No. 761,651. PATENTED JUNE 7, 1904.

J. W. BINGLEY.

AIR BRAKE.

APPLICATION FILED OCT. 16, 1903.

NO MODEL.

Fig. 1,

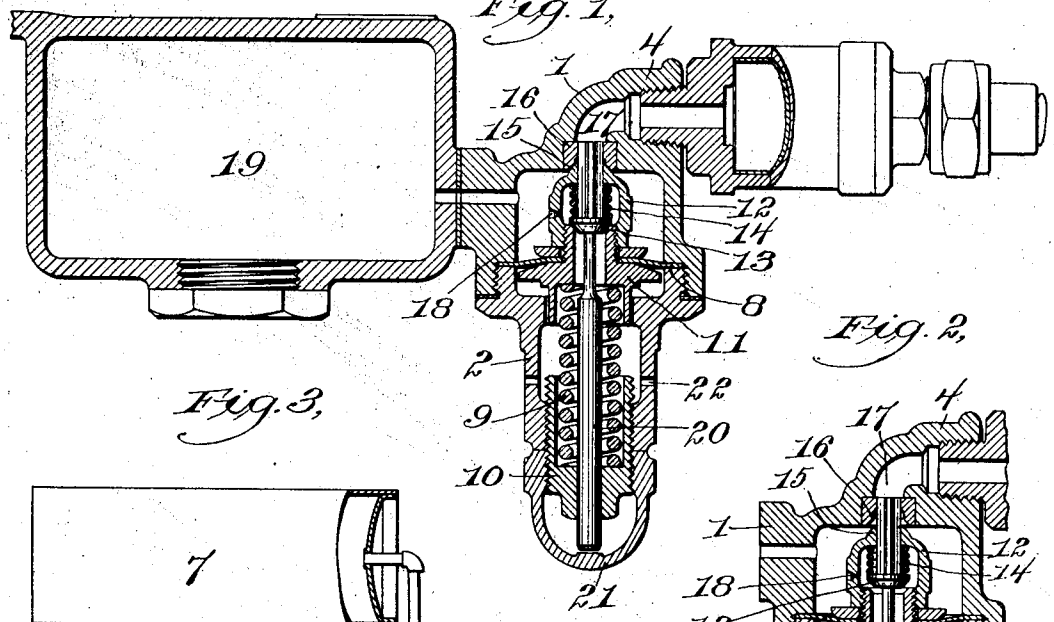


Fig. 2,

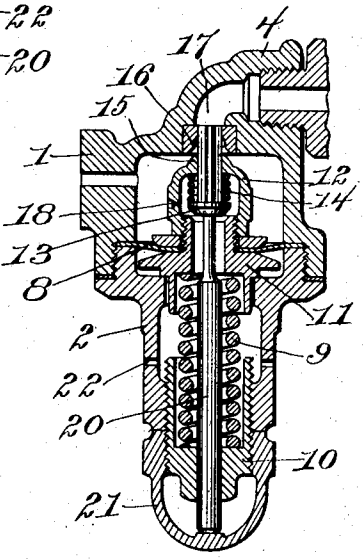


Fig. 3,

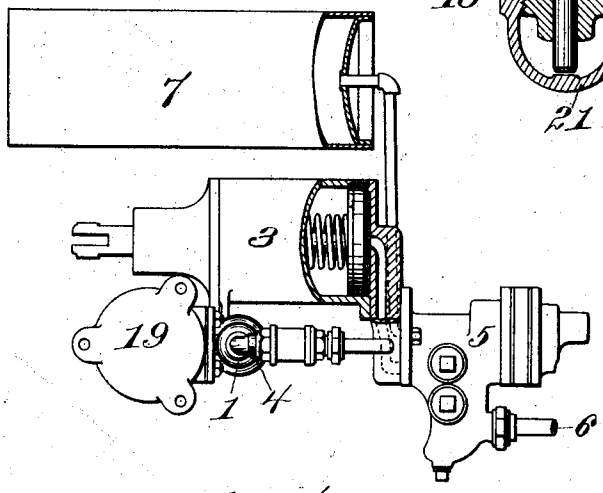


Fig. 4,

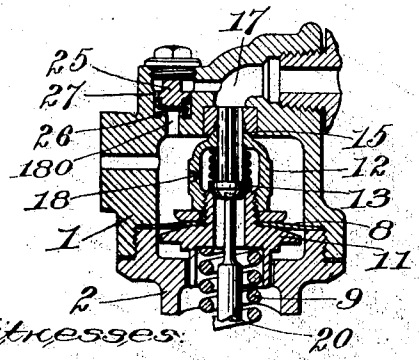
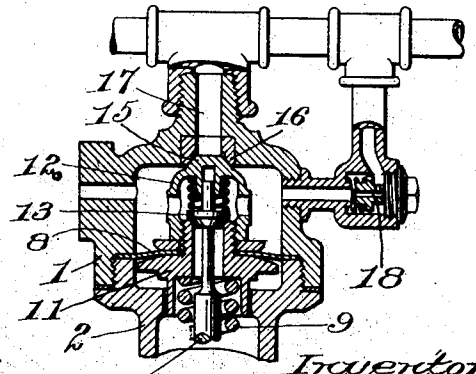


Fig. 5,



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UNITED STATES PATENT OFFICE.

JOHN W. BINGLEY, OF WATERTOWN, NEW YORK, ASSIGNOR TO NEW YORK AIR BRAKE COMPANY, A CORPORATION OF NEW JERSEY.

AIR-BRAKE.

SPECIFICATION forming part of Letters Patent No. 761,651, dated June 7, 1904.

Application filed October 16, 1903. Serial No. 177,317. (No model.)

To all whom it may concern:

Be it known that I, JOHN W. BINGLEY, of Watertown, county of Jefferson, and State of New York, have invented an Improvement in Air-Brakes, of which the following description, in connection with the accompanying drawings, is a specification, like numerals on the drawings representing like parts.

This invention relates to an air-brake apparatus, and is shown as employed in an apparatus of the kind commonly known as the "automatic" air-brake in which the brake-cylinder is charged with air from an auxiliary reservoir on the car under control of a triple valve coöperating with the train-pipe, auxiliary reservoir, and brake-cylinder to cause the brakes to be applied and released in response to changes in pressure of air in the train-pipe, which may be controlled by the engineer.

The present invention relates, mainly, to an appliance to be used in connection with the brake-cylinder or with the passage through which air is admitted to and exhausted from the brake-cylinder in the operation of applying and releasing the brakes, and is especially applicable to brakes designed for use on trains running at high speed.

For very fast running trains it has been found desirable to provide greater power for the brakes than is employed in connection with rolling-stock of the same character which is regularly run at a considerably lower speed, and one way of providing for increased power of the brakes is to increase the air-pressure employed in the system beyond that commonly used on trains regularly running at a lower speed. For example, an equipment designed for use on trains regularly running at about forty miles an hour as a maximum and having the standard or normal air-pressure in the train-pipe and auxiliary reservoirs seventy pounds might be used, with an air-pressure of one hundred and ten pounds for trains regularly running at a maximum speed of sixty miles or more.

