(No Model.) 3 Sheets—Sheet 1.

G. A. BOYDEN.

VALVE FOR AIR BRAKES.

No. 481,134. Patented Aug. 16, 1892.

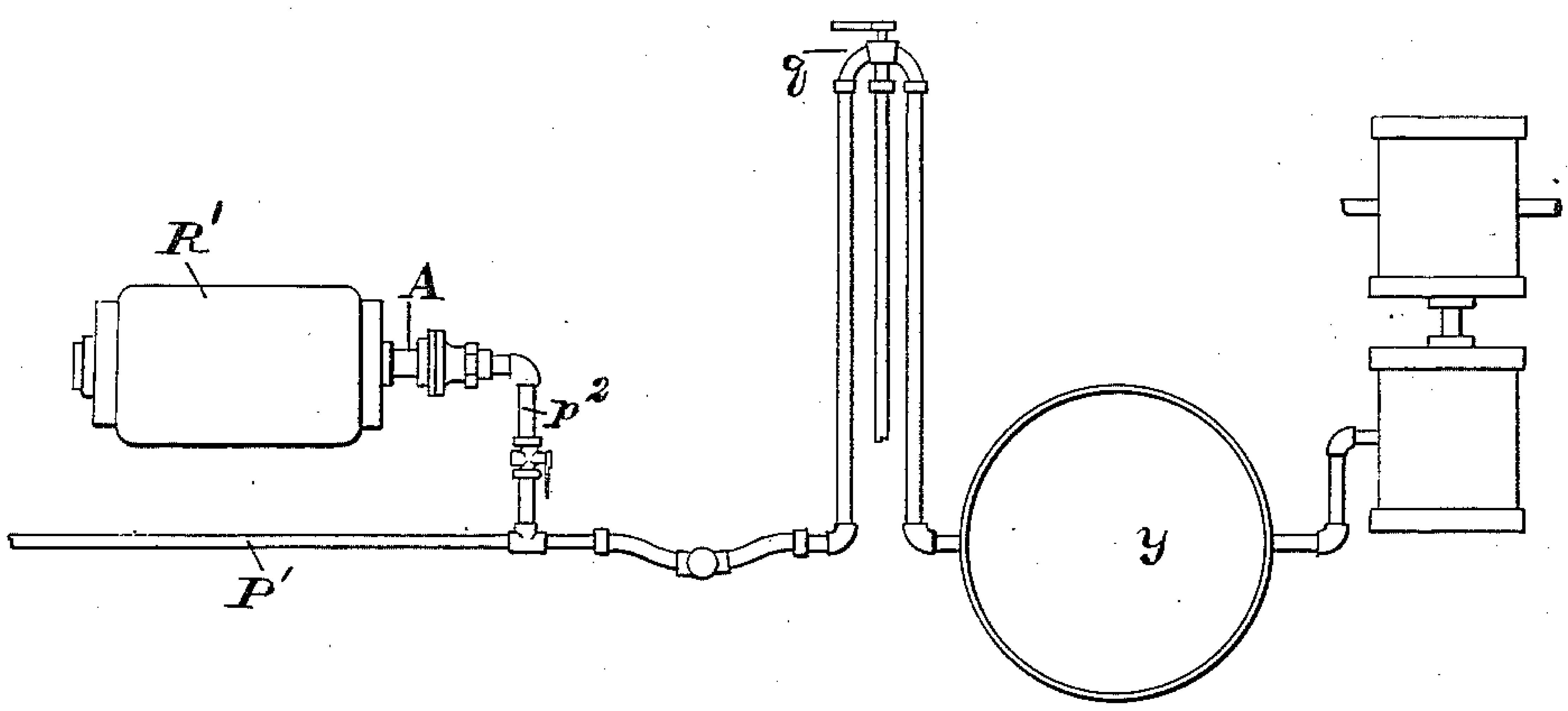

Fig. 1.

