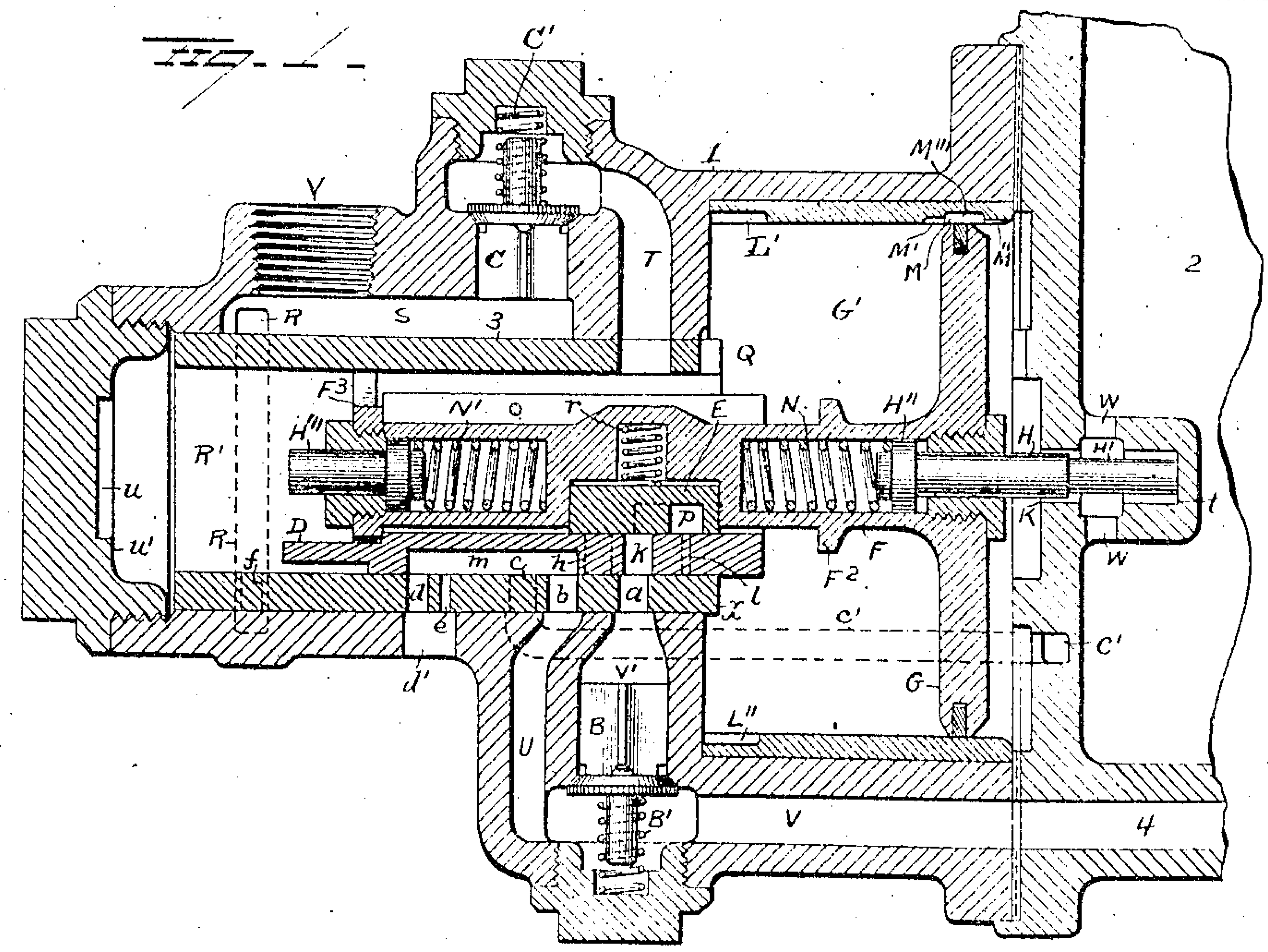
H. M. P. MURPHY.