In emergency applications of the brakes the maximum pressure should be obtained in the brake-cylinders as promptly as possible, and with a high-speed equipment the pressure in the brake-cylinders produced in emergency applications of the brakes may be sixty per cent. or more greater than that commonly employed in a similar equipment as used on trains normally running at a considerably lower speed.

While the increased brake-cylinder pressure is effective and desirable to reduce the speed of a rapidly-running train as soon as possible, it is likely to give too great braking force after the speed of the train has been materially reduced and might then cause the locking of the wheels, so that they would slide on the rails, thus damaging the wheels and acting less effectively to bring the train to a standstill than if the braking force were just less than that which is sufficient to lock the wheels against rotation.

The present invention is embodied in an apparatus which operates automatically to reduce the pressure in the brake-cylinder to a predetermined and regulable amount at the end of a predetermined and regulable period of time after the brakes have been applied with maximum force. Thus the brakes may be applied with adequate force to be very effective in checking the speed of the train when running at a high rate of speed—for example, sixty miles an hour or more—and after the brakes have remained applied with a maximum force a sufficient length of time materially to reduce the speed of the train—for example, to a speed of from thirty to forty miles an hour—the braking pressure is promptly reduced to an amount which will be more effective and reliable for bringing the train to a standstill from the lower speed than the maximum braking force originally applied.

The apparatus forming the subject of this invention may also serve automatically to relieve the pressure in the brake-cylinder in making service applications of the brakes, so that the excessive or maximum pressure carried in the system for use in emergency on the rapidly-running train is not effective in the brake-cylinders in making ordinary service applications of the brakes.

The apparatus forming the subject of this invention comprises a relief-valve controlling

an exhaust or air-escape passage from the brake-cylinder and operating like an ordinary safety-valve to open when subjected to pressure above a predetermined amount and to close when the pressure falls by reason of the escape through the open relief-valve to a predetermined amount, said relief-valve being combined with appliances which render the brake-cylinder pressure ineffective to open the relief-valve until after a definite period of time has elapsed with the brake-cylinder containing a pressure greater than that required to open the relief-valve.