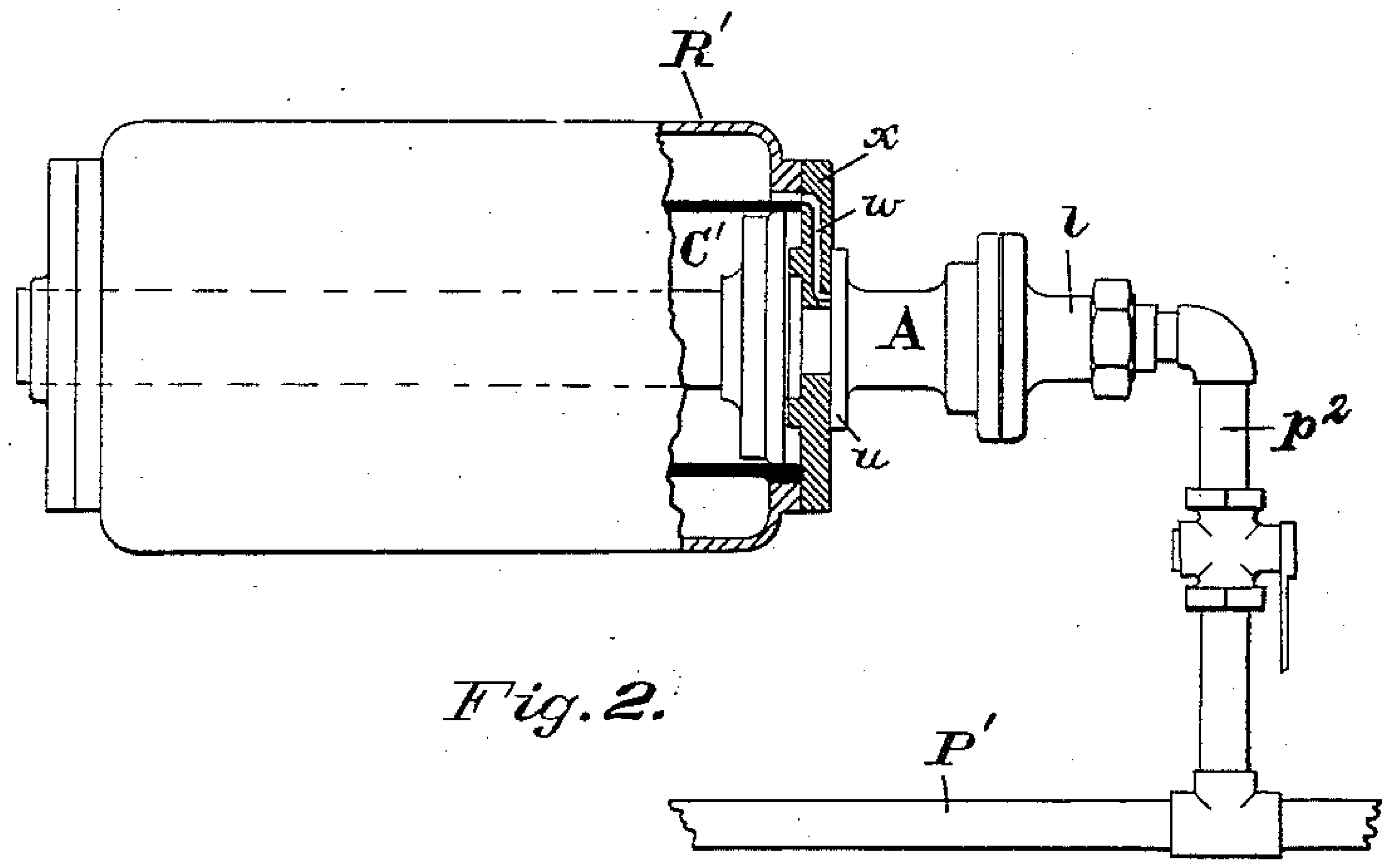

Fig. 2.

Witnesses
A. O. Babendreier.
John E. Morris

Inventor
Geo. A. Boyden
By his Attorney
Chas B. Mann

(No Model.)

3 Sheets—Sheet 2.

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Fig. 3.