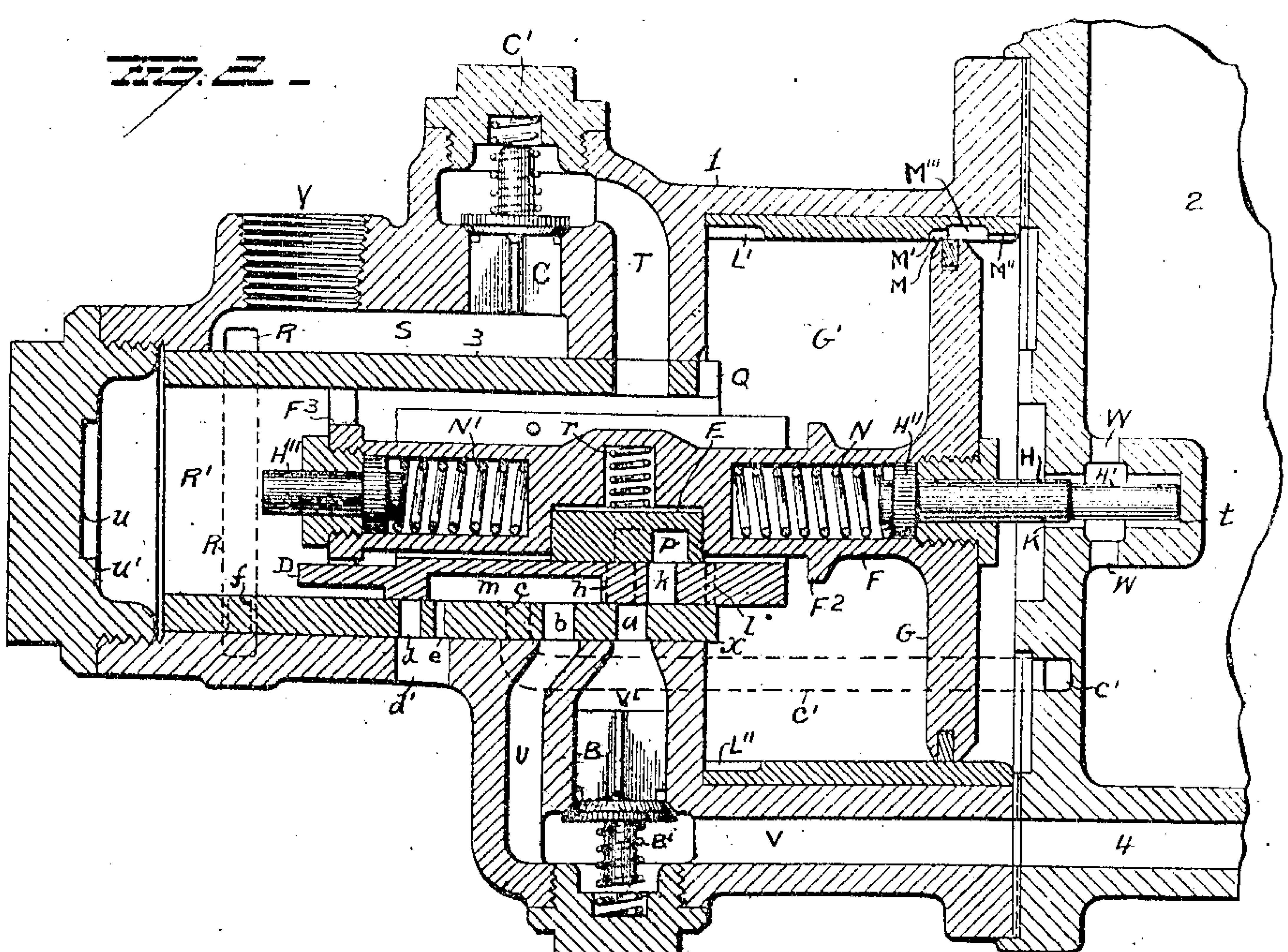
AIR BRAKE APPARATUS.

APPLICATION FILED APR. 4, 1908.

