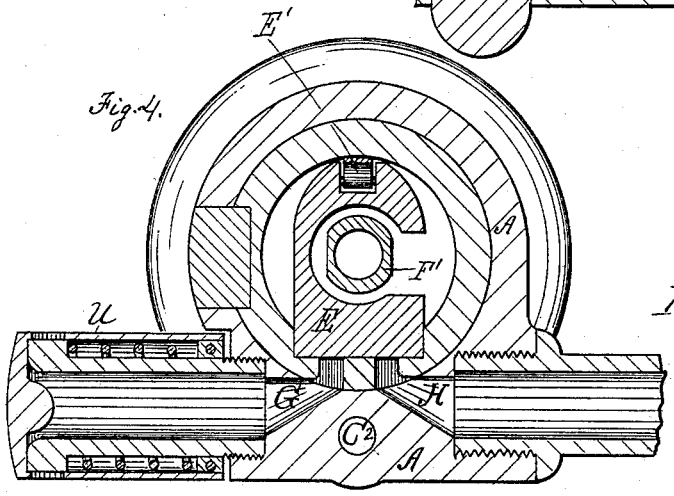


Fig. 4.



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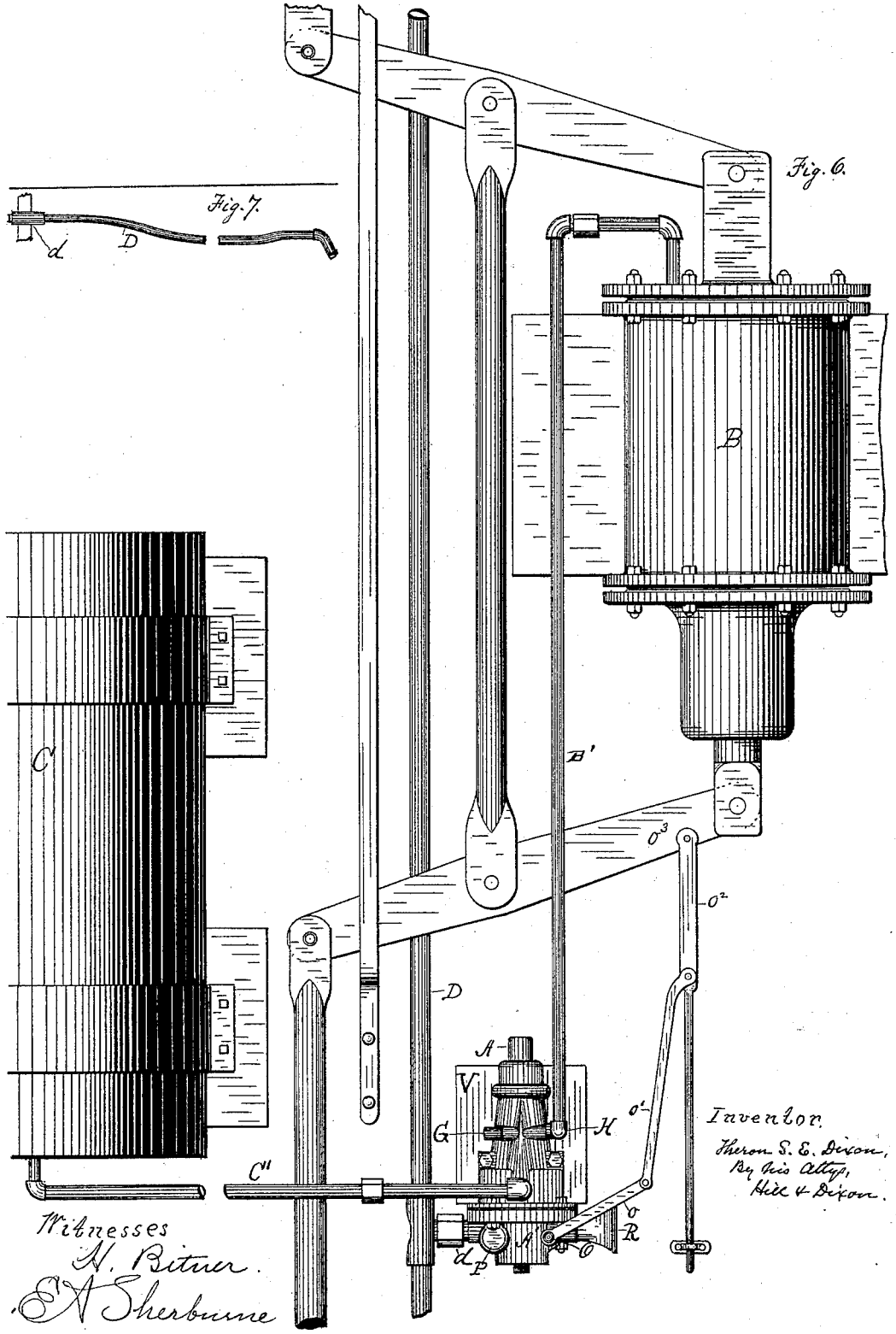

UNITED STATES PATENT OFFICE.

THERON S. E. DIXON, OF CHICAGO, ILLINOIS.

AIR-BRAKE.

SPECIFICATION forming part of Letters Patent No. 418,506, dated December 31, 1889.

Application filed December 2, 1889. Serial No. 332,337. (No model.)

To all whom it may concern:

Be it known that I, THERON S. E. DIXON, a citizen of the United States of America, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Air-Brakes, of which the following is a specification.

Referring to the accompanying drawings, wherein similar reference-letters indicate the same or corresponding parts, Figure 1 is a longitudinal vertical section taken in line 1 1 of Fig. 3. Fig. 2 is a longitudinal horizontal section taken in lines 2 2 of Fig. 3. Fig. 3 is a transverse vertical section taken in lines 3 3 of Fig. 2. Fig. 4 is a transverse vertical section taken in lines 4 4 of Fig. 1. Fig. 5 is a face plan of the valve which forms a portion of the governing-valve device, showing the valve ports and passages, and also showing in dotted circular lines those portions of the valve-surface which come over the ports G H of the valve-casing when the valve is at its normal position. Fig. 6 is a plan view of the brake mechanism as seen when looking upward under the car; and Fig. 7 is a reduced and broken side elevation of the main train-pipe, illustrating the elevated position of the governing-valve for drainage purposes.