Figure 1 is a longitudinal section of an air-brake appliance forming the subject of this invention, the parts being shown in the normal position occupied when the brakes are released, which is also the position occupied in service applications of the brakes, and for a definite time interval after an emergency application of the brakes has been made and again after the brake-cylinder pressure has been relieved. Fig. 2 is a similar section of the main operative parts of the device in the position occupied when the relief-valve is opened to relieve the pressure in the brake-cylinder and cause it to be diminished from the unusual or excessive amount employed in making an emergency application of the brakes to a predetermined lower pressure which may be regarded as the maximum pressure in the normal working of the apparatus, being the maximum pressure employed in making the regular service stops of the trains. Fig. 3 is a representation, on a small scale, of the main components of a car equipment of the automatic air-brake system in connection with which the device forming the subject of this invention is shown as used; and Figs. 4 and 5 are sectional views showing modified constructions of the apparatus forming the subject of this invention.

The working parts of the brake-cylinder relief-valve forming the subject of this invention are contained in a valve-body composed of a main or base section 1 and a section 2, connected therewith and constituting the spring-chamber for the spring which determines the pressure to which the pressure in the brake-cylinder is lowered by the operation of the relief-valve. The main or base section 1 of the relief-valve is adapted to be connected with the brake-cylinder 3 (see Fig. 3) of the automatic air-brake apparatus, said section 1 being shown as provided with a screw-threaded neck 4, constituting the inlet duct or tube and adapted to be connected with the head of the brake-cylinder or with a passage in constant communication therewith—as, for example, the passage from the triple valve 5 to the brake-cylinder in the usual automatic air-brake apparatus comprising the brake-cylinder 3, triple valve 5, train-pipe 6, and auxiliary reservoir 7, which, in connection with the brake-rigging, constitute the equipment for each car.

The details of the car equipment are not shown, as they are well understood, and the relief-valve forming the subject of the present invention may be employed in conjunction with any air-brake apparatus containing a brake-cylinder or equivalent the fluid-pressure in which causes the brakes to be applied with a braking force dependent upon the fluid-pressure exerted in the brake-cylinder.

The relief-valve comprises a diaphragm 8, forming a part of a movable abutment, which is subjected at its upper side to the pressure of the fluid contained in the chamber formed in the base portion 1 of the relief-valve and acted upon by a determinate force in opposition to said pressure, which in the construction shown is derived from the spring 9, contained in the spring-chamber, said spring being supported to exert its pressure against the movable abutment by the spring-abutment 10, shown as screw-threaded and adjustable in the spring-chamber 2, for the purpose of regulating the effective force of the spring against the movable abutment. The diaphragm proper or flexible portion 8 of the movable abutment is shown as having its outer periphery secured between the portions 1 2 of the casing, which, as shown in this instance, are screwed together, with the outer periphery of the diaphragm 8 lying between a shoulder formed in the base portion 1 and the end of the screw-threaded portion of the part 2 of the casing.

The diaphragm proper of the movable abutment has a central opening through it, the said diaphragm 8 being shown in this instance as of annular form and having its inner periphery secured between two rigid portions 11 12, the lower portion, 11, of which is provided with a seat or bearing for the spring 9 and with a tubular neck working loosely in an opening in the upper end of the spring-chamber and serving to contribute to the guidance of the movable abutment when moved in response to the preponderance of pressure upon its upper or lower side. The portion 11 of the movable abutment is provided with a central opening or passage through it terminating at its upper end in a seat for a valve 13, shown as of the puppet-valve type, which is lightly pressed against its seat by a spring 14, contained between the valve 13 and the portion 12 of the movable abutment. Said portion 12 of the movable abutment is provided at its upper end with an annular valve 15, which seats tightly upon a seat 16, surrounding the inlet 17 through the neck 4 to the chamber in the base portion 1 of the valve.

The stem of the valve 13 works through the central opening of the annular valve 15 and in the inlet-passage 17, the said valve-stem being star-shaped or longitudinally grooved, so as to permit the free flow of fluid along it.

