H. M. P. MURPHY.
AIR BRAKE APPARATUS.
APPLICATION FILED APR. 4, 1908.

912,715.

Patented Feb. 16, 1909

3 SHEETS—SHEET 1

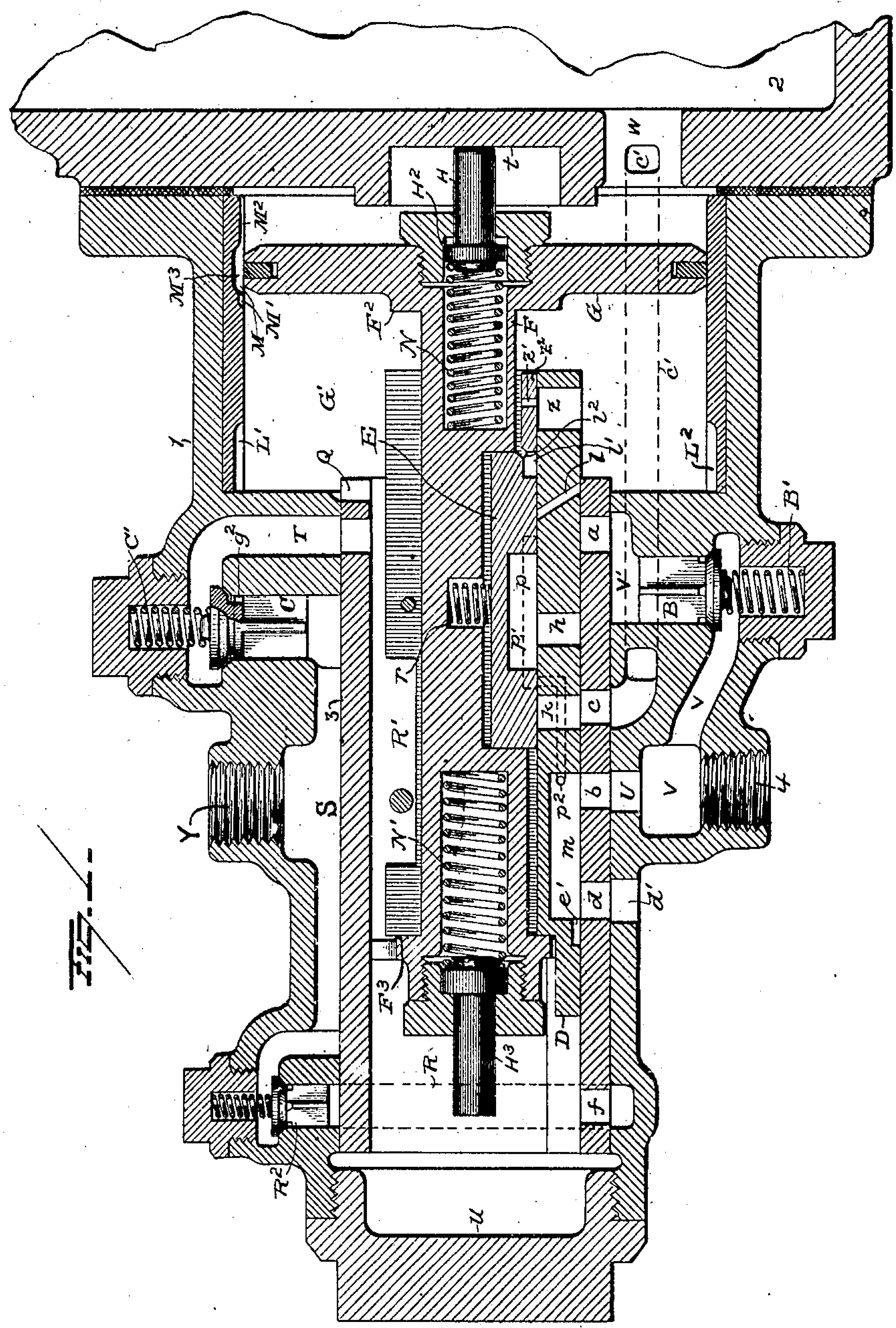

Fig. 1

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3 SHEETS—SHEET 2.

FIG. 2.

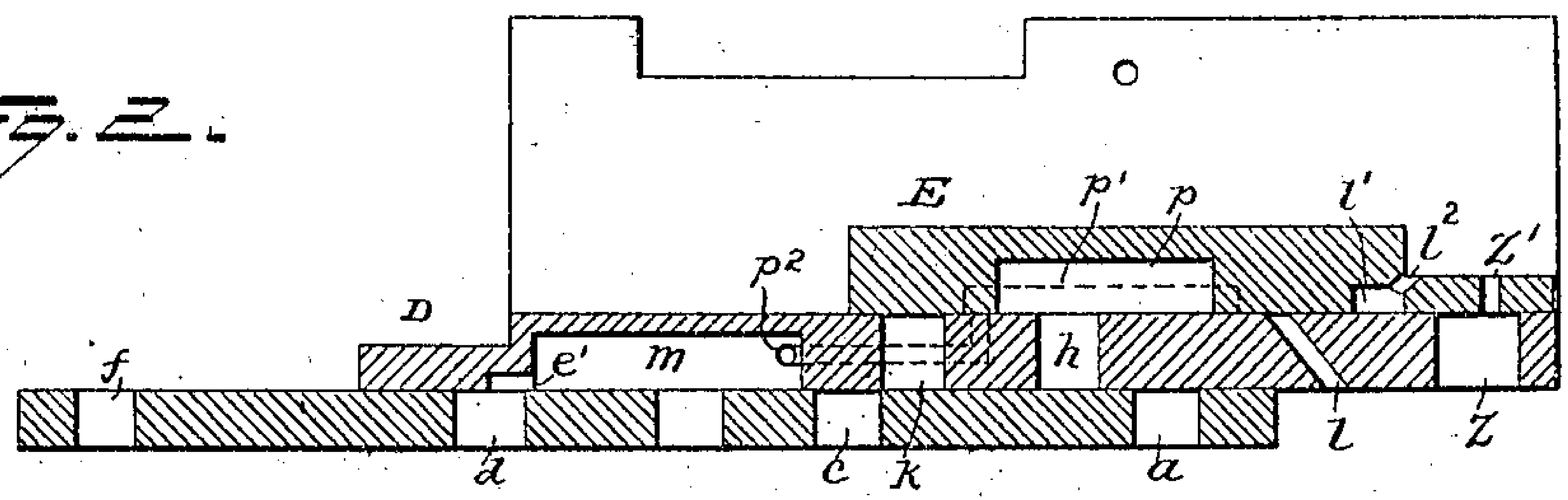


FIG. 3.