This invention comprises certain improvements upon the automatic air-brake apparatus patented to me May 1, 1888, Nos. 382,031 and 382,032; September 18, 1888, No. 389,643, and April 30, 1889, No. 402,418. Of these improvements, which are capable of conjoint or separate use in many different forms of construction and application, the principal ones may be divided into three groups relating, respectively, to the governing-valve, the refilling of the auxiliary reservoirs, and the control of the "quick-action" devices, effecting local discharges of the train-pipe. I will describe these groups in the order above stated, explaining the new principles of operation as I proceed, and adopting the general definitions set forth in my patent, No. 402,418. I shall use the term "governing-valve device" as meaning that device, whatever may be its construction, which is interposed between the air of the train-pipe and that of the auxiliary reservoir and operated by varying the pressure in the train-pipe to admit air from the auxiliary reservoir to the brake-cylinder and discharge it from the brake-cylinder to the atmosphere; the term "local exhaust" or "local discharge" as meaning a discharge of air under each car from the train-pipe to the brake-cylinder or the atmosphere (as the case may be) by means of a local vent provided for such purpose, and shall speak of the governing-valve device as moving outward or inward, according as it moves from or toward the auxiliary reservoir and as being at the service (or emergency) port when its main valve is in position to open said port, and it will be understood that I regard a flexible diaphragm or diaphragms as the known equivalent of a piston or pistons for the purpose of actuating the valves hereinafter mentioned, with the additional definition that by the term "normal positions" as applied to the governing-valve I mean that position which it automatically assumes or occupies when the train-pipe and auxiliary reservoir become equalized after the release of the brakes.

First group: In the patent last mentioned I employed in the governing-valve device two valves—one sensitive and the other non-sensitive—to accomplish in addition to its usual functions the further important function of grading the brake-pressure down when the brakes are set, without releasing them. One of the objects of my present invention is to enable all these functions to be performed by a single valve operated by a single piston or diaphragm, and I have discovered that this may be attained by properly arranging the valve-ports and rendering the valve sensitive in its movement at the middle portion and non-sensitive near the ends of its traverse, thus combining the necessary sensitive and non-sensitive elements in one and the same valve, so as to give it sensitiveness where sensitiveness is needed and non-sensitiveness where non-sensitiveness is necessary, instead of lodging these functions separately in two coacting valves. In accomplishing this I make use of the principle of serial spring-resistances set forth in my patent of May 1, 1888, No. 382,031, with improvements adapted to the new arrangement of the ports and the new results to be produced. The region of necessary sensitiveness in both directions of

movement is limited to the middle part of the valve's traverse, and practically applying this fact to use I give the valve as sensitive a play as possible at this part of its traverse, arranging its normal position and its service-stop position both within the sensitive limits, and opposing its movement from those limits by means of suitable spring-resistances adapted to temporarily arrest it at the proper points, and afterward to return it to its sensitive position.

These improvements may be applied in connection with any form of valve adapted to the purpose. The drawings illustrate the preferable form of apparatus, and may be described as follows:

A is the governing-valve casing, attached by a supporting-block V and bolts *v v* to the under side of the car V′; B, the brake-cylinder, connected to the valve-casing A by a pipe or passage B′ and containing the usual brake-piston and returning-spring; C, the auxiliary reservoir, communicating with the interior of the valve-casing by a pipe or passage C′; D, the train-pipe; E, the valve above referred to, operated by the air-piston F, to which it is connected by the piston-stem F′; G, the exhaust-port through which the brake-cylinder is discharged to release the brakes, and H the port and passage through which said cylinder is charged to apply the brakes, both ports G H (see Fig. 4) being covered by the valve, as shown. The position of these two ports with relation to the valve when at its normal position is indicated by the dotted circles marked G H in Fig. 5. The valve itself is provided with a service-port *e*, a larger emergency-port *e′*, a small transverse channel or passage e^2, and a large transverse recess e^3, and in the inner surface of the valve-casing a groove e^4 extends in under the valve in line with the recess e^3 and of such a length as to communicate with the recess at all times, except when the valve is at the extreme inner end of its traverse, with the brakes quickly releasing. These ports are so arranged that when the valve is moved outward from its normal position (shown in Fig. 1) one step it places the ports *e* H and two steps the ports *e′* H into communication with each other, applying the service-stop and emergency-stop, respectively. When moved inward one step, it connects the ports G H through the small passage e^2 and causes the brake-pressure to be slowly reduced or "graded down," and when moved inward two steps it connects the same ports G H through the large recess e^3 and quickly releases the brakes. At every position of the valve except that last mentioned the recess e^3 is in communication with the reservoir air through the groove e^4, and the air-pressure over the recess therefore balanced, so that the valve is very sensitive in its action. The channel e^2 is so small that the air-pressure over it is insignificant; but to reduce even this to its smallest proportions I prefer to use a bored and plugged passage with small terminal holes to the face of the valve, instead of a channel cut in said face. With this construction the area of the ports G H will practically determine the amount of friction caused by air-pressure against the back of the valve, and in the ordinary working positions it will be so small that it may be disregarded, especially in view of the fact that the valve is controlled by a piston, preferably three and one-half inches in diameter, and therefore of ample power.