The upper portion 12 of the movable abutment, together with the valve 15 when seated, constitutes a partition separating the chamber of the valve 13 from the main chamber in the base portion 1 of the casing, so that with the parts in the normal position (shown in Fig. 1) the fluid-pressure in the brake-cylinder, whatever it may be, is admitted through the inlet 17 and opening in the annular valve 15 into the chamber of the valve 13, but said pressure is excluded from the main diaphragm-chamber in the base portion 1 of the apparatus surrounding the upper portion 12 of the movable abutment. Thus with the parts in the normal position the movable abutment is subjected to a fluid-pressure derived from and equal to that in the brake-cylinder over only an area equal to the area of the opening through the annular valve 15 and the movable abutment is subjected to a further pressure in the same direction derived from the fluid-pressure, whatever it may be, in the diaphragm-chamber surrounding the portion 12 over an area equal to the full area of the movable abutment less the area inclosed in the outer periphery of the annular valve 15. A valve-controlled partition is thus afforded between the portion of the apparatus that is constantly or normally subjected to brake-cylinder pressure and the fluid-pressure chamber, which has been called the "diaphragm-chamber" and which contains the fluid which is the main agent in actuating the movable abutment, which itself constitutes the actuator for the two valves thus far described—namely, the pressure-excluding valve 15 and the relief-valve proper, 13, the former of which acts, as has been already explained, to exclude the brake-cylinder pressure from the diaphragm-chamber when said pressure-excluding valve is seated and when unseated admits the brake-cylinder pressure freely into the said diaphragm-chamber, while the latter valve, 13, is the one through which the brake-cylinder pressure is relieved by exhaust or escape of air to the atmosphere, as will be hereinafter explained. A small passage or by-pass 18 is provided to afford restricted communication between the spaces at the two sides of the partition—that is, from the brake-cylinder side to the diaphragm-chamber—said passage being shown in Figs. 1 and 2 as formed through the portion 12 of the movable abutment. This by-pass or connecting-passage 18 remains constantly open and permits the fluid to flow from the brake-cylinder side of the partition into the diaphragm-chamber, in which it acts upon the upper surface of the movable abutment in opposition to the spring 9. The passage 18 is made small, so that an appreciable determinable time will be required for the fluid entering the diaphragm-chamber from the brake-cylinder to acquire the pressure that is exerted at the brake-cylinder side of the partition, and as it is impracticable to reduce the size of a fluid-passage such as 18 beyond a certain limit the time required to charge the diaphragm-chamber outside of or beyond the partition is increased by placing a small chamber or reservoir 19 in communication with the diaphragm-chamber formed in the base portion 1 of the apparatus around the partition formed by the upper portion 12 of the movable abutment. Thus when fluid is admitted under pressure into the brake-cylinder it passes at once into the interior of the portion 12 of the movable abutment, in which the pressure is at all times substantially the same as that in the brake-cylinder and from which the fluid under pressure passes through the passage 18 into the diaphragm-chamber and into the small reservoir 19, the aggregate capacity of which is such with reference to the capacity of the passage 18 as to require a certain period of time for the pressure therein to equalize approximately with the brake-cylinder pressure at the other side of the partition.

The valve 13 is provided with a stop or unseating device, shown as a rod 20, the lower end of which is normally slightly above the inner surface of a cap 21, surmounting the spring-chamber 2, said cap being shown as screwed upon the adjusting-screw 10 for the spring, and thus serving as a check-nut or means for locking the said screw when adjusted to the desired point and also serving as a cap or finishing-cover for the spring-chamber and as a stop or abutment for the unseating-rod of the valve 13.

When the movable abutment is depressed by fluid-pressure under the conditions which will be hereinafter described, the valve 13 at first moves with and remains seated on the portion 11 of the movable abutment until after the latter has moved so as to unseat the valve 15, when the rod 20 is arrested by the cap 21, so that in the further travel of the movable abutment the seat moves away from the valve 13, which thus becomes unseated or is opened and permits the fluid to flow past it through the opening in the portion 11 of the movable abutment and thence into the spring-chamber, which is provided with one or more vent-passages 22 to the external atmosphere.

The operation of the apparatus is as follows: The spring 9 is adjusted to counterbalance a pressure on substantially the full area of the movable abutment 8 which is the maximum pressure which it is desired should be produced in the brake-cylinder in service applications of the brakes and is the pressure to which the fluid in the brake-cylinder should be lowered after it has been applied for a predetermined time at a greater pressure for the purpose of checking a train running at high speed in case of emergency. It may be assumed, for example, that the brake-cylinder pressure to be used as a maximum in service applications is sixty pounds to the square inch and that in emergency application it is