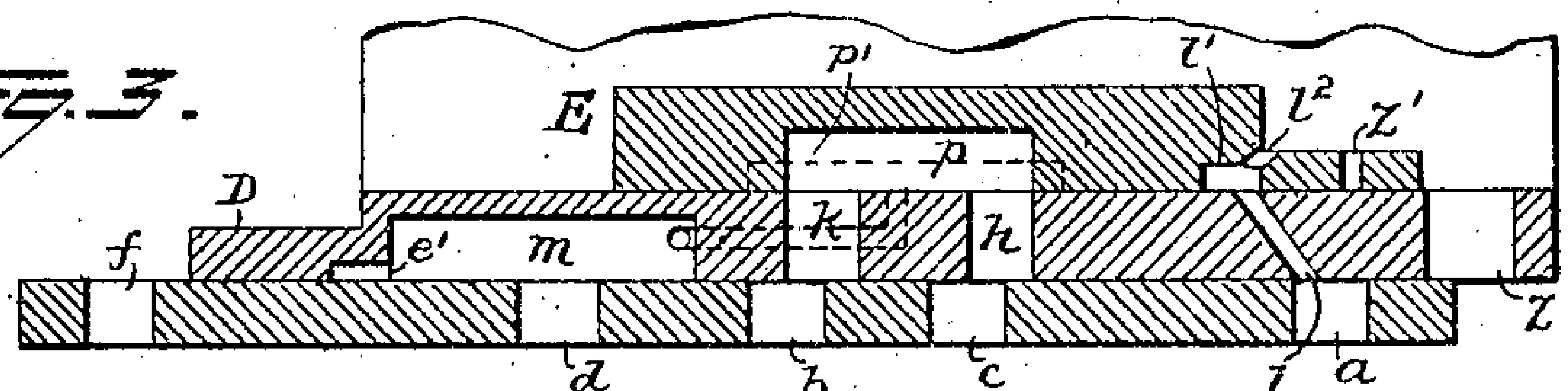


FIG. 4.

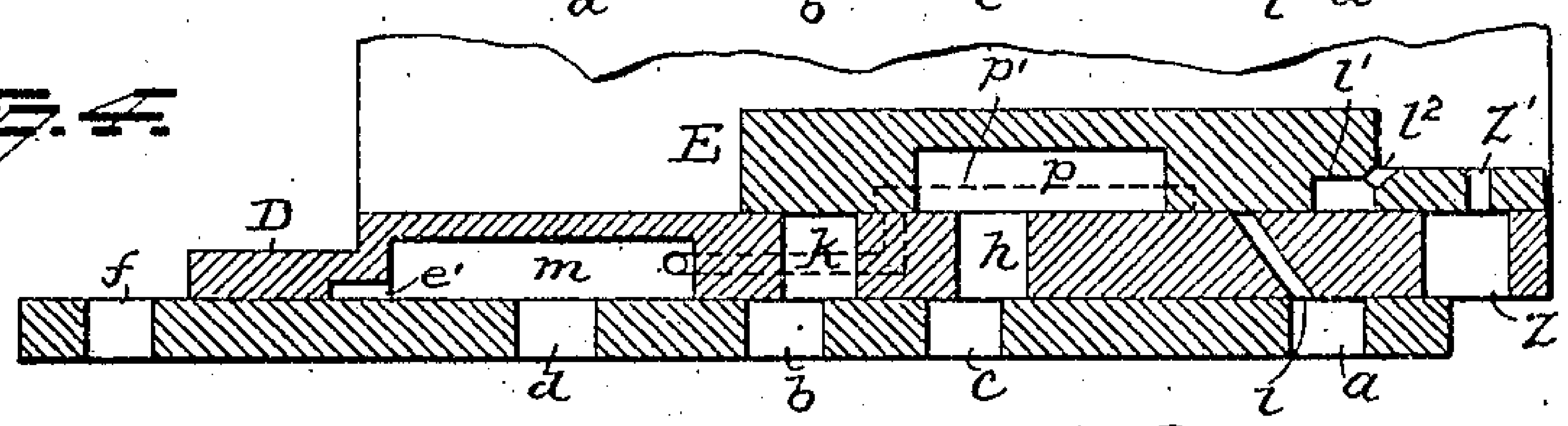


FIG. 5.

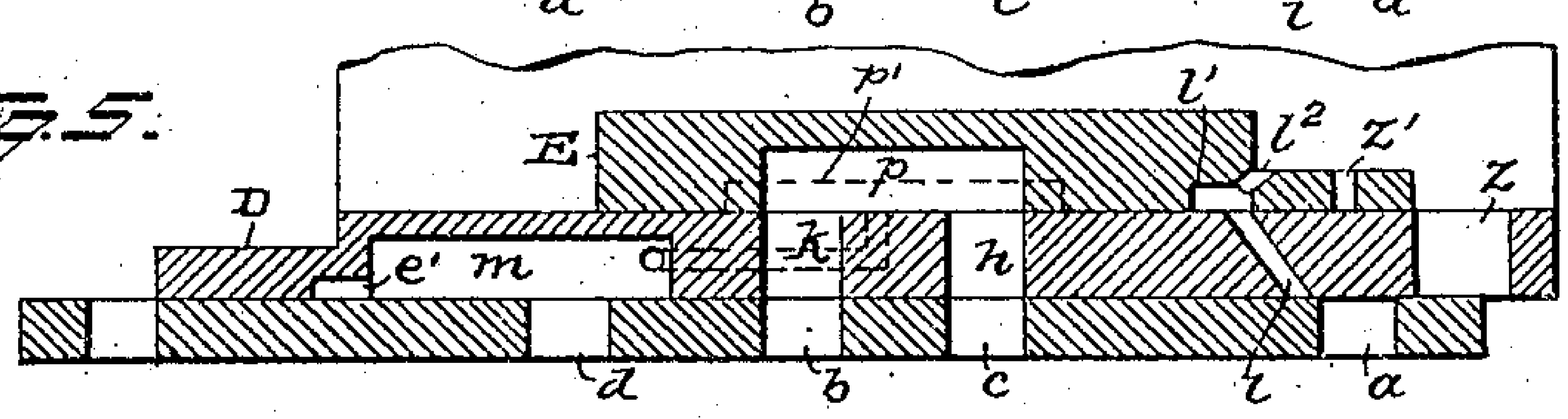


FIG. 6.

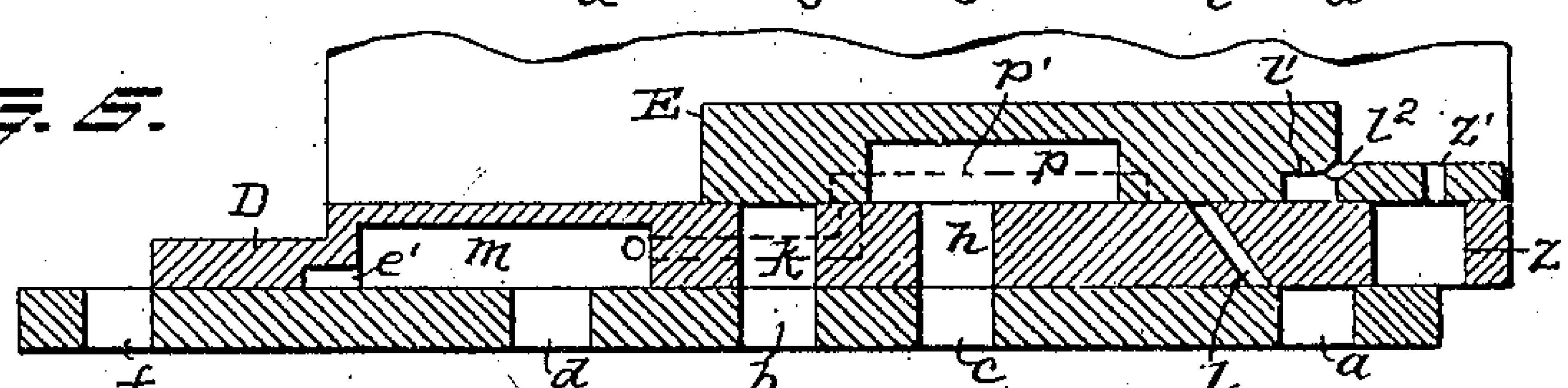


FIG. 7.