It will be seen from the above that the principle involved in the arrangement of the ports consists in placing the ports G H of the valve-casing in a plane more or less transverse to the line of movement of the valve, providing suitable cross-passages in the valve to connect them at the proper points of the valve movement, and arranging the ports *e e′* of the valve in line with the port H in the plane of such movement, and that one principle employed in rendering the valve extremely sensitive consists in providing means for equalizing the pressure in its face-recess with the pressure upon its back. So constructed the valve moves easily and is capable of venting reservoir air slowly or quickly into the brake-cylinder and slowly or quickly out of it, so as to charge, discharge, and grade the brake-pressure just as the engineer may desire. This valve is designed to have a limited range of free sensitive movement at the middle portion of its traverse, but to be opposed, when it attempts to move therefrom in either direction, by an elastic resistance or resistances of predetermined force, which tend to return it to its sensitive position. At the outer end of its traverse the resistance is furnished by the ordinary spring-stop J, which, when the valve moves outward, arrests and detains it at the service-port until the train-pipe air has become sufficiently reduced to allow it to move farther outward and apply the emergency-stop. At the inner end of its traverse I employ two spring-stops or elastic resistances, which come successively into action, opposing its inward movement with different degrees of force. The preferable construction is as follows: The valve E is held, without lost motion, between an annular shoulder *f* at one end and an annular head *f″* at the other end of the piston-stem F′, so as to follow all the movements of the main piston.

I is a ring sliding within the valve-chamber and limited in its outward movement by a stop *a*, against which it is normally held by a spring *s*.

K is a block or stem sliding within the central opening of the ring I, and limited in its outward movement by a stop *k*, which is normally held against said ring by a spring *s′*.

The piston stem, ring, and block are so constructed that as the governing-valve moves inward from its normal position it will first move the block inward, compressing the spring *s′*, and then move the block and ring

inward, compressing both springs *s s'*. I prefer to make the force of spring *s'* equal to about two pounds, that of spring *s* equal to about three pounds, and their united force equal to about five pounds of air-pressure per square inch, acting on the piston F, although these proportions may be varied, if deemed best. With this construction the valve is free to move back and forth between the blocks K and spring-stop J without any resistance except friction, which is reduced to a minimum, while in moving outward and inward from that part of its traverse it is rendered non-sensitive by the opposition of the spring-stop J and springs *s s'*, respectively. Normally it rests against the block K, with all the ports closed. Moved out against the stop J it opens the service-port, and at the outer limit of its traverse the emergency-port. Moved inward against the ring I, it places the ports G H in communication through the small passage e^3 and bleeds down the brake-pressure, and at the inner end of its traverse it places the same ports in communication through the large passage e^3 and quickly releases the brakes. After grading down or releasing, the equalization of air between the train-pipe and auxiliary reservoirs permits the springs *s s'* to return it to its normal position, as hereinafter described.

Further improvements are as follows: To relieve the piston-casing from unequal wear and consequent leakage, it is desirable that the piston should be so supported that its weight will not rest entirely upon the bottom of the chamber in which it moves; and to relieve the piston itself from unequal wear it should be free to turn without disturbing the valve. Various attempts have been made to accomplish these results by providing a guiding-support for the piston, extending either from the piston into the cap A' or from the cap into the piston; but this has heretofore been found impracticable because, owing to imperfections of workmanship and the inequality with which the cap may be bolted to the valve-casing, the guiding-support is liable to be slightly "out of true," and in consequence when the emergency-stop is applied one edge of the piston is held from close contact with the packing-ring *a'*, so that air is liable to leak around it from the reservoir into the empty train-pipe. I have entirely overcome this difficulty by providing a yielding guide for the piston-stem, which allows the piston, under the air-pressure from the reservoir, to rock slightly upon its own guiding-support, and thus to seat itself firmly and evenly against the packing-ring *a'*, even if said guiding-support or the packing-ring *a'* be slightly out of true at the time. The preferable construction is as follows: To save multiplying parts, I employ the cylindrical spring-stem J as the guiding-support for the piston by extending it into a central chamber or recess formed in the piston, as shown at F^2, and providing a rounded annular bead f^2 on the inner wall of the piston to bear upon the guiding-support. In connection with a piston supported in this or any other suitable way I combine the piston-stem F' with a guiding-stem normally held centered by a spring which permits it under the influence of a superior force to yield slightly in any transverse direction and compels it to return to its normal central position when the superior force ceases to act. The guiding-stem may project from the piston-stem into the valve-casing or from the valve-casing into the piston-stem, and may be of any suitable form and construction, the particular construction being immaterial so long as it performs the function of an elastic transversely or laterally yielding guide, automatically tending to hold the piston-stem in its normal central position. I prefer, however, the simple construction shown in Fig. 1, in which a guiding-stem L projects from the block K into the hollow piston-stem and is there provided with a rounded head *l*, closely fitting the bore of the latter stem, in which case the pressure of the spring *s'* upon the block K normally centers the guiding-stem and causes it to center and partially support the piston-stem, while permitting it to yield slightly in any transverse direction under the influence of a sufficient force. With this construction the piston centrally supported and guided at both ends is held in easy suspension, moves easily under slight variations of air-pressure, and is less liable to stick, while able to adjust itself tightly to the ring *a'* and prevent any leakage of air at the emergency-stop. Whatever the form of laterally-yielding guide, the piston-stem is preferably extended loosely through the valve E, and, being unconnected with the valve, except by the shoulders bearing against its ends, is perfectly free to turn without disturbing the valve.

In a train drawn by a locomotive provided with the engineer's brake-valve patented to me October 1, 1889, No. 412,168, when the engineer, after applying the brakes, closes his brake-valve to hold them applied, the limited and slow refilling-pressure admitted from the main reservoir to the train-pipe by said brake-valve will force the governing-valve to the position where it holds the brake-applying ports positively and effectively closed, and therefore no further provision need in that case be made to insure such result; but where a car having the governing-valve hereinabove described is liable to be used with an engine not provided with said brake-valve it is well to give the governing-valve a slight initial resistance, tending to oppose its starting inward from the service-stop position, but disappearing as soon as it moves, so that the air-pressure which acts to move it may preliminarily accumulate for a moment and gather sufficient power to force the valve clear "home" and effectively close said port and hold the brakes set. This improvement will also be of advantage in those forms of brake mech-