eighty-five pounds to the square inch, this being the pressure of equalization of the fluid normally carried in the auxiliary reservoir when expanded into the brake-cylinder when placed and maintained in communication therewith, as in making an emergency application of the brake. The spring 9 will then be adjusted to just counterbalance when in normal position, as shown in Fig. 1, a pressure of sixty pounds to the square inch on the movable abutment. The volume or capacity of the space beyond the partition from the brake-cylinder, including the space in the base portion 1 of the valve-casing and in the supplemental reservoir or chamber 19, freely communicating therewith, is so proportioned with reference to the size of the passage 18 that it will require the desired length of time—say, for example, ten seconds—that the brakes should remain applied with the additional force used in case of emergency before the said space will be charged by flow of air from the brake-cylinder through the passage 18 up to the pressure, assumed to be sixty pounds, to which the fluid in the brake-cylinder is to be lowered after the brakes have remained at the higher pressure for the time thus determined. Normally the casing of the relief-valve and supplemental reservoir 19 will contain air at atmospheric pressure, being in communication with the brake-cylinder, which normally is open to the atmosphere while the train is running or standing with the brakes released. When an emergency application of the brakes is made with the parts proportioned as above assumed, the auxiliary reservoir will be placed by the triple valve in communication with the brake-cylinder and the pressure will equalize in the auxiliary reservoir and brake-cylinder at approximately eighty-five pounds, which pressure will also be exerted through the inlet-passage 17 and at the inside of the partition 12 in the movable abutment of the relief-valve. The fluid will flow under this pressure through the passage 18, and thus will gradually raise the pressure in the diaphragm-chamber of the relief-valve, wherein it will act upon the greater part of the area of the movable abutment. The pressure outside of the partition—*i. e.*, beyond it relative to the brake-cylinder—will thus increase at a definite time-rate and with the proportions before assumed will in ten seconds rise to sixty pounds to the square inch, which acting upon the upper surface of the movable abutment will overcome the spring 9, and thus depress the movable abutment and unseat the valve 15. The unseating of the valve 15 will permit the brake-cylinder pressure of approximately eighty-five pounds to be exerted practically instantaneously over the entire area of the movable abutment, thus strongly overpowering the spring 9 and causing the movable abutment to travel to the full limit of its movement, where it is arrested, as shown in Fig. 2, by engagement with the upper end of the spring-chamber.

In the latter part of the travel of the movable abutment the valve 13 is arrested, and its seat moving from it leaves the passage through the movable abutment open, so that air flows from the brake-cylinder through the movable abutment past the relief-valve 13 and finally through the escape-passages 22 to the atmosphere, this flow continuing until the brake-cylinder pressure is reduced to the point counterbalanced by the spring 9, the pressure of which will then move back the movable abutment and seat the valves 13 and 15, restoring the parts to the normal position, (shown in Fig. 1,) but with the brake-cylinder pressure lowered to the point determined by the force of the spring 9 of the relief-valve—*i. e.*, with the proportions assumed to the pressure of sixty pounds to the square inch. So long as the pressure exerted in the brake-cylinder does not exceed this point, the relief-valve will remain closed and the brake apparatus will operate the same as if the relief-valve were not a part of the same.

In making service applications of the brakes the air is permitted to flow from the auxiliary reservoir into the brake-cylinder at a relatively slow rate as compared with that at which the air enters in making emergency applications, in which the brake-cylinder is charged with maximum pressure as rapidly as possible. Ordinarily in making service applications the air is admitted to the brake-cylinder in several successive operations, the engineer at first reducing the train-pipe pressure so as to admit a moderate pressure of air to the brake-cylinder, which is then retained therein and augmented from time to time by the engineer, who causes the successive additions of air-pressure to be made according to his judgment, so as to bring the train to a standstill at the desired point, which may be done without utilizing the full pressure attainable in the brake-cylinders and as commonly done requires the full pressure, if at all, only shortly before the train is brought to a standstill. In the usual manipulation of the brakes, therefore, the pressure has time to equalize in the diaphragm-chamber of the relief-valve forming the subject of this invention with the brake-cylinder pressure after the first partial admission of air to the brake-cylinder and before the pressure has been augmented therein, and so on after each successive increase in air-pressure, so that by the time that the brake-cylinder pressure has risen to the maximum desired for the service applications, assumed in this case to be sixty pounds to the square inch, the pressure in the diaphragm-chamber will also have risen nearly to sixty pounds to the square inch, and any further increase in brake-cylinder pressure will therefore almost immediately produce sufficient pressure on the movable abutment to over-