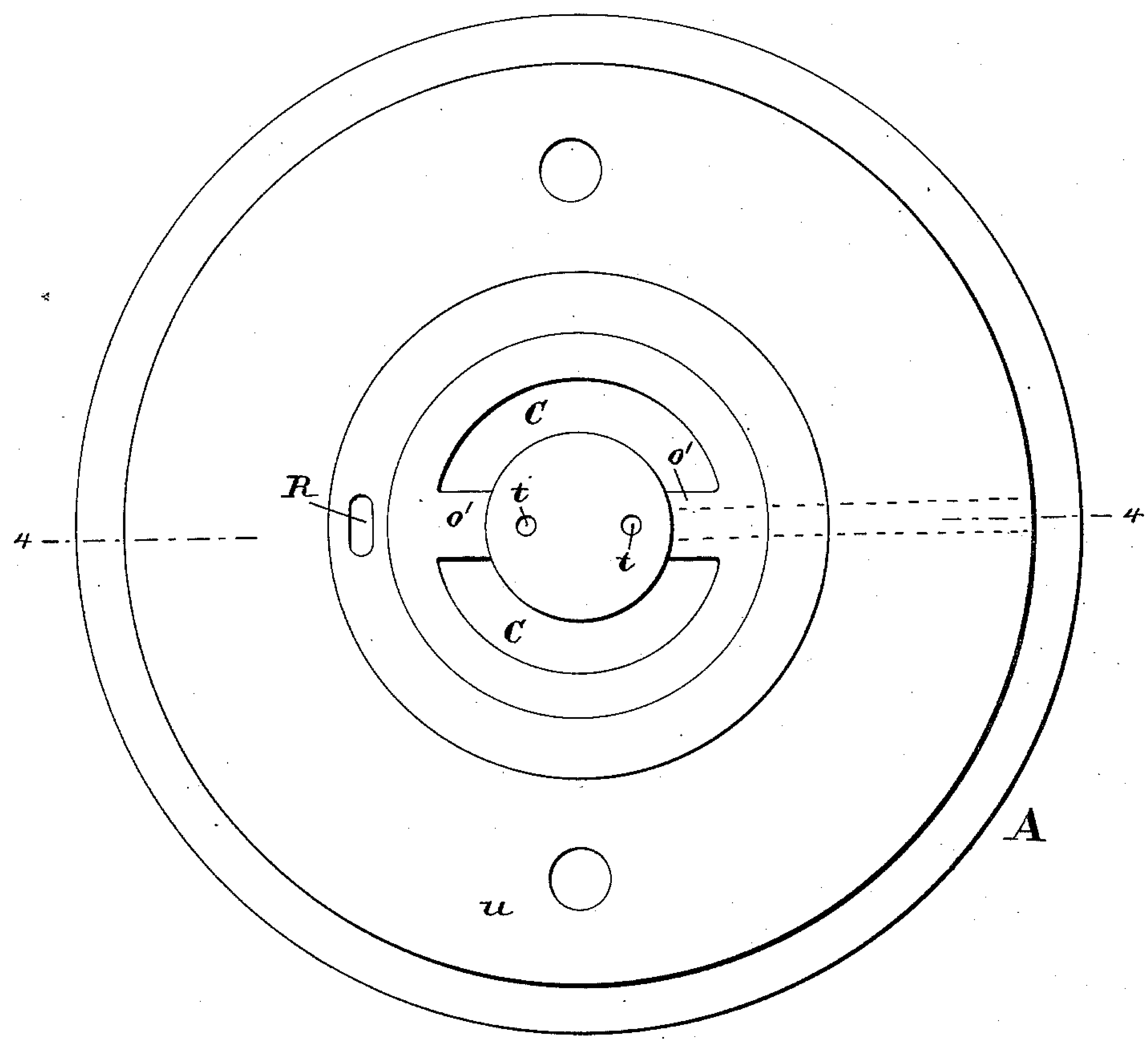

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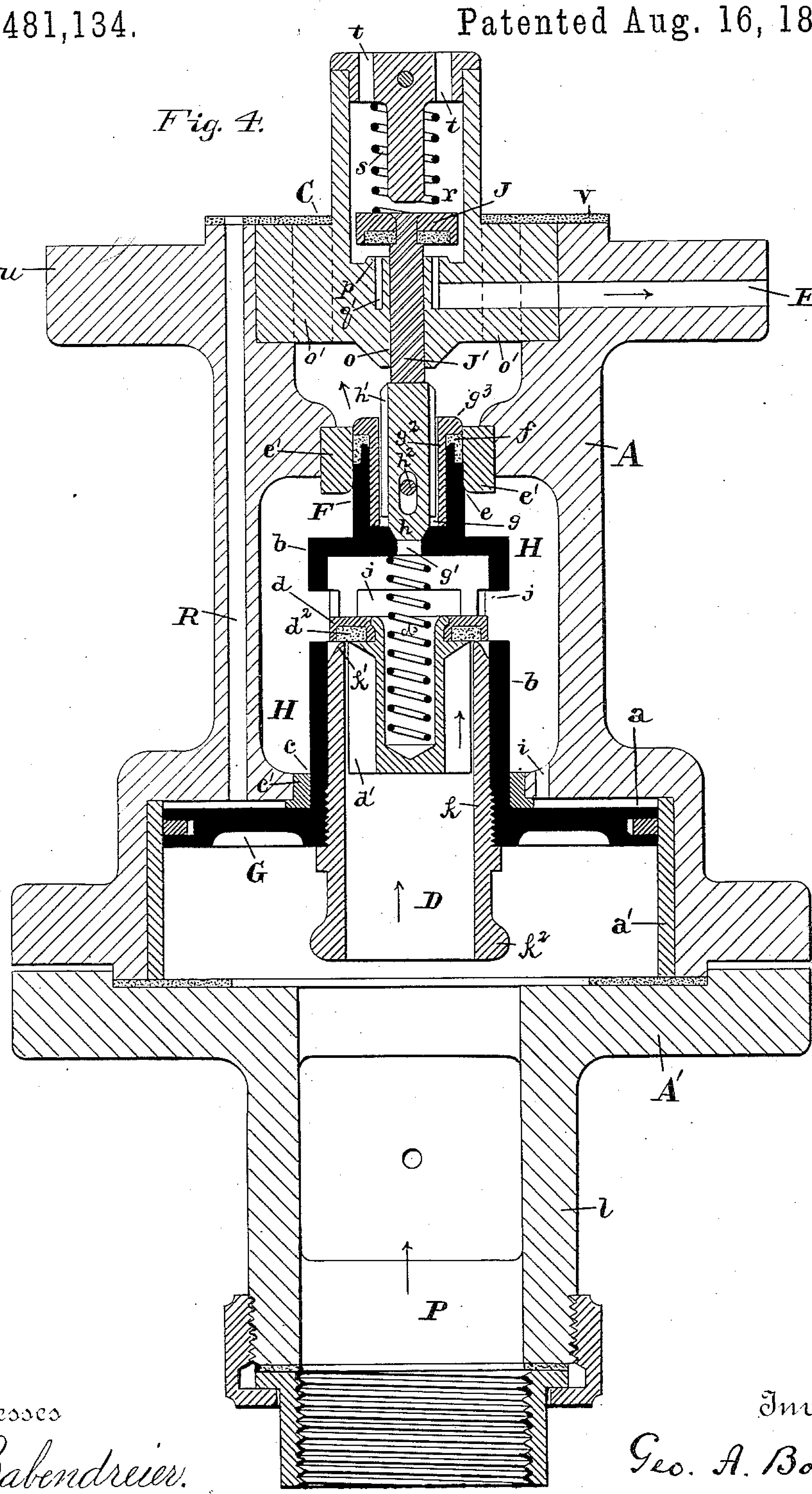
Fig. 4.



Witnesses

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Inventor

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Chas B. Mann

UNITED STATES PATENT OFFICE.

GEORGE ALBERT BOYDEN, OF BALTIMORE, MARYLAND, ASSIGNOR TO THE BOYDEN BRAKE COMPANY OF BALTIMORE CITY, OF MARYLAND.

VALVE FOR AIR-BRAKES.

SPECIFICATION forming part of Letters Patent No. 481,134, dated August 16, 1892.

Application filed September 30, 1889. Serial No. 325,474. (No model.)

To all whom it may concern:

Be it known that I, GEORGE ALBERT BOYDEN, a citizen of the United States, residing at Baltimore, in the State of Maryland, have invented certain new and useful Improvements in Valves for Air-Brakes; and I do declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

This invention relates to improvements in valve mechanism of automatic air-brake systems, and has for its principal object to provide for the admission of air-pressure to the brake-cylinder from both the train-pipe and the auxiliary reservoir, so as to affect a powerful application of the brakes, and at the same time produce a reduction of air-pressure in the train-pipe adjacent to the valve mechanism to quicken the application of succeeding brake mechanisms, so that the brakes on all the cars of the train will be applied at nearly the same instant.