anism which employ a small plug-valve to open and close a service-port through a main valve, because it will conduce both to effectively seat the plug-valve and to hold it seated. The spring-stop shown in my patent of September 18, 1888, No. 389,643, at *m* (as there lettered) may be used to accomplish this slight initial resistance, and with a view to such use I have further improved said stop by effecting its function by means of the same spring that is ordinarily employed to press the valve to its seat, and thus saving the expense of a separate spring. To this end I secure the valve-spring E′ to the back of the valve E in any suitable manner and cause it to engage with a slight projection or recess of the valve-casing when the valve is at the service-port, as shown, for example, at e^5. Any other form of slight resistance which acts initially and then disappears may, however, be employed for the purpose. The result is, that when the engineer closes his brake-valve before equalization the reservoir-pressure will fall slightly below the train-pipe pressure before the valve which operates to close the service-port is able to start inward; but when it once starts, the initial resistance disappears, and the slight excess of train-pipe pressure then causes the valve to completely close said port and effectively hold it closed. Should it be found that after closing said port the valve is so sensitive as to be liable to be accidentally dislodged, notwithstanding the friction of the spring piston-packing, a slight recess (shown in dotted lines at e^6, Fig. 1) may also be provided to receive the back of the spring E′, to enable the spring to tend to detain the valve in the position where it holds said port closed, leaving it entirely sensitive in its traverse between the two points of detention e^5 e^6, as already described.

With this last-mentioned improvement, when applied in connection with my improved governing-valve, it will be advantageous to make the recess e^6 of such length as to allow the valve to move freely outward far enough to enable the piston to close the equalizing-port, hereinafter described, without opening any of the valve-ports, the spring then striking the outer end of the recess and temporarily detaining the piston and valve from further accidental outward movement. By this means all reflux of air from the auxiliary reservoir to the train-pipe in applying the brakes will be prevented, and their quick application throughout the train will be absolutely assured. Indeed, with these improvements, the valves will be so sensitive and certain of operation as to effectually prevent shock at the service-stops, rendering the adoption of any special means for that purpose entirely unnecessary.

Second group: The main invention of this group consists in combining an ample refilling-passage with a valve or piston which normally holds it restricted to the dimensions of a small equalizing-passage at all times, except when the excess of train-pipe pressure over and above the auxiliary reservoir-pressure is so great as to insure the quick release of all the brakes throughout the train. By this means provision is made for quick and certain application and release of the brakes, and a quick refilling of the reservoirs whenever desirable, without allowing either of said functions to interfere with the others.

The principle and rationale of this improvement will be best explained by reference to the prior state of the art. For example, in the automatic air-brake systems now in common use the refilling-passage is opened by the arrival of the triple valve at its brake-releasing position, and is not closed again until the brakes are reapplied. When open, the train-pipe air is free to pass into the auxiliary reservoirs until complete equalization takes plates. This takes place consecutively from the front to the rear end of the train, with each reservoir charged somewhat higher than the next in rear; hence, after the forward reservoirs have become equalized at the higher pressures, the depletion of the train-pipe which is still going on at those in rear is liable to reduce its pressure (especially when the main-reservoir supply is short) to such a degree as to render it unable to release the rear brakes and even to endanger the accidental reapplication of the forward brakes. In such a system the prevention of the latter danger can be effected only by allowing the refilling-passage to remain wide open after equalization, because the application of a valve to close or restrict the passage at equalization would simply lock up the higher pressure in the forward reservoirs, after which any considerable reduction of train-pipe pressure by the depletion in rear would be almost certain to reapply the forward brakes, whereas by allowing the passages to remain wide open the reflux of air through them from the reservoirs will aid in preventing such accident. This reflux is, however, injurious when attempting to reapply the brakes, rendering it necessary for the engineer to suddenly discharge a considerable quantity of air from the train-pipe in order to apply them at all, and in long trains occasionally preventing this application on the rear cars. In my patent of April 30, 1889, No. 402,418, I removed these difficulties to some extent by employing an ample refilling-passage H, (as there lettered,) normally restricted to the dimensions of a small equalizing-passage by means of a spring-valve E, (as there lettered,) which, when the passage has been opened, restricts it again before equalization fully takes place, and which therefore operates to reserve at the forward cars a slight excess of train-pipe pressure to aid in supplying the depletion at the rear ones. The spring there used, however, had another function to perform that required its force to be limited, and the consequent reserve of train-pipe pressure effected by it

was only two or three pounds, which is less than the excess required to insure a quick release of the brakes; hence the difficulty, although mitigated, was not entirely removed, because the train-pipe pressure was still liable in long trains to run down, so as not to quickly release the rear brakes, and in extreme cases so as to even endanger the accidental reapplication of the forward ones. My present improvement completely solves all these difficulties by applying a force to hold the restricting-valve closed, which is greater than the force necessary to move the governing-valves to release the brakes. For example, suppose the latter force to be five pounds and the former ten, (measured in terms of air-pressure per square inch upon the actuating devices,) then if the train-pipe pressure be increased six or eight pounds it will release all the brakes without suffering substantial depletion, because only the small equalizing-ports will be open, while if increased twelve or fifteen pounds or more it will merely vent through the ample refilling-ports the excess over ten pounds, retaining the latter pressure in reserve to enforce the release of the rear brakes. During the entire operation the pressure in all the reservoirs will be held considerably lower than that in the train-pipe, so that no accidental reapplication of any of the brakes can occur, and when the operation is ended the excess remaining in the train-pipe will equalize through the restricted passages into the reservoirs, leaving the system ready for the quick reapplication of the brakes by the engineer.