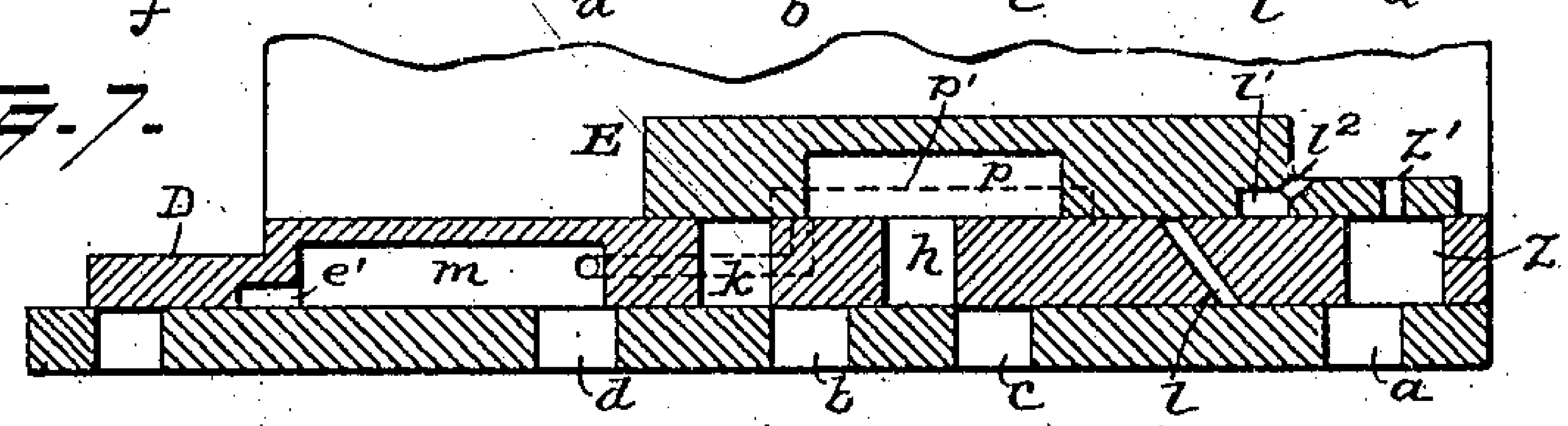


FIG. 8.

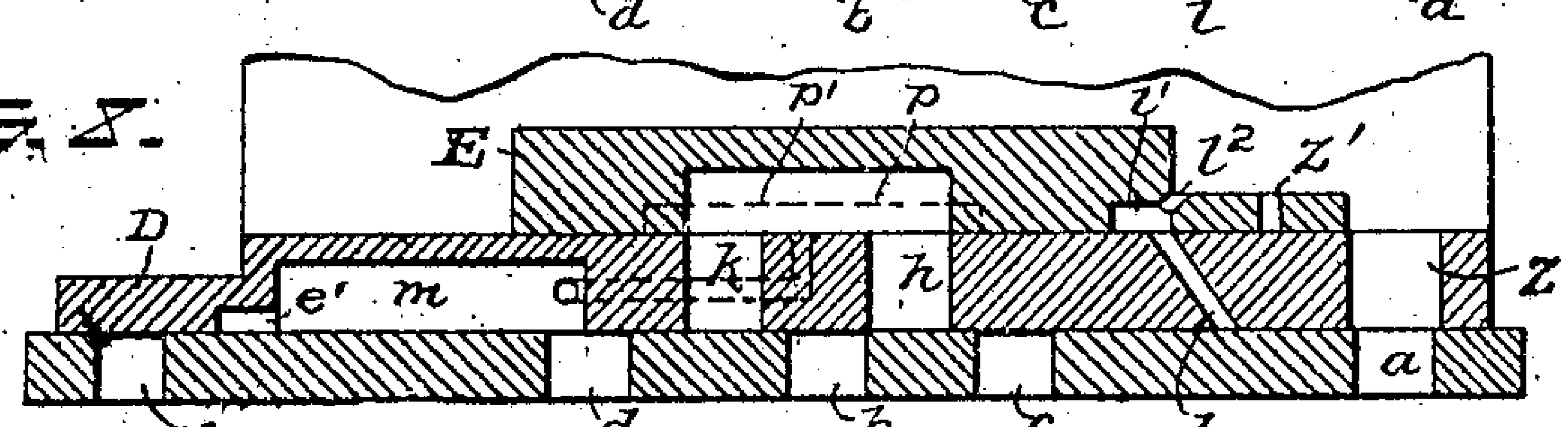
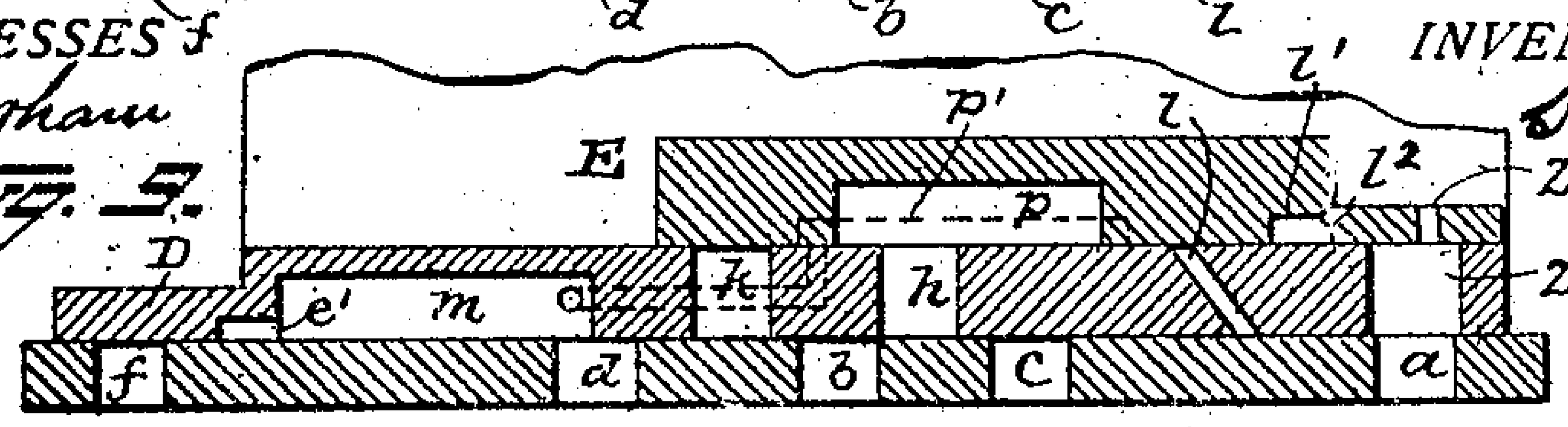


FIG. 9.



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3 SHEETS—SHEET 3.

Fig. 10.

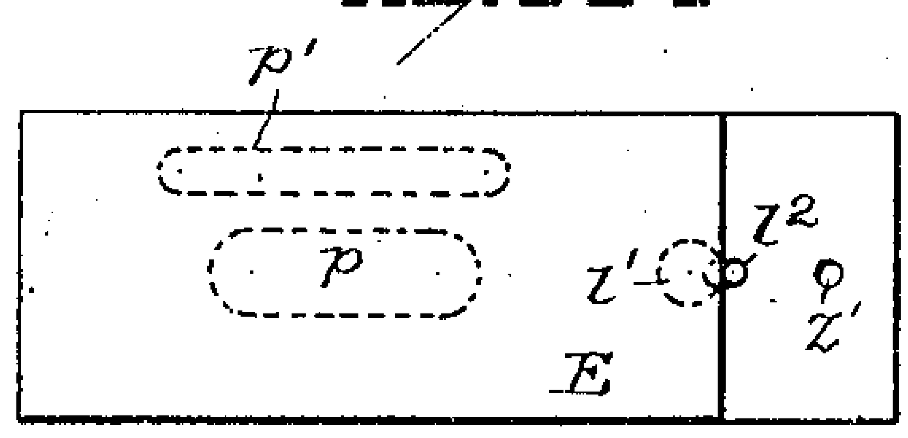


Fig. 11.