In my patent of June 26, 1883, No. 280,285, I brought out an improved triple-valve mechanism having a check-valved passage from the train-pipe so arranged as to admit train-pipe air direct to the brake-cylinder at the same time that auxiliary-reservoir air is in the brake-cylinder. In my present invention I use the check-valved feed-passage of my 1883 patent, leading from the train-pipe through the triple-valve piston to the main valve-chamber, and thence both to the auxiliary reservoir and the brake-cylinder for the double purpose of supplying the auxiliary reservoir and also enabling train-pipe air to be vented directly through the main valve-chamber into the brake-cylinder to aid in applying the brakes in emergency stops.

Referring to the drawings, Figure 1 is an elevation showing the principal elements comprising an ordinary air-brake system and the application thereto of the improved valve mechanism by which the air-pressure is controlled. Fig. 2 is a view illustrating an air-brake cylinder, an auxiliary reservoir, a portion of the train-pipe, and the valve mechanism for controlling the air-pressure in the brake-cylinder, the same representing the equipment of a single car. Fig. 3 is a view of the valve, looking toward the inner end, which is attached to the brake-cylinder. Fig. 4 is a longitudinal section through the valve mechanism on the line 4 4.

Similar letters of reference in the several figures indicate the same parts.

The brake system in general to which my present improvements are shown applied is that in common use, and includes, in addition to the brake-cylinder C′, auxiliary reservoir R′, and train-pipe P′, (illustrated in Fig. 2,) the usual equipment of the locomotive—such as an air pump or compressor, a storage-tank, and an engineer's valve q—all of which parts are familiar to persons skilled in the construction and operation of brake mechanisms.

In addition to the parts named a complete automatic air-brake system includes as one of its essential elements a valve mechanism located on each car and serving to control the admission and escape of air in the brake-cylinder for effecting the application and release of the brakes. This valve mechanism is popularly known as a "triple valve," and the present improvements relate more particularly to this element or part of the brake system and introduces a new mode of operation.

The valve-case shown comprises two pieces, the body part A and the head A′, which are suitably secured together. The open end C of the valve-case is attached in the present instance to the brake-cylinder C′ by bolts passing through flange u, with an interposed gasket v for making a tight joint. The passage R connects with the auxiliary reservoir R′, the passage P with a branch p^2 of the train-pipe, and the passage E is for the exhaust from the brake-cylinder.

To economize space under the car, the auxiliary reservoir R′ may be placed around the brake-cylinder C′, as shown, instead of being removed or separate therefrom, as is usual, and when so arranged communication is established between the auxiliary reservoir and the improved valve mechanism through a passage w in the head x of the brake-cylinder. It will be obvious, however, that it is not necessary to the operation of my improvements that the auxiliary reservoir should be thus constructed and arranged, as the usual forms of auxiliary reservoir and brake-cylinder will operate in unison with the improved valve mechanism with equal advantages.

The valve-case is provided with a piston-chamber *a* in open communication with the train-pipe connection or passage P, and in the present instance, this chamber is furnished with a bushing or lining *a'*, within which is fitted a piston G, having a central tubular extension *b* of smaller diameter than the piston and entering the valve-chamber H through an opening *c* at one end. This opening *c* is furnished with a bushing *c'*, which also serves as a guide for the said tubular extension *b*, which projects through it into chamber H. At its end this extension is furnished with a valve F, co-operating with the main valve-port *e* at the end of said chamber. This valve-port is formed by a bushing *e'*. When the port *e* is open, air may pass from the valve-chamber H to the brake-cylinder C' by the openings C. The valve F is operated to open and close communication with brake-cylinder C' from both the auxiliary reservoir R' and train-pipe P'.

The main valve F is of the kind known as a "plug-valve," and is provided with a suitable packing *f* to make an air-tight fit in the port through the bushing *e'*. This valve F has a chamber *g*, terminating in a small port *g'*, and said chamber is lined by a tube g^2, provided with an end flange g^3 for confining the packing *f*. The said small port *g'* serves to establish communication between the valve-chamber H and the brake-cylinder C' when the main valve F is in its closed position. This small port *g'* is controlled by the graduating-valve *h*, which has suitable grooves *h'* on its sides and fits movably in the lining-tube g^2. The conical end of the graduating-valve *h* is adapted to fit air-tight over the small port *g'*, and when unseated or moved to uncover the said port compressed air will pass from the valve-chamber H along the grooves *h'* and then to the brake-cylinder. The stem of the graduating-valve has a cross-slot, through which passes a pin h^2 for limiting the movement of the graduating-valve, and also serving to hold the lining-tube g^2 in position. The end of the stem of the graduating-valve projects beyond the lining-tube g^2, and when the main valve F is entered within the main port *e* sufficiently far the projecting end of the stem of said graduating-valve engages the stem J' of the release-valve.