The preferred construction is as follows: Through the under side of the bushing F^3, I cut a port m, leading into the reservoir-pipe C′. Within this chamber I place a piston or plug valve M, seating upward against an annular seat m' and normally held closed by a spring M′, which is adjusted to a force equal, say, to ten pounds air-pressure per square inch, acting on the upper exposed surface of the piston or plug valve, thus rendering it an efficient retaining-valve for retaining in the train-pipe this excess of pressure to insure the release of all the brakes throughout the train. When this valve is pressed down and unseated, it opens an ample port, through which air is free to pass from the train-pipe to the reservoir; but it will close and remain closed unless the train-pipe pressure is ten pounds or more above the reservoir-pressure. In the valve or its seat, preferably the former, I cut a small groove or port m^2, through which equalization is effected, and, if desired, a slow refilling of the reservoir. The passage m is preferably arranged so as to come immediately at the outer edge of the piston F when the latter is at its normal position. It will therefore be open for equalization or slow refilling when the main piston F is in its normal position, and when the piston is moved inward to grade down or release the brakes, and closed to train-pipe air, but open to air flowing from the reservoir and clearing out the passage when said piston is moved outward to apply or grade up the brakes. This construction therefore accomplishes all the objects above described by a very simple and inexpensive means. Moreover, by using the retaining-valve M, controlled by the opposing air-pressures and the spring independently of the force of the governing-valve piston, and operating to fully open and to restrict without entirely closing the air-passage, I am enabled to use a single passage for all purposes, thus dispensing on the one hand with refilling or equalizing passages controlled by the main slide-valve E, and on the other hand with a secondary slow refilling or equalizing passage controlled by a special valve operated by the piston F. In addition to this, the application of the device at the under side of the valve-casing enables it to perform the very useful function of draining the chamber in which the main piston F is arranged, the condensation-water being able at any time to run down through the passage into the auxiliary reservoir. To this end the top of the plug-valve M is preferably beveled, so as to deflect the drainage-water to the restricted opening m^2, through which it will readily pass to the reservoir.

Wherever placed, the device has the very important practical advantage of keeping the small channel m^2 clear of obstruction, because any dust or dirt that may lodge therein when the retaining-valve is closed to a restricted vent will be forced out by the powerful blast of air that sweeps its surface when it fully opens. As the retaining-valve thus closes with, say, ten or twelve pounds excess of pressure remaining in the train-pipe, the restricted port m^2 performs the important function of equalizing such excess into the reservoir after the closing of the valve. Such equalization may, however, be effected by providing anywhere a small secondary passage for this purpose—for example, through the main piston-stem F′, as shown in dotted lines at m^3, Fig. 1, suitable packing being preferably interposed around it where it strikes the stop J. This modification of my invention, however, involves more complication and the additional expense of making the secondary passage, as well as greater liability to clogging up with dirt, and is therefore not regarded as the preferable form.

An extension of the pipe C′ into the inner end of the main piston-chamber provides for the inflow of air from the auxiliary reservoir into said chamber, and enables the latter to drain directly downward into the reservoir. A passage C^2, extending from the chamber in which the two springs s s' are arranged downward to the pipe or passage C′, drains said spring-chamber into the auxiliary reservoir. These two passages—the one leading directly from the reservoir to the periphery of the main piston-chamber and the other leading directly from said reservoir to the

spring-chamber—also enable an increase of reservoir-pressure to reach and act upon the entire face of the main piston when at the inner end of its traverse, thus dispensing with the necessity of providing a groove in the bushing or in the central boss of said piston, as heretofore practiced.

Third group: This relates to the control of the valve whose function is to close the local discharge preparatively to the recharging of the train-pipe, and which I therefore term the "closing-valve." The object of the invention is to provide a closing-valve which shall be simple and inexpensive in construction, and which will remain open with absolute certainty during the operation of the local exhaust from the train-pipe, and when said exhaust has been sufficiently effected will close and remain closed with absolute certainty until the train-pipe has been recharged. The principle of the invention consists in employing a closing-valve which acts independently of the train-pipe pressure, and controlling it by a piston or diaphragm actuated by variations of air-pressure produced by the movements of the governing-valve. As a further improvement, for purposes of simplicity and economy, I employ the brake-piston itself as the valve-controlling agent, by so connecting it to the valve that in the act of applying the brakes it will close the valve, and in the act of releasing them open it.

The preferable construction is as follows: In the drawings, Figs. 2 and 3, n is the local-discharge passage, provided with any suitable opening-valve—for example, the slide-valve N, opened by the outward movement of the governing-valve piston to apply the emergency-stop, and closed by the spring J′ upon the return movement of said piston in the general manner described in my patent of May 1, 1888, No. 382,032. In the passage n, outside of the opening-valve N, I apply the closing-valve O, preferably using for that purpose a common form of turn-cock provided with a handle o. This handle I control by the brake-piston—for example, by connecting the outer end of the handle to one of the cylinder-levers o^3, operated by said piston, as shown at o' o^2, and I arrange the port of the cock so as to be closed by the movement of the piston in the act of applying the brakes and opened by the return movement of said piston in the act of releasing them. As soon as the brakes have been applied, therefore, the valve O will have closed the local discharge, and will hold it closed till they are again released, and the form of the valve O being such that no pressure of train-pipe air in the passage n can tend to open it, the recharging of the train-pipe for the purpose of closing the valve N and releasing the brakes will be unattended with any accidental loss of air through the local-discharge port. The same construction enables me to shorten up the cap A′ by arranging the cock O at one side of the spring-stem J, and connecting the train-pipe D at the other side, where, at a point nearly opposite to the cock O, I place the ordinary cock P, for cutting out any governing-valve from the air-brake system, when desirable so to do, the port through the cock for admitting train-pipe air being shown at D′. To the same end I make the spring-stem J hollow and place the spring J′ inside of it, bearing at its outer end upon a post J^2, through which is provided an opening j, directly in line between the end of the train-pipe passage and the port n, so that when the piston is at the emergency-stop the valve N will open a passage straight from the train-pipe to the open-air port, as shown in Fig. 2. The pressure of the spring J′ tends to hold the stem J central to the piston F, and it is also guided by the inner wall of the cap A′. Suitable holes are provided to freely admit the train-pipe air to the piston-chamber.

In Fig. 6 a guiding device o^2 is represented for guiding the movements of the arm o' when actuated by the cylinder-lever o^3; but this may be dispensed with, if preferred.

Another improvement is as follows: It has been found desirable in practice to fit the cut-off cock P tightly to its seat and apply a retaining-spring to hold it in position when opened and closed. It is also desirable to hold the cock O pressed down into its casing by spring force. By the improvement now referred to I accomplish both objects by the use of a single spring, as shown in Fig. 3, where T is the spring in question, extending from the cock P to the cock O, and provided, preferably, with a projection t, which fits into and presses upon the end of the latter cock when said parts are in their normal working position. The spring, being made tapering and doubled back upon itself, as shown, also serves as a handle for the cock P.