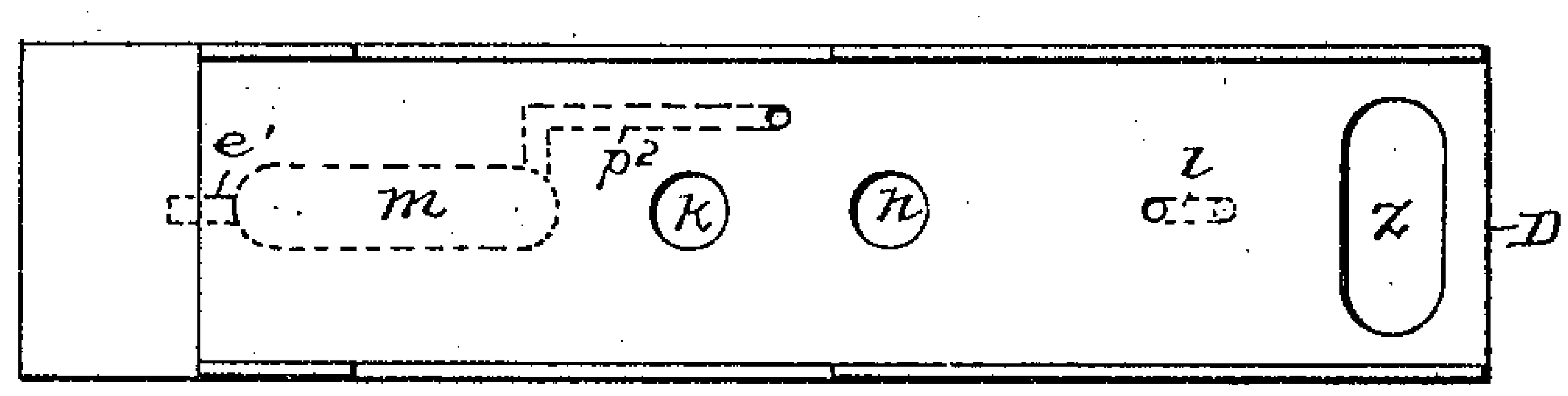
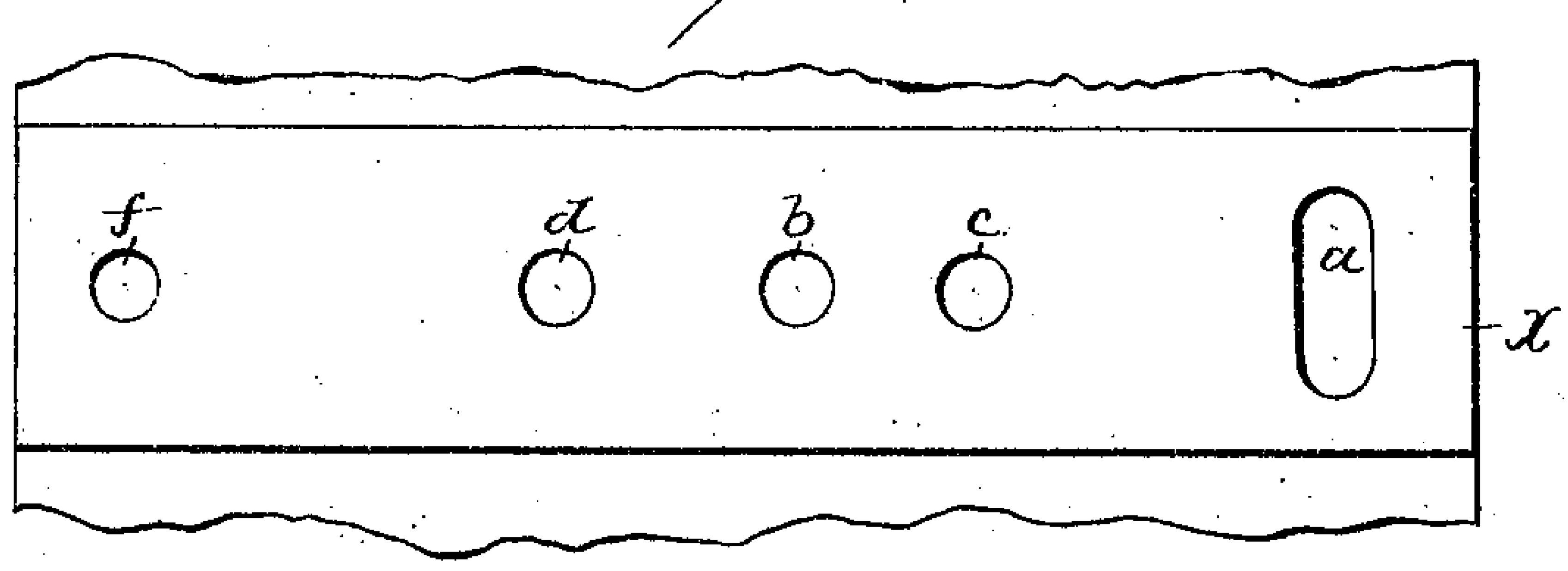


Fig. 12.



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UNITED STATES PATENT OFFICE.

HOWARD M. P. MURPHY, OF PITTSBURG, PENNSYLVANIA, ASSIGNOR OF ONE-FOURTH TO L. H. BOWMAN, OF MUNHALL, PENNSYLVANIA, AND ONE-EIGHTH TO JOSEPH M. FLANNERY, OF PITTSBURG, PENNSYLVANIA.

AIR-BRAKE APPARATUS.

No. 912,715. Specification of Letters Patent. Patented Feb. 16, 1909.

Application filed April 4, 1908. Serial No. 425,194.

To all whom it may concern:

Be it known that I, HOWARD M. P. MURPHY, a resident of Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented certain new and useful Improvements in Air-Brake Apparatus; and I do hereby 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.

My invention relates to improvements in air brake apparatus and more particularly to triple valve mechanisms, the object of the invention being to provide simple and efficient means for controlling the operation of the brakes under any and all of the conditions which arise.

A further object is to so construct a triple valve mechanism that it shall be very sensitive to variations of train pipe pressure, regardless of the length of the train on which my improvements may be employed.

A further object is to improve, in other respects, the construction of triple valve mechanism to enhance the efficiency of the same.

A further object is to so construct a triple valve mechanism that the maintenance of brake cylinder pressure will be insured when the brakes are fully applied, notwithstanding any leaks which might occur.

A further object is to embody in a triple valve mechanism, "quick action" and "quick service" features and to so construct the mechanism as to provide for various rates of release of the brakes and recharge of the auxiliary reservoir.

With these objects in view, the invention consists in certain novel features of construction and combinations and arrangements of parts as hereinafter set forth and pointed out in the claims.