The auxiliary reservoir R' and piston-chamber *a* are in communication through the passage R, formed in the valve case. Said passage supplies air on the side of piston G which is opposite the train-pipe passage P. This passage R does not lead through the valve-chamber H. The passage R between the piston-chamber and auxiliary reservoir is larger or of greater capacity than the passage *i*, through which air from the auxiliary reservoir is admitted to the valve-chamber H. The said passage *i*, through which auxiliary-reservoir air is conducted to the valve-chamber H in applying the brakes, is smaller—that is, it has a less transverse area and a restricted or smaller conducting capacity—than either the said passage R or the main port *e*, and it can conveniently be located, as shown, in the partition where the guide-bushing *c'* is fixed, which partition serves to separate or isolate the auxiliary-reservoir side of the piston-chamber *a* from the valve-chamber H, and thus makes it possible when applying the brakes in an emergency for the piston G to be subjected on its auxiliary reservoir side to a greater air-pressure than that contained in the valve-chamber H. A passage D is formed through the piston and extends from the train-pipe side of the piston-chamber *a* to the valve-chamber H, and in said passage is located a check-valve *d*, which is arranged to allow compressed air to pass from the train-pipe P' to the auxiliary reservoir R' for charging, and when the main valve-port *e* is open from the train-pipe direct to the brake-cylinder for quick action in emergency applications of the brakes; but said check-valve prevents air passing from the auxiliary reservoir and brake-cylinder back to train-pipe.

The construction of the check-valve *d* and its coacting parts may be varied from that shown. In the present instance guide-wings *d'* are connected to the valve, and the latter carries a packing d^2. The check-valve is recessed, and a spiral spring d^3, seated in said recess, presses the check-valve and keeps it normally on its seat *k'*, and when thus seated communication between the valve-chamber H and the brake-pipe is closed. The check-valve *d* is located in the tubular extension *b* of the piston, and passages *j* in said tubular extension *b* permit train-pipe air to pass into the valve-chamber H. In the tubular extension an internal tube or lining *k* is fitted, one end of which serves as a seat *k'* to the check-valve, while the other end k^2 projects at the opposite side of the piston G and serves as a handle or grasp part. The guide-wings *d'* of the check-valve slide in the internal tube *k*.

The check-valved passage D, through which train-pipe air flows when applying the brakes for an emergency stop, has a much greater area or capacity than the small passage *i*, through which the auxiliary-reservoir air flows. The nozzle *l*, for connection with the train-pipe P', is formed on the head A' of the valve-case, and air under pressure is conducted from the train-pipe through said nozzle.

The exhaust-passage E, through which air is discharged from the brake-cylinder C' to the atmosphere to release the brakes, is controlled by a release-valve J, having a stem J', sliding in a bearing *o*, which latter is supported by bridge-pieces *o'*. This passage extends through one of the bridge-pieces *o'*, and the openings C at the sides of said bridge-pieces form supply-passages communicating with the brake-cylinder. The release-valve J is in line with the graduating and main valves *h* and F, and these valves are so arranged that when the main valve is fully closed the end of the stem of the graduating-valve presses the stem J′ of the release-valve and lifts the latter from its seat *p*. This valve-seat *p* is provided with a port *q*′ in communication with a chamber *r* on one side and the exhaust-passage E on the other. The release-valve J is located within this chamber *r*, and the latter is in open communication with the brake-cylinder through passages *t*. A spiral spring *s* engages the release-valve and tends to keep it to its seat *p*.

It is well understood that in valves of this general character a flexible diaphragm may be used as a recognized equivalent of the piston G. This and other equivalent changes may be made without in any wise departing from the present invention. In the present embodiment the valve-case is bolted by its flange to the head of the brake-cylinder in such manner that the passages *t*, communicating with the exhaust-passage, and the supply-openings C, communicating with the main and graduating valve-ports, will open to the brake-cylinder, while the large passage R is placed in communication with the auxiliary reservoir through a passage *w*, which in this instance is in the cylinder-head.