In the automatic air-brake mechanisms heretofore in general use the governing-valves have been arranged below the level of the main train-pipe and below the level of the hose-connections between the cars, and therefore could not drain their condensation-water into and through the main train-pipe. This necessitated either a drain-cup in the valve-casing or a branch or connecting pipe between the main train-pipe and the valve-casing having a downward curve or bend to receive the condensation-water, and the latter construction in turn necessitated such length in the branch as to delay more or less the application of the brakes. To remedy this, I mount the governing-valve device at or above the level of the main train-pipe—that is to say, the connecting-joint by which the train-pipe is attached to the valve-casing and through which the latter drains into the former is elevated to a level which comes at or above that part of said train-pipe which is in the immediate vicinity of the valve-casing and the ends of the iron pipe where it connects with

the flexible coupling-hose between the cars, so that any condensation-water forming in the cap A′ can drain into the main train-pipe, and thence to the coupling-hose, where it will discharge when the cars are uncoupled. I then connect the main train-pipe to the valve-casing as directly as possible, the connecting-joint being shown at *d*. In Fig. 7 the connection to the governing-valve casing is shown at the left-hand end and the connection to the flexible hose between the cars at the right-hand end, the former being slightly above the latter, for the purposes hereinbefore set forth.

R is a rubber or caoutchouc valve applied to the outer end of the local quick-action vent to prevent access of dust to the face of the valve N and cock O.

If preferred, the spring-stop J may be given a slight lateral play in its guiding-bearings, inasmuch as the powerful spring J′, when extended to the inner end of the hollow stop, as shown, will by its longitudinal pressure hold the stop normally in a central position, leaving it free, however, to yield slightly in any transverse direction to permit the adjustment of the piston F to the packing-ring *a′* when at the emergency-stop position.

The device shown at U, Fig. 4, is a dust-shield applied to the outer end of the passage H, which discharges the air from the brake-cylinder to release the brakes, and is not claimed here because already covered by my patent of September 18, 1888.

Having thus described the principles of my several improvements, and the best form in which I contemplate their application, what I claim as new, and desire to secure by Letters Patent, is—

1. In a fluid-pressure brake mechanism, the combination of train-pipe, auxiliary reservoir, brake-cylinder, and a governing-valve device provided with a single controlling-valve adapted to occupy a normal position intermediate between the extremities of its traverse and to open a port from the auxiliary reservoir to the brake-cylinder by its outward movement, and to open a port from the brake-cylinder to the atmosphere by its inward movement, both ports being closed while in its normal position, substantially as described.

2. In a fluid-pressure brake mechanism, the combination of a governing-valve device provided with a single valve controlling a grading-down port and a release-port with a spring-stop to resist with predetermined force the inward movement of said valve from its normal position to the position where it opens the grading-down port, substantially as described.

3. In a fluid-pressure brake mechanism, the combination of a governing-valve device provided with a single valve controlling a grading-down port and a release-port with a spring to resist with predetermined force the inward movement of said valve from its normal position to the position where it opens the grading-down port, and thereafter to return the valve to its normal position, substantially as described.

4. In a fluid-pressure brake mechanism, the combination of a governing-valve controlling a grading-down port and a release-port with a spring to resist with predetermined force the inward movement of said valve from the position where it opens the grading-down port to the position where it opens the release-port, and thereafter to exert its force to return the valve to its normal position, substantially as described.

5. In a fluid-pressure brake mechanism, the combination of a governing-valve controlling a grading-down port and a release-port with two spring-stops which come successively into action to resist with predetermined and different degrees of force the inward movement of said valve from its normal position, first tending to resist with limited force its movement to open the grading-down port, and then tending to resist with greater force its movement to open the release-port, substantially as described.

6. In a fluid-pressure brake mechanism, the combination of a governing-valve controlling a grading-down port and a release-port with two springs which come successively into action to resist with predetermined and different degrees of force the inward movement of said valve from its normal position, first tending to resist with limited force its movement to open the grading-down port, and then tending to resist with greater force its movement to open the release-port, and thereafter coacting to return the valve to its normal position, substantially as described.

7. In a fluid-pressure brake mechanism, the combination of a governing-valve controlling two ports capable of discharging air from the brake-cylinder with two springs which come successively into action to resist the inward movement of said valve to open said ports and to return it to its normal position, substantially as described.

8. In a fluid-pressure brake mechanism, the combination of a governing-valve with a spring to resist its outward movement at a predetermined point in its traverse, and two springs which come successively into action to resist its inward movement at predetermined points in its traverse with different degrees of force, substantially as described.

9. In a fluid-pressure brake mechanism, the combination of a governing-valve with a spring to resist its outward movement and two springs which come successively into action to resist its inward movement, said springs being so arranged as to give the valve free play at the intermediate portion of its traverse, substantially as described.

10. In a fluid-pressure brake mechanism, the combination of the train-pipe, auxiliary reservoir, brake-cylinder, and springs J′ *s s′*, with a governing-valve device which stands in its normal position with the brake-cylinder

port closed when in contact with the spring s' without compressing it, and which opens the service-port when it strikes the spring J', the emergency-port when it compresses the spring J', the grading-down port when it compresses the spring s', and the release-port when it compresses the spring s, substantially as described.

11. In a fluid-pressure brake mechanism, the combination of a valve-seat provided with ports to the brake-cylinder and atmosphere, respectively, with a governing-valve provided with a passage adapted to connect said ports and thereby vent air from the brake-cylinder when said valve is at a predetermined position in its traverse, and means for admitting reservoir air to said passage when the valve is away from said position, whereby the valve is rendered sensitive during a portion of its traverse, substantially as described.

12. In a fluid-pressure brake mechanism, the combination of a valve-seat provided with ports to the brake-cylinder and atmosphere, respectively, with a governing-valve provided with a passage adapted to connect said ports and thereby vent air from the brake-cylinder when said valve is at a predetermined position in its traverse, and with a port or groove in the valve-seat for admitting reservoir air to said passage when the valve is away from said position, substantially as and for the purpose described.