In the accompanying drawings; Figure 1 is a sectional view of a triple valve mechanism embodying my improvements, the parts being shown in their "normal recharge and free release" position; Fig. 2 is a view showing the valve devices in "restricted recharge and restricted release" position; Fig. 3 is a similar view with the parts in "quick service" position; Fig. 4 shows the positions of the valve devices when in "quick service lap" position; Fig. 5 illustrates the "full service" position of the valve devices; Fig. 6 is a view showing the "full service lap" position; Fig. 7 shows the position of the valve devices when they assume their "equalization lap and maintaining" position; Fig. 8 shows the parts in "emergency" position; Fig. 9 shows "emergency lap" position of the valve devices; Fig. 10 is a top plan view of the graduating valve; Fig. 11 is a top plan view of the main valve, and Fig. 12 is a plan view of the seat for the main valve.

1 represents a casing which may be secured to the end of an auxiliary reservoir 2 so that the latter will form a head for one end of the casing, or the latter may, if desired be provided with a separate head which may, in turn be secured to any convenient support and provided with suitable ducts and passages.

A bushing 3 is pressed into the casing 1 and the lower portion of this bushing constitutes a seat X for a main slide valve D which is movable longitudinally within the bushing, by means of the rod F of a piston G, the latter being movable within a chamber or cylinder G^1 between one end of the bushing 3 and the opposite head of the casing adjacent to the auxiliary reservoir. For reasons which will hereinafter become apparent, motion should not be transmitted to the valve D throughout the full travel of the piston G and its rod, but there should be a certain amount of lost motion between said piston rod and the valve. For this reason, the rod F is provided with two shoulders F^2—F^3 for engaging the valve at respective ends thereof, and these shoulders are so spaced apart that the rod can move a certain distance in one direction or the other before engaging the valve.

The rod F is recessed between its ends for the reception of a secondary or graduating valve E which has a close fit within said recess so that it will partake of the movements of the rod through the full travel of the latter, and this secondary or graduating valve is pressed toward its seat on the main valve D, by means of a light spring *r*.

Provision is made at Y for the attachment of the train pipe and this inlet communicates with a duct S over the bushing 3, the interior of which latter constitutes the valve chamber R^1, and the duct S is connected with this valve chamber through the medium of a duct R, and a port *f* in the valve seat X. A check valve R^2 is located at the intersection of the ducts R and S, said check valve being so disposed as to prevent a passage of train pipe fluid from the duct S to duct R, but permitting a passage of fluid, under certain conditions, from the valve chamber R^1 through the port *f*, and ducts R and S to the train pipe. The train pipe duct S also communicates with a large duct T and at the juncture of these ducts a check C is located and pressed upon its seat by a light spring C^1, and so disposed as to prevent a passage of fluid through the duct T in the direction of the duct S. The check valve C is provided with a small duct g^2 which operates to premit a restricted flow of train pipe fluid from the duct S to the duct, T, under certain conditions, when the pressure of the train pipe fluid is such as to raise the check valve an insufficient distance to fully open communication between the ports S and T. The valve C (as will hereinafter become apparent) therefore acts as an excess pressure valve at certain times. The purpose of thus providing for a restricted passage of train pipe fluid to the chamber with which the duct T communicates will be hereinafter explained. The duct T communicates with the valve chamber R^1 and, through the forward portion of the latter, with the piston chamber G^1.

A duct 4 leads to the brake cylinder and this duct communicates with a duct V which latter communicates with a duct U terminating under a port *b* in the valve seat X so that in certain positions of the valve D as hereinafter explained, brake cylinder air may be exhausted through a duct d^1 in the casing 1, and so that supply fluid may also be admitted to the brake cylinder in certain other positions of the valve.

A duct V^1 communicates at one end with a large port *a* in the valve seat X and at the other end with the duct V for the passage of fluid (as controlled by the valves) from the train pipe and from the auxiliary reservoir to the brake cylinder, and in the duct V^1 a check vlave B (held to its seat by a light valve B^1) is located, so as to prevent brake cylinder fluid from entering the said duct, from the duct V. The main slide valve seat X, contains also a port *d* communicating with the atmosphere through the duct d^1, which latter may, if desired, be connected by a suitable pipe, with a retaining valve. The valve seat X also contains a port *c* which is connected by means of a duct c^1 with a large duct W, the latter communicating at one end with the auxiliary reservoir 2 and with the chamber G^1 at the right of the piston in the latter.

The rod F is adapted to contain, in addition to the spring *r* hereinbefore referred to, two other springs N and N^1. The spring N^1 is of moderate strength and operates to normally hold a rod H^3 in the position shown in Fig. 1. The spring N presses, at one end against the bottom of its socket in the rod F, while its other end bears against the head H^2 of a rod H, which latter projects beyond the piston G and is adapted to engage an abutment at the auxiliary reservoir end of the chamber G^1.

The main valve D contains a cavity *m* for establishing communication under certain conditions between the exhaust port *d* and the port *b*, and this cavity performs no other functions at any time except to cause the vlave D to be pressed firmly on its seat by the fluid pressure above it. The valve D also has a port *h* which, under certain conditions, communicates with the port *c* in the seat X. In addition to the ports and passages hereinbefore mentioned, the valve D is provided with a port K and a smaller port *l*, the former being adapted to register (under certain conditions) with the port *b* in the seat X, and the port *l* being made to register in certain positions of the valves, with the port *a* in the valve seat. The secondary or graduating valve E contains a cavity *p* for connecting the ports *h* and *k* under certain conditions but at no time to form any other connections. The valve E is disposed so as to permit of the uncovering and closing of the port *l* and also to close communication between the ports *h* and *k* by forming a cover for these ports. It will be observed from an inspection of the several views of the drawings illustrating different positions of the valve, that the ports *h* and *k* are never uncovered by the graduating valve E.

The valve D is provided near its right hand end with a large port Z and the graduating valve E is provided with an extension Z^2 having a small port Z^1 to become disposed over the port Z for controlling, under certain conditions, the passage of fluid from the chamber G^1 at the left of piston G, to the brake cylinders through the port *a* and the ducts which connect the latter with the brake cylinders.

In order to permit the passage of fluid from the chamber G^1 at the left of piston G, to the port *l* when the valves assume the positions shown in Fig. 3, the graduating valve E is provided with a cavity l^1 and a port l^2. A cavity p^1 in the valve E and a duct p^2 in the valve D serve to provide means for exposing a portion of the face of the valve E to atmospheric pressure in order to permit the pressure in the chamber R^1 to hold the valve E to its seat against pressure under said valve from the auxiliary port *c*. The wall or lining of the chamber or cylinder G^1 is provided at its left hand end with comparatively large grooves forming ducts L^1 L^2 for the purpose of permitting, (when the piston G is at this end of the chamber G^1,) a flow of air around said piston. A large duct or passage Q in the end of the bushing 3 will permit air thus flowing past the piston through the ducts L^1—L^2 to enter the valve chamber R^1 when said piston engages the end of the bushing 3.

A duct M is located in the wall or lining of the chamber or cylinder G^1 at the right hand end thereof. This duct varies in size at different portions thereof so as to form three passages M^1, M^2, M^3, each differing in capacity from the others, that is to say,—the passage M^1 is of moderate size; the passage M^2 is restricted as compared to the passage M^1, while the passage M^3 which communicates with the passages M^1 and M^2 is of greater capacity than the passage M^1. The duct M, variously proportioned as above explained, constitutes a by-pass around the piston G under certain conditions and for purposes which will be hereinafter fully explained. It will be observed that when the piston G occupies a position near the right end of the chamber G^1 the duct M provides means for admitting train pipe fluid to that portion of the chamber G^1 to the right of piston G, from which the auxiliary reservoir is charged through the duct W which connects the chamber G^1 to the right of piston G with the auxiliary reservoir 2 as before explained.