come the spring 9 and cause the relief-valve to open so as to relieve the brake-cylinder of such slight excess of pressure over sixty pounds as may have been required to cause the opening of the relief-valve. When, however, a full service application of the brakes is made as promptly as possible by the engineer, the brake-cylinder pressure, although increasing gradually and slowly as compared with the time required in making an emergency application, may increase at a more rapid rate than the pressure in the diaphragm-chamber increases by admission of air through the by-pass 18. In making the regular full service application, for example, the brake-cylinder pressure may rise to sixty pounds in an interval of four or five seconds, while with the proportions assumed it would require more than ten seconds for the pressure in the diaphragm-chamber to rise to sixty pounds, as the air would be flowing through the by-pass 18 under less pressure than is the case in an emergency application in which it was assumed to acquire sixty pounds pressure in the diaphragm-chamber with the air flowing thereto from a brake-cylinder pressure of eighty-five pounds in an interval of ten seconds. Therefore with the construction shown in Fig. 1 under the conditions last assumed the pressure in making a full application of the brakes would rise above sixty pounds and might acquire approximately the full pressure of equalization, assumed to be eighty-five pounds, before the diaphragm-chamber would have acquired a sufficient pressure to cause the relief-valve to open. This might not in practice be objectionable, as the brake-cylinder pressure would be promptly relieved within slightly over ten seconds after the beginning of the service application of the brakes and shortly after the full pressure of equalization had been attained, which under the conditions of service would generally be before the speed of the train was sufficiently reduced to render the additional brake-cylinder pressure objectionable. If, however, it is desired to relieve the brake-cylinder pressure in service applications as soon as it exceeds the assumed normal maximum pressure of sixty pounds, this may be accomplished by constructing the by-pass so that with the gradual increase of brake-cylinder pressure which takes place in a service application the pressure in the diaphragm-chamber will rise substantially as rapidly as the brake-cylinder pressure.

In the construction shown in Fig. 4, for example, an additional or supplemental by-pass 180 is provided, said by-pass or passage from the brake-cylinder to the diaphragm-chamber containing a valve 25, normally held unseated by a light spring 26 and having a passage 27 through the portion of said valve outside of the area that covers the port-opening controlled by it, which passage 27, in connection with the by-pass 18, affords sufficient capacity for the flow of air from the brake-cylinder into the diaphragm-chamber to charge the latter approximately as rapidly as the brake-cylinder pressure increases in a service application of the brakes, so that the pressure on both sides of the partition remains approximately equal, and the pressure on the movable abutment rises to sixty pounds by the time that the brake-cylinder pressure has risen to sixty pounds or only slightly in excess thereof. Therefore when the brake-cylinder pressure exceeds sixty pounds the movable abutment will be actuated to open the vent-valve, which then operates as an ordinary safety-valve or relief-valve to prevent further rise in brake-cylinder pressure. When, however, the brake-cylinder pressure is raised promptly, as in making an emergency application of the brakes, the sudden access of pressure on the piston-valve 25 will overcome its spring 26 and seat the said valve, thus closing the supplemental by-pass and permitting the air to flow into the diaphragm-chamber only through the main by-pass 18, so that the apparatus then operates precisely the same as described in connection with the construction shown in Fig. 1.

The invention is not limited to the specific construction shown, which may be varied widely in details, another modification being illustrated in Fig. 5, wherein the pressure-excluding valve 15 is not of annular form, but seats directly over and closes the inlet-passage 17, while the main by-pass 18 is formed in a passage from the brake-cylinder connection to the diaphragm-chamber of the pressure-excluding valve 15. If both main and supplementary by-passes are required for the purpose explained in connection with Fig. 4, they may be made, as shown, in a valve working in the by-pass passage and having the main by-pass formed within the port-covering portion of the valve, so as to remain open when the valve is seated, while the supplementary by-pass is formed in or near the periphery of the valve or by a loose fit of the valve in the cylindrical chamber in which it works. With a relatively slow increase in the brake-cylinder pressure the air will flow both through and around the piston-valve and charge the diaphragm-chamber approximately as rapidly as the brake-cylinder is charged; but with a sudden increase of brake-cylinder pressure, such as produced in making an emergency application, the valve will be seated and the diaphragm-chamber will be charged only through the main by-pass passage through said valve, so that the desired predetermined time will be required before the pressure in the diaphragm-chamber becomes sufficient to cause the relief-valve to open.