The operation of this improved valve mechanism is as follows: To charge the auxiliary reservoir and prepare the brakes for action, compressed air from the train-pipe entering through connecting-nozzle *l* acts upon the piston G and moves said piston, so that the graduating-valve *h* and the main valve F will close their respective ports and thus cut off communication with the brake-cylinder C′. The exhaust-valve J will at the same time be moved to uncover its port, and the check-valve *d*, yielding to the preponderance of pressure exerted on its train-pipe side, will unseat, and air from the train-pipe will be conducted by passages D, *j*, *i*, and R to the auxiliary reservoir R′. An approximate equalization of air-pressure will thus be brought about in the auxiliary reservoir R′, valve-chamber H, and train-pipe, and the check-valve will be seated. When it is desired to gradually apply the brakes, the handle of the engineer's valve *q* will be moved for a moment to such a position that communication between the storage-tank *y* on the locomotive and the train-pipe P′ will be closed and an escape-orifice opened to the atmosphere. Thereby the air-pressure in the train-pipe will be reduced slightly—say about five pounds or less. This reduction of pressure on the train-pipe side of the piston G disturbs the balance previously existing on opposite sides thereof, resulting in establishing a preponderance of air-pressure on the auxiliary-reservoir side, and the air delivered from the auxiliary reservoir through the passage R and acting upon the piston G causes the latter and its attached parts to move outward and permit the release-valve J to seat, thereby closing communication between the brake-cylinder C′ and the exhaust-passage E. This outward movement of the piston G will continue after the release-valve J has become seated and until the graduating-valve *h* has been unseated by the pressure of air in the valve-chamber H, thus allowing auxiliary-reservoir air to flow through small port *g*′ into the brake-cylinder C′, where it acts upon the piston thereof to effect the application of the brakes. When by reason of the flow of air into the brake-cylinder the pressure in valve-chamber H and in auxiliary reservoir R′ has been reduced to or below that in the train-pipe, a slight return or inward movement of the piston G will be produced sufficient to cause the reseating of the graduating-valve *h*, and thus close communication between valve-chamber H and the brake-cylinder and confine the air admitted within the latter. In case it is desired to gradually increase the air-pressure in the brake-cylinder, the above-described operation is repeated. To permit the air in the brake-cylinder to escape and effect the release of the brakes, the air-pressure in train-pipe is restored or increased by a proper movement of the engineer's valve. The increase of pressure in the train-pipe causes the piston G to move inward to the limit of its stroke, when it will occupy the position illustrated in Fig. 4, thereby raising the release-valve J from its seat and placing the brake-cylinder in communication with the exhaust-passage E and allow the air to escape. At the same time the restoration of pressure in the train-pipe will unseat the check-valve *d* and air from the train-pipe will flow into the auxiliary reservoir, recharging the latter for future use. The recharging will continue until the pressure in the auxiliary reservoir equals that in the train-pipe, when the check-valve will be seated by its spring. When it becomes necessary or desirable to apply the brakes of a train quickly and with full power for an emergency stop, the engineer's valve *q* will be moved to close communication between the storage-tank *y* and train-pipe and open the latter to the atmosphere and produce a sudden reduction of pressure of about ten or fifteen pounds in the train-pipe. The effect of this sudden diminution of pressure in the train-pipe is immediately manifested at the nearest valve mechanism or that on the first car, causing the valve-piston G to be moved by the higher pressure of auxiliary-reservoir air quickly to its full outward position, thus moving the main valve F and opening wide the main port *e*, so that the air-pressure contained in the valve-chamber H may exhaust freely into the brake-cylinder. The supply of air from auxiliary reservoir to the valve-chamber H is conducted through the restricted or small passage *i*. Hence when the main port *e* is opened wide and the air in valve-chamber escapes through the larger passage thus provided the pressure in said valve-chamber is quickly reduced below that in the piston-chamber *a* on the auxiliary-reservoir side. This follows because the passage *i*, supplying auxiliary-reservoir air to the valve-chamber H, is so much smaller than the passage R, supplying the same kind of air to the piston-chamber. The sudden and full opening of the main port *e* allows all or nearly all of the air-pressure on the brake-cylinder side of the check-valve *d* to escape, whereupon the check-valve will be immediately unseated and train-pipe air will pass directly into the brake-cylinder C′, thus effecting the quick application of the brakes and also a further reduction of pressure in the train-pipe that will be sufficient to accelerate the action of the valve mechanisms on the cars following. The piston G will in the meantime be held to its outward position by the relatively higher air-pressure from the auxiliary reservoir, which is delivered through the large passage R, while the transmission of auxiliary-reservoir air to the brake-cylinder is retarded by having to pass through the relatively smaller passage *i*. During its preliminary traverse outward or toward the train-pipe side the piston G operates to close the exhaust-passage, and its farther or continued movement in the same direction opens the main valve F and allows air to pass from both the auxiliary reservoir and the train-pipe to the brake-cylinder when making a quick application of the brakes. It will be observed that the valve mechanism depends for its action upon the movements of the piston G and that the latter is subjected to two opposing forces—auxiliary-reservoir air on one side and train-pipe air on the other—and that its movement in one direction is effected by the preponderating pressure of auxiliary-reservoir air, while its movement in the opposite direction results from a preponderance of pressure on the train-pipe side. If the passage , through which auxiliary-reservoir air must flow upon the sudden opening of the main-valve port *e* for an emergency stop, was as large as or larger than the check-valved passage for supplying train-pipe air, the quick action referred to and the utilization of train-pipe air direct in the brake-cylinder could not be effected for the very obvious reason that the inward flow of train-pipe air at, say, fifty-five or sixty pounds, to the brake-cylinder would be opposed and checked by the flow of auxiliary-reservoir air at a higher pressure, say, seventy pounds; but by restricting the passage through which auxiliary-reservoir air is conducted in the course of its transmission to the brake-cylinder, so that its capacity for the flow of air will be less than that of the main port *e* and less than the check-valve passage leading from the train-pipe, a considerable volume of train-pipe air will flow into the brake-cylinder, notwithstanding the admission of the auxiliary-reservoir air under a higher pressure, because the flow of auxiliary-reservoir air is so retarded by the smaller passage *i*, through which it is conducted, that an appreciable period of time is required to raise the pressure in the brake-cylinder to that in the auxiliary reservoir, and it is during this interval and before the pressure in the brake-cylinder is raised to that in the train-pipe that the air in the latter is free to enter the brake-cylinder. It will thus be seen that the sudden uncovering of the main port or passage *e*, leading to the brake-cylinder, by the movement of the main valve opens communication between the train-pipe and brake-cylinder and also between the auxiliary reservoir and the brake-cylinder; but that the flow of the higher-pressure air from the auxiliary reservoir into the brake-cylinder is retarded by being compelled to traverse a relatively small orifice or passage, while the lower-pressure train-pipe air is permitted to flow through a larger orifice or passage.

From the foregoing explanation it is obvious that there is a coaction at the time of applying the brakes for emergency stops between the restricted passage which supplies auxiliary reservor air, the larger passage which supplies train-pipe air, and the single valve which controls the communication of air from both of said passages to the brake-cylinder. As soon as the pressure above the check-valve caused by the auxiliary-reservoir air, plus the pressure of the spring d^3, exceeds the pressure exerted by the train-pipe air on the other side, the check-valve will close and the further ingress of train-pipe air to the brake-cylinder will be cut off, while the auxiliary-reservoir air will continue to flow, thus augmenting the pressure therein. To effect the release of the brakes, the air-pressure must be restored in the train-pipe to overcome the pressure on the auxiliary-reservoir side of the piston G, whereupon the parts will act in the manner already described.