It is apparent from an inspection of the drawings that fluid can pass from the valve chamber R^1 through port f and duct R, past the check valve R^2 to the train pipe duct S when the port f is not covered by the main valve D as shown in Figs. 1 to 6, but that train pipe fluid can never enter the valve chamber R through this path, being prevented from so doing by the check valve R^2. It will also be observed that the passage of fluid from the valve chamber R^1 to the train pipe duct S, will be prevented when the parts assume the positions shown in Figs. 7, 8 and 9, because the port f will then be closed by the main valve D. The main valve, in its movements to the positions shown in Figs. 7, 8 and 9, will always operate to close the port f only after uncovering the port a which communicates with the brake cylinder ducts.

That portion of the chamber G^1 to the left of the piston G, together with the valve chamber R^1 which freely communicates with said chamber G^1, may be conveniently termed "a controlling space", because by the variations of pressure in these communicating chambers, the operation of the valve mechanism is controlled by manipulation of a "brake valve" by the engineer.

In Fig. 1 of the drawings, the valves and piston are in what may be termed as "normal recharge and free release" position, which is the position the parts will assume when the rate of rise of train pipe pressure is moderate as would be the case near the central and rear portions of the average freight train. It may now be assumed that (after the brakes were applied) the release was made and the rise of train pipe pressure was moderate. As the piston was forced by this rise of train pipe pressure, toward the right, (the train pipe fluid entering the piston chamber by the ducts S and T) drawing the valves D and E with it, through the medium of the rod F, the piston G first uncovered the passage M^1 and then the larger passage M^3,—the rod H coming into contact with the abutment t just before the groove M^3 is uncovered and thus causing the spring N to be compressed so that it will operate to exert a slight back pressure on the piston, and will, when the pressures on the two sides of the piston become approximately equal, cause the piston to close the large passage M^3, in order to prevent an excessive back flow of fluid from the auxiliary reservoir when it is subsequently desired to apply the brakes.

As before stated, train pipe fluid cannot pass to the controlling space at the left of the piston through the duct R, by reason of the chuck valve R^2, consequently the only path by which train pipe fluid can enter the controlling space is that formed by the ducts S and T. Now the spring C^1 is so designed that it will permit of a slight lift of the valve C by a very slight excess of pressure on its lower side, so that during the motion of the piston towards its release positions, practically full train pipe pressure is permitted to act in the controlling space, thus insuring a positive release of the brakes, (the train pipe fluid entering the controlling space through the ducts S and T and the small duct g^2 of the check valve C). But as soon as the piston uncovers the groove M^1 fluid from the controlling space flows through said groove M^1 so rapidly to the auxiliary reservoir that, because of the very restricted inlet through the duct g^2, the pressure in the controlling space falls slightly to a value intermediate train pipe pressure and auxiliary reservoir pressure, but under the assumed condition of a moderate rise of train pipe pressure, the pressure in the controlling space will still be sufficiently in excess of that in the auxiliary reservoir to cause the piston to continue its motion till the large groove M^3 is uncovered thereby, when of course a still further reduction of pressure in the controlling space will take place, as the duct M^3 is of much greater capacity than the duct g^2. (At this time the spring C^1, which is short and stiff, prevents the check valve C from rising far enough to permit of a free flow of air from the duct S to the duct T as the rise of train pipe pressure is only moderate and thus the valve C acts as an excess pressure valve under these conditions). On account of this reduction of pressure in the controlling space, the pressures acting on the two sides of the piston will become so nearly equalized that their difference is no longer sufficient to overcome the friction of the moving parts and they will assume the position shown in Fig. 1. It will now be seen that with the parts in the positions shown in Fig. 1, the auxiliary reservoir is receiving a supply of compressed air through the duct W from that portion of the chamber G^1 to the right of the piston G and that this portion of the chamber is being supplied with compressed air from the controlling space through the passage M^3 of duct M and that fluid is entering the controlling space from the train pipe through the duct g^2 at a moderate rate. As this is the proper charging rate for average conditions, and as this is the most usual charging position of the mechanism, this rate of recharge may be termed the "normal" rate. In the position of the mechanism shown in Fig. 1, the main slide valve D establishes a free communication between the ports *b* and *d* by means of the cavity *m*, thus permitting a rapid discharge of brake cylinder air from the ducts V and U to the outlet d^1 and thence to the atmosphere. Thus it is seen that a moderate rise of train pipe pressure will cause the mechanism to provide for both a free release of the brakes and a normal rate of recharge of the auxiliary reservoir.

In the above description, a moderate rate of rise of train pipe pressure has been assumed, but should there be only a very slight rise of train pipe pressure, as is the case toward the rear of very long trains, (that is to say, if the force acting on the piston during its motion toward its release portions is only very slightly in excess of that necessary to overcome the friction of the moving parts) when the piston reaches such a position that it uncovers the end of the passage M^1, the resulting flow of air from the controlling space to the auxiliary reservoir will so reduce the pressure in the controlling space that the piston will no longer be able to overcome the resistance of the moving parts, and its further motion will cease. At this time the ports *b* and *d* will be freely connected by the cavity *m* of the valve D, thus providing for the free exhaust of brake cylinder fluid, but the rate of recharge of the auxiliary reservoir will be slightly less than it would have been if the large groove M^3 had been uncovered by the piston. Consequently, the amount of fluid taken from the train pipe under the given condition of a very slow rise of train pipe pressure, is less than would have been taken had the valve been able to assume its "normal recharge and free release" position as shown in Fig. 1. A greater amount of fluid will, therefore, continue to flow toward the rear portion of the train (beyond the point where this valve mechanism may be located) than would otherwise be the case and will thus tend to compensate for the large train pipe volume and, as a result, will provide for a more rapid release of the brakes on the extreme rear end of the train than has heretofore been accomplished. This position may therefore be conveniently termed a "compensating recharge and free release" position.

If after the auxiliary reservoirs at the forward portion of the train have become nearly fully recharged and consequently the pressure near the rear of the train, (where the valve mechanism with the parts in the positions now under consideration are located) begins to build up more rapidly, the valve will be forced from this position (namely, its compensating recharge and free release position) to its "normal recharge and free release" position, as shown in Fig. 1, thus permitting of a more rapid replenishment of the auxiliary reservoir pressure than would be possible if the mechanism were retained in its "compensating recharge and free release" position. This movement will result from the fact that when the rise of train pipe pressure is moderately rapid, the small groove or passage M^1 is unable to convey fluid rapidly enough from the controlling space to the right hand side of piston G in order to maintain the pressures acting on said piston sufficiently nearly equalized to prevent them from overcoming the friction of the moving parts and subsequently the tension of the spring N, and moving the parts to the position shown in Fig. 1.

It may now be assumed that after an application of the brakes, the release is made by subjecting the mechanism to a very rapid rise of train pipe pressure, such as would obtain at the forward portion of a train near the locomotive. In this case the check valve C will be raised by the high train pipe pressure so as to fully open communication between the ducts S and T and thus permit the passage of a large volume of train pipe fluid into the chamber G^1 to the left of the piston G. This will result in causing a rapid motion of the piston G to the extreme right, as the ducts M^1 and M^3 cannot convey sufficient fluid around the piston to cause even an approximate equalization of pressure on its two sides, (the check valve C being wide open). Consequently the piston G is forced against the right hand end of its chamber, and the valves are carried by it into the positions shown in Fig. 2 which may be called the "restricted recharge and restricted release" position of the mechanism for when the parts are in the positions above mentioned, air will be permitted to flow to the auxiliary reservoir only through the very restricted passage M^2. Thus, although the train pipe pressure is much higher than that in the auxiliary reservoir, the recharge of the latter will be comparatively slow, thereby preventing for a considerable length of time, an overcharge of said reservoir with fluid of a higher pressure than is normally carried in the train pipe; (at the same time, a more rapid flow of train pipe fluid toward the rear of the train will be insured for the purpose of effecting the prompt release of the brakes there located) moreover when the valves are in this "restricted recharge and restricted release" position as shown in Fig. 2, the cavity *m* in the valve D will communicate with the brake cylinder port *b* and only a small extension e^1 of said cavity *m* will communicate with the exhaust port *d*. The release of brake cylinder fluid will thus be restricted or retarded to a considerable extent and consequently tend to produce a uniform release of the brakes throughout the whole train (those toward the rear of the train having an unrestricted release as previously explained) and thus the severe running out of "slack" between the cars will be prevented.