13. In a fluid-pressure brake mechanism, the combination of a valve-seat having ports to the brake-cylinder and atmosphere, respectively, which are out of communication with each other when the governing-valve is at its normal position, with a governing-valve having a port or ports adapted to be brought into communication with said port to the brake-cylinder to vent reservoir air into said cylinder by an outward movement of the valve from its normal position, and also having a passage or passages adapted to place the ports of the valve-seat in communication with each other to vent air from the brake-cylinder by an inward movement of the valve from its normal position, substantially as described.

14. In a fluid-pressure brake mechanism, the combination of a valve-seat having ports to the brake-cylinder and atmosphere, respectively, which are closed and out of communication with each other when the governing-valve is at a predetermined position in its traverse, with a longitudinally-acting spring to resist the movement of the valve inward from said position, and with a governing-valve having a port or ports adapted to be brought into communication with said port to the brake-cylinder to vent reservoir air into the brake-cylinder by an outward movement from said position, and also having a passage or passages adapted to place said ports of the valve-seat in communication with each other to vent air from the brake-cylinder by an inward movement from said position, but only when moved inward sufficiently to place said spring under compression, substantially as described.

15. In a fluid-pressure brake mechanism, the combination of a valve-seat having ports to the brake-cylinder and atmosphere, respectively, with a valve having two passages which are adapted to place said ports in communication with each other at different positions in its traverse, substantially as described.

16. In a fluid-pressure brake mechanism, the combination of a valve-seat having ports to the brake-cylinder and atmosphere, respectively, with a valve having the ports e e' and passages e^2 e^3, adapted to operate with relation to the ports in the valve-seat, substantially as described.

17. In a fluid-pressure brake mechanism, the combination of a valve-seat having ports to the brake-cylinder and atmosphere, respectively, and having a groove e^4, with a valve having the ports e e' and passages e^2 e^3, adapted to operate with relation to the ports and groove in the valve-seat, substantially as described.

18. In a fluid-pressure brake mechanism, the combination of a governing-valve device provided with a single controlling-valve, which, in applying the brakes, is moved outward to open a service-port by the reduction of pressure in the train-pipe, and in order to hold the air-pressure in the brake-cylinder is returned inward in consequence of a reduction of the air-pressure in the auxiliary reservoir, with a spring-stop to temporarily limit its return movement at a point where it holds the passage from the auxiliary reservoir to the brake-cylinder closed and thereby prevent the discharge of air from the brake-cylinder by the continuation thereof, substantially as described.

19. In a fluid-pressure brake mechanism, the combination of a governing-valve whose inward movement to open the brake-release port is opposed by a spring-stop with a port or passage for refilling the auxiliary reservoir, and to control said port or passage a retaining-valve whose opening is opposed by a spring of such force as to prevent it from opening until after the governing-valve shall have fully opened the brake-release port, substantially as described.

20. In a fluid-pressure brake mechanism, the combination of a governing-valve whose inward movement to open the brake-release port is opposed by a spring-stop with a port or passage for refilling the auxiliary reservoir, and to control said port or passage a retaining-valve whose opening is opposed by an independent spring, substantially as described.

21. In a fluid-pressure brake mechanism, the combination of the train-pipe, governing-valve device, brake-cylinder, and auxiliary reservoir, with a passage for refilling the auxiliary reservoir from the train-pipe, pro-

vided with a retaining-valve for holding a sufficient excess of air-pressure in the train-pipe after the governing-valve has been moved to its brake-releasing position to insure the movement of the other governing-valves throughout the train to their brake-releasing positions, with means for equalizing such excess of pressure after the brakes have been released, substantially as described.

22. In a fluid-pressure brake mechanism, the combination of the train-pipe, brake-cylinder, auxiliary reservoir, and a governing-valve device having a spring resisting its movement to the brake-releasing position, with a passage for refilling the auxiliary reservoir from the train-pipe, provided with a retaining-valve for holding a sufficient excess of air-pressure in the train-pipe to insure the movement of the governing-valve to its brake-releasing position, and with a restricted port or passage for equalizing such excess of pressure after the brakes have been released, substantially as described.

23. In a fluid-pressure brake mechanism, the combination of the train-pipe, governing-valve device, brake-cylinder, and auxiliary reservoir, with a passage for refilling the auxiliary reservoir from the train-pipe, provided with a retaining-valve for holding an excess of air-pressure in the train-pipe in effecting the release of the brakes, and a restricted port or opening for equalizing such excess of pressure after the brakes have been released, located between the retaining-valve and its seat, whereby any dirt accidentally lodged in such restricted port or opening may be dislodged upon the opening of the retaining-valves, substantially as described.

24. In the governing-valve device of a fluid-pressure brake mechanism, the combination of the operating-piston with a transversely-yielding guide, substantially as described.

25. In the governing-valve device of a fluid-pressure brake mechanism, the combination of the operating-piston with a spring-stop arranged to act as a transversely-yielding guide, substantially as described.

26. In the governing-valve device of a fluid-pressure brake mechanism, the combination of the operating-piston with a spring-stop arranged at its inner end and adapted to act as a guide for the piston, substantially as described.

27. In the governing-valve device of a fluid-pressure brake mechanism, the combination of the operating-piston with a spring-stop arranged at its inner end and adapted to act as a transversely-yielding guide for the piston, substantially as described.

28. In a fluid-pressure brake mechanism, a governing-valve piston suspended at both ends and capable of a limited oscillation upon its suspending-support, substantially as described.

29. In a fluid-pressure brake mechanism, the combination of a governing-valve piston suspended at both ends and capable of a limited oscillation upon its suspending-support with a spring to resist such oscillation, substantially as described.

30. In a governing-valve device of a fluid-pressure brake mechanism, the combination of the operating-piston with a guiding-support at its outer end and a transversely-yielding guide at its inner end, whereby the piston is held in suspension, but is permitted to have a limited rocking movement, substantially as described.