As hereinbefore intimated, this valve mechanism belongs to the class of air-brake valves known as "triple valves," of which there are numerous examples, differing somewhat in construction and embodying variations and modifications in the form and arrangement of parts; but all of them, however specially constructed, contemplate a valve structure having suitable connections for the train-pipe, the auxiliary reservoir, and the brake-cylinder, and are provided with passages or ports leading, first, from the train-pipe to the auxiliary reservoir; second, from the said reservoir to the brake-cylinder, and, third, from the brake-cylinder to the atmosphere; hence the name triple valve. In some cases a plurality of valves govern these passages or ports.

It is to be observed that some of the distinguishing features of this invention are, first, that provision is made whereby train-pipe air may pass direct to the brake-cylinder through the triple valve, thus utilizing the triple-valve mechanism to effect what is known as a "quick action" of the brakes without necessitating the use of an "auxiliary" valve, as heretofore; second, quick action of the brakes is produced by the admission of both auxiliary-reservoir air and train-pipe air to the brake-cylinder by use of a single valve and properly proportioning the passages of the triple valve, so that train-pipe air at a lower pressure than that in the auxiliary reservoir may be admitted to the brake-cylinder; third, the novel mode of operation, whereby in applying the quick-action feature three different pressures are momentarily produced in the triple-valve case—that is, the highest pressure on auxiliary-reservoir side of piston, a lower pressure on the train-pipe side of said piston, and the lowest pressure where the port *e* is located, which leads to the brake-cylinder.

In the embodiment shown the main valve of the triple valve is of the reciprocating plug form, which is deemed advantageous, in that it admits of a certain extent of reciprocating movement within its port *e* without opening or uncovering the latter, so that the unintentional slight variations of air-pressure that occur in the train-pipe will be productive of no disadvantage, as the piston G can have a limited movement without allowing any air to pass. Another advantage of this "plug" form of valve is that it permits the closing of the release-valve before the opening of the ports controlled by it and by the graduating-valve. These specific improvements in form, while advantageous in the particulars mentioned, do not affect the new mode of operation due to the reorganization of the triple valve and which results in the addition thereto of a new function. My invention therefore is not limited to this form of valve.

As ordinarily constructed heretofore the triple valve has been arranged to effect two grades of brake application by use of auxiliary-reservoir pressure alone, these two grades differing in degree rather than in kind. The first may be called "full pressure" and the second is known as "graduation." For effecting these two grades of application a main and a graduating valve are employed, corresponding generally, though embodied in different forms, with the main graduating-valves F and *h* here shown. These, together with a release-valve and feeding-valve, are usually arranged to be actuated by a piston.

An example of the class of triple valves just referred to is shown in United States Patent to George Westinghouse, Jr., dated October 14, 1879, No. 220,556. Triple valves of this kind and in a great variety of forms are well known; but they do not possess the quick-action principle, which utilizes train-pipe air in the application of the brakes and effects a reduction of train-pipe pressure by so doing. On the contrary, in such valves the pressure available in the brake-cylinder is derived from the auxiliary reservoir alone.

Efforts have heretofore been made to combine with a triple valve certain additional mechanism by which train-pipe air could be introduced directly into the brake-cylinder in effecting the application of the brakes for emergency stops; but in every such instance a supplemental passage or passages, together with a supplemental or auxiliary valve, has had to be employed in connection with the triple valve proper, in order that the ordinary functions of the triple valve might be preserved and the additional function of introducing train-pipe air into the brake-cylinder for emergency stops be combined therewith.

An example of the class of valves referred to in the last preceding paragraph which employ an auxiliary valve, combined with an ordinary triple valve, is shown in United States Patent to George Westinghouse, Jr., dated March 29, 1887, No. 360,070.

It will be seen that my present invention for introducing train-pipe air into the brake-cylinder for emergency stops differs essentially from the device shown in the said Patent No. 360,070, because I have provided a new principle of construction and a new mode of operation, by use of which the desired result aforesaid may be produced without the aid of the auxiliary valve heretofore required for the purpose.

An examination of the particular embodiment of the present invention will disclose the fact that it is a triple valve *per se*, without auxiliary or supplemental valve devices, and, further, that its conversion into a quick-action valve and its greater capacity for action over ordinary forms of triple valves is due to means which I have invented for retarding or restricting the flow of auxiliary-reservoir air to the main port or passage leading to the brake-cylinder as compared with the more open or free delivery of train-pipe air to the said main port or passage. By thus delaying or restraining the flow of auxiliary-reservoir air it becomes possible to open both passages to the brake-cylinder, and the difference in size of these passages allows a considerable portion of the air from the train-pipe at lower pressure to enter the brake-cylinder before the air from auxiliary reservoir at higher pressure raises the pressure in the brake-cylinder to such a degree as to prevent the ingress of train-pipe air, and, further, a single valve—the main valve of the triple valve proper—is here made to perform the office of opening communication to the brake-cylinder from both the train-pipe and the auxiliary reservoir in the quick application of the brakes for emergency stops. My invention therefore includes any form of structure of valve wherein a single valve admits both train-pipe air and auxiliary-reservoir air to the brake-cylinder in applying for emergency stops, and which structure is provided with means for restricting or retarding the flow of auxiliary-reservoir air to the brake-cylinder as compared with the flow of the train-pipe air thereto.

The graduating-valve *h* of the present valve mechanism performs the ordinary functions of such a device and is brought into useful action only in making "graduation" applications of the brakes. It does not affect in any manner the "quick-action" or emergency-stop feature. Hence its presence or absence is not essential thereto.