Assume now that it is desired to make a service application of the brakes and that the mechanism is in any of the release positions: The gradual reduction of train pipe pressure (such as is usually made in service applications of automatic brakes) will cause a simultaneous reduction of pressure in the valve chamber R^1, and in the piston chamber G^1 to the left of the piston G,—the air from these chambers passing out freely to the train pipe through the port *f*, duct R, past check valve R^2 and through the duct S. The flow of fluid from the auxiliary reservoir, through the duct M^1 being restricted, the piston will be forced toward the left. When the piston is thus forced toward the left, the duct M will become closed. After taking up the lost motion between the rod F and valve D, the rod will cause said valve to move with it to the left and because of pushing (instead of pulling) this valve by the rod F, the graduating valve E will be in the extreme left hand position with reference to the main slide valve D and will therefore connect ports *h* and *k* by the cavity *p* and will also uncover the upper end of port *l*. The first motion of the main slide valve D to the left, will disconnect the exhaust cavity *m* from the brake cylinder port *b* and the further movement of the valve D will cause the port *l* to register with the port *a*, and subsequently port *h* will register with port *c* and also port *k* will register with port *b*. It will thus be seen, as shown in Fig. 3, that auxiliary reservoir air is free to pass through the duct c^1, ports *c* and *h*, cavity *p*, ports *k* and *b* and ducts U and V to the brake cylinder.

The registration of the small port *l* with the port *a* permits of a slight flow of train pipe fluid to the brake cylinders in order to assist in transmitting the reduction of train pipe pressure throughout the train and to slightly augment the pressure obtained in the cylinders. It will be noted that the air thus admitted through the port *l* to the brake cylinders must enter the latter by passing the check valve B, which latter at all times prevents a back flow of air through the duct *a*. This position of the valve may be termed, its "quick service position" and is shown in Fig. 3. The relative sizes of the ports *c*, *h*, *b*, *k* and cavity *p* to the port *l* are such that the reduction of pressure in the auxiliary reservoir will take place much more rapidly than the reduction of pressure in the train pipe if the latter be made through the port *l* alone; consequently as soon as the engineer stops the reduction of train pipe pressure by means of his brake valve, the pressure behind the piston G will fall below that in front of it and said piston will move to the right. The slight difference of pressures required to cause this motion is merely sufficient to overcome the friction of the piston and the graduating valve, so that when the piston has moved until the left hand shoulder F^3 engages the main slide valve, its further motion will be stopped by this means, because it requires considerably more force to move the main valve than is necessary to move the piston and graduating valve alone. By this means therefore, the mechanism is caused to assume a "lap" position, the parts being located with reference to each other and to the seat as shown in Fig. 4. It will be observed that the graduating valve E has now closed the port *l* and disconnected and closed the ports *h* and *k*. This position of the mechanism may be termed the "quick service lap position". If now, a further train pipe reduction is made by the engineer, the piston will again move to the left and first cause ports *k* and *h* to be connected by means of the graduating valve and then uncover port *l*,—thus permitting a further flow of auxiliary reservoir air and of train pipe air to the brake cylinder. The object in connecting the auxiliary reservoir and brake cylinder ports before the port *l* is opened, is to prevent very slight train pipe reductions, (such as occur from leakage) from causing the venting of train pipe fluid to the brake cylinder, as such venting would only amplify the objectionable results obtained from such undesired reductions of train pipe pressure.

The "quick service" position of the mechanism (*i. e.*, that above described and shown in Fig. 3) is the position which will be assumed when the service reduction of train pipe pressure is made at a fairly slow rate, as is the case on most freight and long passenger trains. When, however, the service reduction is made on short trains and is consequently fairly rapid the mechanism may assume a position (as shown in Fig. 5) to the left of its quick service position, and which may be termed the "full service position". In this position of the mechanism, the ports *c* and *h* and *b* and *k* are freely connected but the port l has passed over the port a and consequently will no longer permit a flow of train pipe fluid to the brake cylinders, which flow (under the conditions assumed) is obviously not only unnecessary but undesirable. When the auxiliary reservoir pressure has become depleted to a point slightly below that of the train pipe pressure, the graduating valve E will be caused to assume a "lap" position as shown in Fig. 6, which position may be termed "full service lap position."

If the train pipe pressure be reduced, at the service rate, to such a low degree that the pressure in the brake cylinder has become equal to that in the auxiliary reservoir, a further reduction of train pipe pressure will obviously cause the piston G to move the slide valves to the left of their service positions for (because of the equalization of pressures in the brake cylinder and auxiliary reservoir) the pressure in the auxiliary reservoir cannot drop any lower, as a result of this motion of the parts to the left. Consequently, the motion of the parts will continue until the port f is closed by the valve D, and thus all further flow of air from the valve chamber R^1 to the train pipe is prevented. The valves will now assume the position illustrated in Fig. 7. This position of the mechanism may be termed "equalization lap and maintaining position."

It may be here stated that the rod H^3 is of sufficient length to engage the abutment u in the "quick service" position of the valve for the purpose of adding the resistance of the spring N^1 to the motion of the valve in its movement past "quick service" position toward the "emergency" position, (which latter will be presently described) as well as to cause the graduating valve to close port Z except for the small port Z^1 of the main valve (when the pressures become equalized on both sides of the piston) in the "equalization lap" and "emergency lap" positions of the valve D.

It will be observed that on account of the different distances between the ports in the valve D and the ports in the seat X, and the length of the rod H^3, when the port Z in the valve D registers with the brake cylinder port a, the spring N^1 is adapted to tend to cause the graduating valve E to close said port Z except for the small port Z^1 in the extension Z^2 of said valve E, in the lap positions of the valves shown in Figs. 7 and 9. The purpose of this arrangement, is to prevent an excessive flow of train pipe fluid to the brake cylinder at the time of the release. The coöperation of the ports Z and Z^1 thus serve to control the flow of fluid from the controlling space (viz. chambers G^1 and R^1) to the brake cylinder.

Reverting now to the "equalization lap and maintaining" position of the mechanism, as shown in Fig. 7, it may be stated that in this position, the piston G has not yet moved far enough to open or uncover the ducts or grooves L^1 L^2. During the movement of the valve D to this position, it is clear from the spaces existing between the ports, that the port a was slightly opened; after which the port f and ports c and b were closed. During this same movement and at all times, the check valve B prevents a flow of fluid from the brake cylinder through port a to the slide valve chamber. The object in slightly opening port a before closing port f is to provide means whereby, in emergency applications and in case the brake cylinder pressure becomes depleted by leakage after equalization, the low pressure in the brake cylinder can cause a flow of air from the piston chamber G^1 at the left of the piston, past the check valve B, and thus cause the auxiliary reservoir pressure to force the piston to its extreme left hand position,—simultaneously opening port a wide and permitting air to flow from the auxiliary reservoir through the grooves L^1, L^2, duct Q and port a to the brake cylinder.