31. In the governing-valve device of a fluid-pressure brake mechanism, the combination of the operating-piston with a guide for its longitudinal movement held in position by a spring which permits the guide to yield transversely under a deflecting force sufficient to overcome the resistance of the spring, substantially as described.

32. In the governing-valve device of a fluid-pressure brake mechanism, the combination of the operating-piston with a spring-stop and a guide held in lateral position by the stop-spring, substantially as described.

33. In a fluid-pressure brake mechanism in which a passage is opened for locally venting the train-pipe under the car, the combination therewith of a valve or cock for opening and closing said passage, operated by variations of pressure in the brake-cylinder, substantially as described.

34. In a fluid-pressure brake mechanism in which a passage is opened for locally venting the train-pipe under the car, the combination therewith of a valve or cock for closing said passage, operated by the movement of the brake-piston, substantially as described.

35. In a fluid-pressure brake mechanism in which a passage is opened for locally venting the train-pipe under the car, the combination therewith of a valve or cock for opening and closing the same, operated by variations of pressure effected by the governing-valve in a cylinder or chamber independent of the train-pipe, whereby the train-pipe may be recharged and the brakes released without the liability of accidentally reopening said passage, substantially as described.

36. In a fluid-pressure brake mechanism, the combination of two cocks with a spring-handle attached to one and normally engaging in a recess in the end of the other, whereby said handle serves to hold the former in an adjusted position and to press the latter to its seat, substantially as described.

37. In the governing-valve of a fluid-pressure brake mechanism, the combination of a horizontal piston-chamber containing the operating-piston, and a pipe or passage from the auxiliary reservoir opening directly into the bottom of said chamber at the inner side of the piston for the purpose of draining the same, substantially as described.

38. In the governing-valve device of a fluid-pressure brake mechanism, the combination of the operating-piston with a piston-chamber lying horizontal and provided with a res-

ervoir-refilling passage leading downward out of the bottom of said chamber between the limits of the piston traverse, whereby the refilling-passage drains the piston-chamber, substantially as described.

39. In the governing-valve device of a fluid-pressure brake mechanism, the combination of the operating-piston with a piston-chamber lying horizontal and provided with a reservoir-refilling passage leading downward out of the bottom of said chamber at the outer side of the piston when the latter is in its normal position, and a passage for the inflow of air from the reservoir into the piston-chamber at the inner side of the piston, whereby the drainage of the piston-chamber is effectually secured, substantially as described.

40. In the governing-valve device of a fluid-pressure brake mechanism, the combination of the operating-piston with a spring-stop located in a chamber or cap at the inner end of the valve-casing, and a valve-casing provided with two passages for the inflow of air from the auxiliary reservoir, one entering at the inner side of the piston and the other at the inner end of the piston-stem, whereby when the piston is seated at the inner end of its traverse the air entering from the reservoir acts upon its entire inner surface, and whereby both the piston and the spring-chamber are effectually drained, substantially as described.

41. In a fluid-pressure brake mechanism, the combination of the train-pipe and a governing-valve device mounted at or above the level of the main train-pipe and its coupling-hose connection, whereby the casing containing the valve device is drained into a portion or all of said main train-pipe, substantially as described.

42. In the governing-valve device of a fluid-pressure brake mechanism, the combination of an operating-piston or movable abutment and a controlling-valve which in applying the brakes is moved outward to open a service-port by the reduction of pressure in the train-pipe, and in order to hold the air-pressure in the brake-cylinder is returned inward in consequence of a reduction of the air-pressure in the auxiliary reservoir, with means for affording an increased resistance to the initiation of said return movement, whereby any increased resistance encountered by the valve in closing the service-port is overcome and a complete closure thereof effected, substantially as described.

43. In the governing-valve device of a fluid-pressure brake mechanism, the combination of a valve-casing provided with one or more inner projections or depressions and a controlling-valve provided with a spring mounted upon the valve for the purpose of holding it upon its seat and adapted to engage with such depressions or projections at a predetermined point or points in its traverse, substantially as described.

44. In a fluid-pressure brake mechanism, the combination of the piston and governing-valve with a spring-stop to momentarily resist the initial inward movement of the valve to close the service-port, substantially as described.

45. In the governing-valve device of a fluid-pressure brake mechanism, the combination of an operating-piston or movable abutment and a controlling-valve which in applying the brakes is moved outward to open a service-port by the reduction of pressure in the train-pipe, and in order to hold the air-pressure in the brake-cylinder is returned inward in consequence of a reduction of air-pressure in the auxiliary reservoir, with a lateral spring-stop so applied as to act upon the valve while it is holding the service-port closed and the brakes applied to momentarily resist the outward movement of said valve to open said port, substantially as described.

46. In the governing-valve device of a fluid-pressure brake mechanism, the combination of an operating-piston or movable abutment and a controlling-valve which in applying the brakes is moved outward to open a service-port by a reduction of pressure in the train-pipe, and in order to hold the air-pressure in the brake-cylinder is returned inward in consequence of a reduction of the air-pressure in the auxiliary reservoir, with means for affording an increased resistance to the initiation of said outward movement to prevent the accidental opening of the service-port, substantially as described.

47. In the governing-valve device of a fluid-pressure brake mechanism, the combination of an operating-piston or movable abutment and a controlling-valve which in applying the brakes is moved outward to open a service-port by a reduction of pressure in the train-pipe, and in order to hold the air-pressure in the brake-cylinder is returned inward in consequence of a reduction of the air-pressure in the auxiliary reservoir, with means for affording an increased resistance to said outward movement to prevent the accidental opening of the service-port and for affording the valve a slight play before it encounters said increased resistance, substantially as and for the purpose set forth.

48. In a fluid-pressure brake mechanism, the combination of the train-pipe, auxiliary reservoir, brake-cylinder, and a governing-valve device controlling the ports or passages between the auxiliary reservoir and the brake-cylinder and between the brake-cylinder and the atmosphere, arranged so that at the normal pressure the port or passage to the brake-cylinder is held closed, and an increase of pressure in the train-pipe acts to open said port or passage to the atmosphere.

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