The term "movable abutment" is intended to include any device in the nature of a piston or diaphragm that is subjected to fluid-pressure which when sufficient produces the de-

sired movement of said movable abutment. The diaphragm proper, 8, of the movable abutment herein shown serves mainly as a tight packing to cause the fluid-pressure to be fully exerted on the movable abutment without leakage past the same. The term "diaphragm-chamber," used for convenience, should be understood as referring to the fluid-pressure chamber containing the fluid which acts directly upon the movable abutment of whatever mechanical construction may be adopted, said abutment being the actuator for the valves proper of the apparatus—namely, the discharge-valve 13 or relief-valve proper and the pressure-excluding valve 15, which when seated excludes direct or unobstructed access of pressure from the part to be relieved of pressure into the diaphragm-chamber of fluid-pressure chamber for the fluid that actuates the movable abutment.

The entire apparatus may be properly called a "timed" relief-valve, as it operates like an ordinary relief-valve or safety-valve, except that under the proper conditions the time of its opening is deferred for a predetermined interval after the pressure in the space to be relieved has been in excess of the amount to which it is lowered by the operation of the relief-valve as soon as said time interval has elapsed.

The diaphragm-chamber, together with the supplemental chamber 19, when required in conjunction with the by-pass around the pressure-excluding valve constitutes a measuring chamber or space, as well as the pressure-chamber for the actuating fluid, the said parts determining the time rate at which the pressure in said measuring-chamber increases when supplied through the by-pass with air from a given higher pressure, and thereby measuring and determining the time interval required for the pressure to acquire the requisite amount to actuate the movable abutment and valves connected therewith, and the invention is not limited to the specific mechanical construction shown for providing a measuring chamber or reservoir of the requisite capacity.

The spring 9 is merely a convenient and usual device for opposing a definite determinable force to the fluid-pressure acting upon the movable abutment so as to cause the movable abutment to move in one or the other direction according as the fluid-pressure exceeds or becomes less than the said predetermined force, and the invention is not limited to this specific device as the means for furnishing the opposing or counterbalancing force.

While the valve 15 has for convenience been called a "pressure-excluding" valve, as normally when seated or closed it excludes direct access of pressure to the diaphragm-chamber, its function as a valve is by opening to admit the high pressure from the space to be relieved into the diaphragm-chamber more rapidly than it is admitted through the time-measuring by-pass, so as to afford a prompt increase in pressure at the moment when the relief-valve proper is to be opened, and thus cause the same to open fully and afford rapid and practically instantaneous reduction of pressure. The timed relief or deferred operation of the relief-valve might be obtained without this operation of the pressure-excluding valve by utilizing only its function when closed as a partition or portion of the structure serving to separate the space to be relieved from the space containing the measuring and relief-valve actuating fluid, except for the time-measuring by-pass or restricted communication between these spaces.

A structure in which the pressure-excluding valve was omitted or not utilized as a valve would be within the invention and would operate as a timed relief-valve, but would open less promptly as the pressure in the measuring-chamber continued to rise above the point at which it was just sufficient to open the discharge-valve or relief-valve proper. It is, however, of important advantage to provide for the prompt and full opening of the relief-valve as soon as the predetermined time interval has elapsed, as by this construction the brakes may remain applied with the full emergency-pressure for the desired predetermined interval of time, after which the pressure will be reduced promptly to the predetermined amount, which is more effective for bringing the train to a standstill from the slower speed to which it has been brought by the action of the brakes under the full emergency-pressure.

The terms "upper," "lower," and the like have been used for convenience in identifying the parts as shown in the drawings and are not to be understood as indicating any limitation in the matter of the position in which the parts are arranged or used.

I claim—

1. The combination in an automatic fluid-pressure brake system of an auxiliary reservoir, a triple valve, and brake-cylinder, with a timed relief-valve controlling an escape-passage from the brake-cylinder and means whereby the said valve is automatically opened after the expiration of a predetermined time interval during which the brake-cylinder pressure has remained greater than the amount to which it is lowered by said relief-valve, substantially as and for the purpose set forth.

2. A timed relief-valve comprising an escape-passage and discharge-valve controlling the same, combined with a movable abutment controlling the operation of said discharge-valve, and a fluid-pressure chamber for the actuating fluid for said movable abutment and means for normally preventing free communication between said pressure-chamber and the space containing the fluid-pressure to be relieved; and means for slowly admitting fluid to said pressure-chamber whereby the requi-

site pressure to actuate the movable abutment is acquired after the lapse of a determinable interval of time, substantially as described.

3. A timed relief-valve comprising a discharge-valve controlling an escape-passage, combined with a movable abutment controlling the operation of said discharge-valve, and a fluid-pressure chamber for the actuating fluid for said movable abutment, and a pressure-excluding valve controlled by said movable abutment, which, when closed, prevents free access of pressure to said chamber; and means for slowly admitting fluid to said pressure-chamber, whereby the requisite pressure to cause the movable abutment to open the said pressure-excluding and discharge valves is acquired after the lapse of a determinable interval of time, substantially as described.