When the parts of the mechanism assume the equalization lap position or any other position to the left of the same and consequently the main valve has uncovered the port a; if, after reducing the train pipe pressure sufficiently to cause the mechanism to assume such a position, any pressure equal to or less than this reduced pressure be maintained in the train pipe through the medium of a properly adjusted reducing valve under the control of the engineer, the brake cylinder pressure cannot drop below the maintained pressure in the train pipe, as air is, under the conditions stated, perfectly free to flow from the train pipe to the brake cylinder by opening the check valves C and B flowing through the ducts S and T and ports Z^1, Z and a and ducts V^1, V and 4. Thus it will be seen that the mechanism provides a simple and efficient means for the maintenance of brake cylinder pressure in spite of leakage, and yet in no way interferes with the proper action of the mechanism when a release is desired, as under the conditions stated, there is no way for the air to enter the auxiliary reservoir and consequently the release may be effected with as much ease as in the case of other triple valves which do not embody a maintenance feature. It is also evident that this feature, as embodied in my improved mechanism is entirely automatic (as long as the train pipe pressure is maintained) and that it in no way interferes with the satisfactory operation of the valve when operated on trains having the ordinary forms of triple valves, but will operate in perfect unison with them under all conditions.

Consider, now that the mechanism is in one of its release positions and that the train pipe pressure is suddenly reduced in order to cause an emergency application of the brakes. This will, of course, effect a rapid motion of the piston and slide valve to the left, causing them to pass over their service positions, as the reduction of pressure in the train pipe is so rapid that the pressure behind the piston cannot fall as rapidly through the service ports, and consequently the parts move rapidly to their extreme left hand positions, as indicated in Fig. 8. The port *f* is now closed and the port *a* is wide open. The ports *b*, *c* are also closed and the cavity *m* of valve D is resting over port *d* and thus exposing a large portion of the area of the face of the valve to atmospheric pressure in order to permit the low pressure above it to hold it to its seat, notwithstanding any tendency that the higher pressure existing in the small port *c* may have to lift it from its seat. As the valve moves beyond its service positions toward that shown in Fig. 8, although all further flow of air from in front of the piston to the train pipe is stopped the instant that the port *f* is closed, still, as the port *a* is opened before port *f* is closed, a very rapid reduction of pressure now occurs from in front of the piston through the port *a* and its connecting ducts to the brake cylinder. In fact, the opening of the port *a* not only insures the full and rapid motion of the piston and valves to their extreme left hand positions, but also provides means for rapidly venting a large amount of train pipe fluid to the brake cylinder (train pipe fluid passing by check valve C and through ducts S and T and port *a* to the brake cylinder) in order to assist in transmitting the emergency reduction of train pipe pressure throughout the train and to augment the cylinder pressure.

When the valves reach the positions shown in Fig. 8, the movement of the piston will be limited by the end of the bushing 3 and any over travel of the main slide valve D will be prevented by the abutment *u*. It is also apparent that there will now be a free flow of air from the auxiliary reservoir through the port W, around the piston through the grooves L^1, L^2, and through the duct Q and port *a* to the brake cylinder. This flow of auxiliary reservoir air is sufficiently restricted to permit a large amount of train pipe fluid to enter the brake cylinders, it being evident, as previously pointed out that a free path is provided in the "emergency" position, for the passage of train pipe fluid to the cylinder.

When the pressure in the slide valve chamber finally tends to become greater than that in the train pipe, the check valve C is closed by its spring and a back flow of air to the train pipe is thus prevented, as the port *f* is also closed as previously pointed out. When the pressures in the auxiliary reservoir and brake cylinder (said pressures now acting on the respective sides of piston G) become approximately equal, the moving parts will assume the position shown in Fig. 9,—which position may be termed "emergency lap" position. The main valve D is still in its emergency position, but the piston G and graduating valve E have been moved slightly to the right, thus cutting off the grooves L^1 and L^2. This motion of the piston is caused by the spring N^1 through the medium of the rod H^3. When the graduating valve E moves to the "emergency lap" position shown in Fig. 9, the port *a* will be closed, except for the restricted passage afforded by the small duct Z^1 in said valve E.

When it is desired to release the brakes at any time it is evident that the train pipe fluid may pass by the check valve C into the chambers R^1 and G^1 and thus act upon the piston G and force it at once to its release positions.

Having fully described my invention what I claim as new and desire to secure by Letters-Patent, is:—

1. In a triple valve mechanism, the combination with a casing, a piston therein, valve devices for controlling the application and release of the brakes, the space at one side of said piston constituting a controlling space, and means for introducing auxiliary reservoir fluid at the other side of said piston, of means for subjecting the side of the piston at which train pipe pressure is introduced, to a pressure intermediate that of train pipe pressure and auxiliary reservoir pressure.

2. In a triple valve mechanism, the combination with a casing, a piston therein, valve devices for controlling the application and release of the brakes, the space at one side of said piston constituting a controlling space, and means for introducing auxiliary reservoir fluid at the other side of said piston, of a duct for train pipe fluid communicating with the controlling space, and means for restricting the passage of fluid through said duct to the controlling space.

3. In a triple valve, the combination with a casing, a piston therein, valve devices for controlling the application and release of the brakes, the space at one side of said piston constituting a controlling space, and means for introducing auxiliary reservoir fluid at the other side of said piston, of a duct for train pipe fluid communicating with the controlling space, and an excess-pressure valve in said duct.

4. In a triple valve mechanism, the combination with a casing, a piston therein, valve devices connected with said piston for controlling the application and release of the brakes, the space at one side of said piston constituting a controlling space, and means for introducing auxiliary reservoir fluid at the other side of said piston, of a duct for train pipe fluid communicating with said

controlling space, a check valve in said duct, and a restricted passage for train pipe fluid controlled by the movements of said check valve.

5. In a triple valve mechanism, the combination with a casing, a piston therein, a chamber in which said piston is contained, a valve chamber, valve devices connected with the piston and located in said chamber for controlling the application and release of the brakes, the space in the valve chamber and in the piston chamber at one side of the piston constituting a controlling space, and means for introducing auxiliary reservoir fluid at the other side of said piston, of a train pipe duct communicating with the controlling space, an excess-pressure valve in said duct, a second duct connecting the train pipe duct with the valve chamber, and a check valve in said second duct and preventing passage of fluid from the train pipe duct to the valve chamber.

6. In a triple valve mechanism, the combination with a casing, a piston therein, valve devices connected with said piston for controlling the application and release of the brakes, the space at one side of said piston constituting a controlling space, means for introducing auxiliary reservoir fluid at the other side of the piston, and a brake cylinder duct, of means for affording a restricted passage between the controlling space and the brake cylinder duct when the ports are in "lap" position between the service and emergency positions of the mechanism.

7. In a triple valve mechanism, the combination with a casing, a piston therein, a main valve and a graduating valve, connections between said valves and the piston, the space at one side of said piston constituting a controlling space, means for introducing auxiliary reservoir fluid at the other side of said piston, and a brake cylinder duct, of a large port near one end of the main valve and a restricted port in the graduating valve to register with said large port when the latter communicates with the brake cylinder duct and the parts are in their "lap" position between "service" and "emergency" positions of the mechanism.

In testimony whereof, I have signed this specification in the presence of two subscribing witneesses.

HOWARD M. P. MURPHY.

Witnesses:
A. N. MITCHELL,
R. S. FERGUSON.