Having thus explained the principle of my invention and described means by which it may be embodied and practiced, what I claim as new, and desire to secure by Letters Patent, is—

1. In triple-valve mechanism for automatic air-brakes, the combination of a passage from the train-pipe, a passage from the auxiliary reservoir, which is smaller or more restricted than said train-pipe passage, and a single valve coacting with both of said passages and controlling communication between them and the brake-cylinder, whereby when an emergency application of the brakes is desired the train-pipe air and auxiliary-reservoir air, the former at lower pressure than the latter, will both pass to the brake-cylinder through the triple valve.

2. In valve mechanism for automatic air-brakes, the combination of a communication with the brake-cylinder from both the auxiliary-reservoir and train-pipe, a single valve controlling said communication, and means to retard or restrict the flow thereto of the auxiliary-reservoir air when applying the brakes in comparison with the flow of train-pipe air, whereby train-pipe air at lower pressure than said auxiliary-reservoir air will pass said valve when making an emergency application of the brakes.

3. In a triple valve, the combination, with a suitable chamber, of a port therefrom to the brake-cylinder, a valve controlling said port, and passages to the said chamber from the train-pipe and from the auxiliary reservoir, the latter passage being of less capacity than the former, whereby train-pipe air may pass direct to the brake-cylinder through the triple valve to effect a quick action of the brakes for emergency stops.

4. In a valve for automatic air-brakes, the combination of a communication with the brake-cylinder, a suitable valve controlling said communication, two air-passages coacting with said valve and relatively proportioned as to their capacity to allow the flow of both train-pipe air and auxiliary-reservoir air each at a different pressure to pass said valve when open, and a check-valve to prevent the return of air to the train-pipe.

5. A valve for controlling automatic air-brakes, having, in combination, a piston which is moved in one direction by pressure from the train-pipe and in the other direction by pressure from the auxiliary reservoir, a valve-chamber which has a check-valved communication from the train-pipe, a communication with the auxiliary reservoir, and a port communicating with the brake-cylinder, said port being of greater area or capacity than the said communication with the auxiliary reservoir, and a valve controlling said port and moved by the piston, whereby when the said port is opened the pressure in the valve-chamber will be reduced momentarily below that in the train-pipe, and air from the latter will thereupon pass to the brake-cylinder.

6. In a triple valve for automatic air-brakes, the combination of a chamber having a port leading to a brake-cylinder, a passage opening into said chamber and which supplies auxiliary-reservoir air thereto, a piston-chamber and piston, a valve controlling said port and operated by the piston, and a passage from the auxiliary reservoir direct to said piston-chamber and avoiding the chamber first mentioned and which is larger or of greater capacity than the said passage which supplies auxiliary-reservoir air.

7. In valve mechanism for automatic air-brakes, the combination of a piston-chamber, a piston, a valve-chamber having a brake-cylinder port, a passage for supplying auxiliary-reservoir air when applying the brakes, which passage is smaller or of less capacity than said port, a passage to supply train-pipe air when applying the brakes, a valve in the valve-chamber coacting with said port and controlling the flow of air to a brake-cylinder from both a train-pipe and an auxiliary reservoir, and a passage from the auxiliary reservoir to the said piston-chamber and which in its course avoids the said valve-chamber.

8. In a triple valve for automatic air-brakes, the combination of a valve-chamber having a port leading to the brake-cylinder, a piston-chamber and piston, a passage from the auxiliary reservoir direct to the piston-chamber and which avoids the said valve-chamber, a passage which is smaller or more restricted than either the said port or the said direct passage to the piston-chamber, this small passage opening into the valve-chamber, and a valve controlling said port and operated by the piston.

9. In a triple valve for automatic air-brakes, the combination of a chamber having a port communicating with the brake-cylinder, a piston-chamber and piston, a passage from the train-pipe to the ported chamber, a partition provided with a passage which is smaller or more restricted than either the said port or the train-pipe passage, said partition serving to partially separate the ported chamber from the said piston-chamber, and a valve moved by said piston and controlling said port, whereby both train-pipe air and auxiliary-reservoir air may pass the same valve-port for an emergency stop.

10. The combination, in valve mechanism for air-brakes, of a piston, a valve-chamber having a communication with a brake-cylinder, one from the train-pipe and another through a throttled or more restricted passage from the auxiliary reservoir, a valve to govern the communication leading to the brake-cylinder, a tubular extension of the

piston entering the valve-chamber and moving the valve and containing a passage which forms the said communication between the train-pipe and valve-chamber, and a check-valve controlling said last-named passage.

11. In valve mechanism for automatic air-brakes, the combination of a main port communicating with a brake-cylinder from both the train-pipe and the auxiliary reservoir, a suitable valve controlling said main port, a graduating-valve which admits air-pressure in small volume to the brake-cylinder, and air-passages coacting with said main port and relatively proportioned as to their capacity to allow both train-pipe air and auxiliary-reservoir air, each at a different pressure, to pass to said main port when the latter is open.

12. In valve mechanism for automatic air-brakes, the combination of a chamber having a main port leading to the brake-cylinder, a reciprocating valve of plug form coacting with said main port and capable of a certain extent of movement without opening the said port, a graduating-valve *h*, fitting loosely in said plug-valve, and a release-valve unconnected with the said main valve and controlling an air-escape port.

In testimony whereof I affix my signature in presence of two witnesses.

GEORGE ALBERT BOYDEN.

Witnesses:
CHARLES L. SULLIVAN,
JNO. T. MADDOX.