4. The combination with the brake-cylinder of a fluid-pressure brake system; of a relief-valve comprising a fluid-discharge valve; a movable abutment controlling the operation thereof, and a pressure-chamber for the actuating fluid for said movable abutment, said fluid-pressure chamber being normally in restricted communication with the brake-cylinder; whereby fluid under pressure passes from the brake-cylinder into the fluid-pressure chamber slowly, and a determinable interval of time is required to produce sufficient pressure in the pressure-chamber to actuate the movable abutment, substantially as and for the purpose described.

5. The combination of a discharge-valve controlling a passage from a space to be relieved, with a movable abutment controlling the operation of said discharge-valve, and a pressure-chamber for the actuating fluid for said movable abutment, the said pressure-chamber being normally in restricted communication with the space to be relieved, whereby fluid-pressure may be maintained in the space to be relieved greater than the pressure required to actuate the movable abutment during an interval of time in which the pressure-chamber is being charged from the space to be relieved through the restricted connecting-passage, substantially as described.

6. The combination of a discharge-valve controlling a passage from a space to be relieved, with a movable abutment controlling the operation of said discharge-valve, and a pressure-chamber for the actuating fluid for said movable abutment, the said pressure-chamber being normally in restricted communication with the space to be relieved; and a pressure-excluding valve which, when open, establishes free communication between the pressure-chamber and space to be relieved, whereby fluid-pressure may be maintained in the space to be relieved greater than the pressure required to actuate the movable abutment during an interval of time in which the pressure-chamber is being charged from the space to be relieved through the restricted connecting-passage, and at the expiration of said time interval the pressure-excluding valve is opened to admit fluid into the pressure-chamber freely from the space to be relieved, thereby causing the discharge-valve to be opened to afford prompt relief of the pressure.

7. The combination of a discharge-valve controlling a passage from a space to be relieved, and a movable abutment controlling the operation of said discharge-valve, and a pressure-chamber for the actuating fluid for said movable abutment, and a pressure-excluding valve also controlled by said movable abutment, which valve, when closed, prevents, and when open establishes, free communication between the pressure-chamber and space to be relieved, and main and supplemental by-passes affording restricted communication between said pressure-chamber and the space to be relieved; and means for closing said supplemental by-pass when the pressure in the space to be relieved is suddenly increased, whereby the pressure in the pressure-chamber increases in approximate equality with that in the space to be relieved when the pressure rises slowly in the latter, but is maintained substantially lower than the pressure in the space to be relieved for a determinable interval of time when said pressure is suddenly increased.

8. The combination of a discharge-valve controlling a passage from a space to be relieved; a movable abutment controlling the operation of said discharge-valve, and a measuring pressure-chamber for the actuating fluid for said movable abutment, said chamber being normally in communication with the space to be relieved through a small passage, whereby fluid-pressure may be maintained in the space to be relieved greater than the pressure required to actuate the movable abutment during an interval of time dependent upon the capacity of the measuring-chamber and small passage connecting the same with the space to be relieved.

9. The combination of a discharge-valve controlling a passage from a space to be relieved; a movable abutment controlling the operation of said discharge-valve; a measuring pressure-chamber for the actuating fluid for said movable abutment; a pressure-excluding valve controlled by said movable abutment, which valve, when closed, prevents, and when open establishes, free communication between the pressure-chamber and space to be relieved; and a by-pass affording communication between said pressure-chamber and the space to be relieved when the pressure-excluding valve is closed, whereby pressure may be maintained in the space to be relieved greater than the pressure required to actuate the movable abutment, during an interval of time de-

pendent upon the capacity of the said measuring-chamber and by-pass, substantially as and for the purpose described.

10. The combination of the discharge-valve controlling a passage from a space to be relieved; a movable abutment controlling the operation of said discharge-valve; a measuring pressure-chamber for the actuating fluid for said movable abutment, a pressure-excluding valve controlled by said movable abutment, which valve, when closed, prevents, and when open establishes, free communication between the pressure-chamber and space to be relieved; with main and supplemental by-passes affording restricted communication between the said measuring pressure-chamber and the space to be relieved; and means for closing said supplemental by-pass when the pressure is suddenly introduced into the space to be relieved.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

JOHN W. BINGLEY.

Witnesses:
W. F. NICOL,
JNO. F. MALONEY.