912,714. Patented Feb. 16, 1909.

4 SHEETS—SHEET 1





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4 SHEETS—SHEET 2.

Fig. 3.

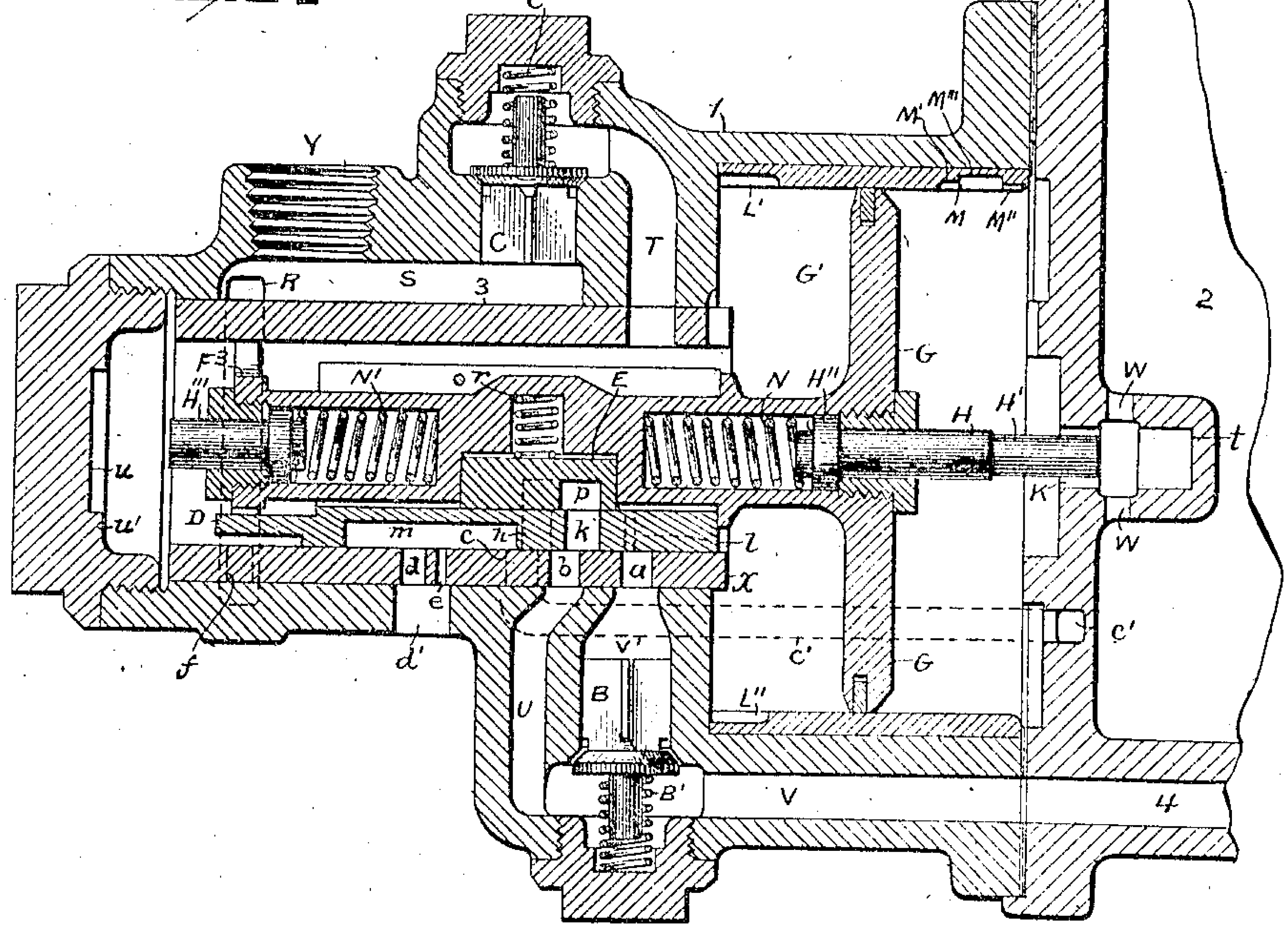
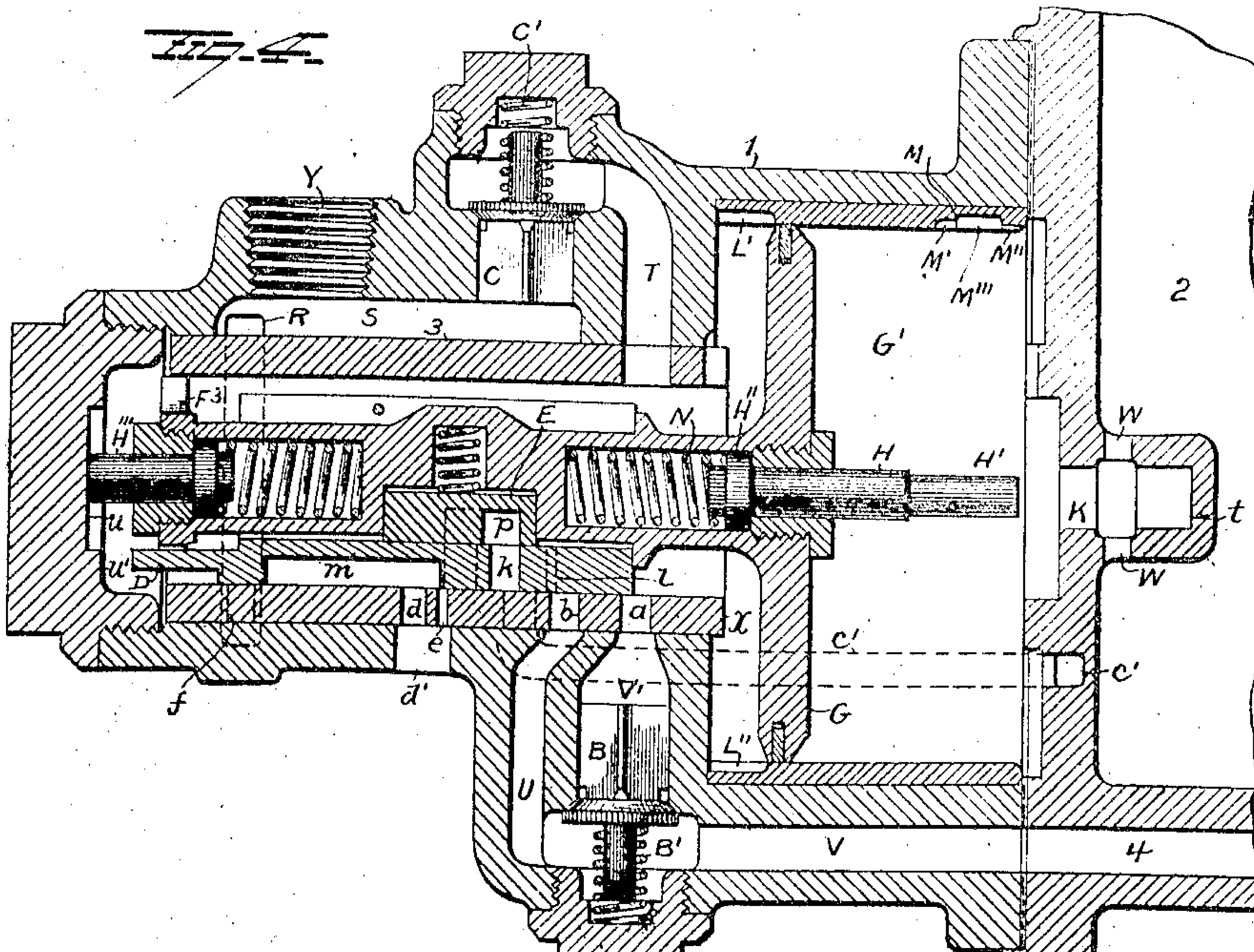


Fig. 4.



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4 SHEETS—SHEET 3.

Fig. 5.

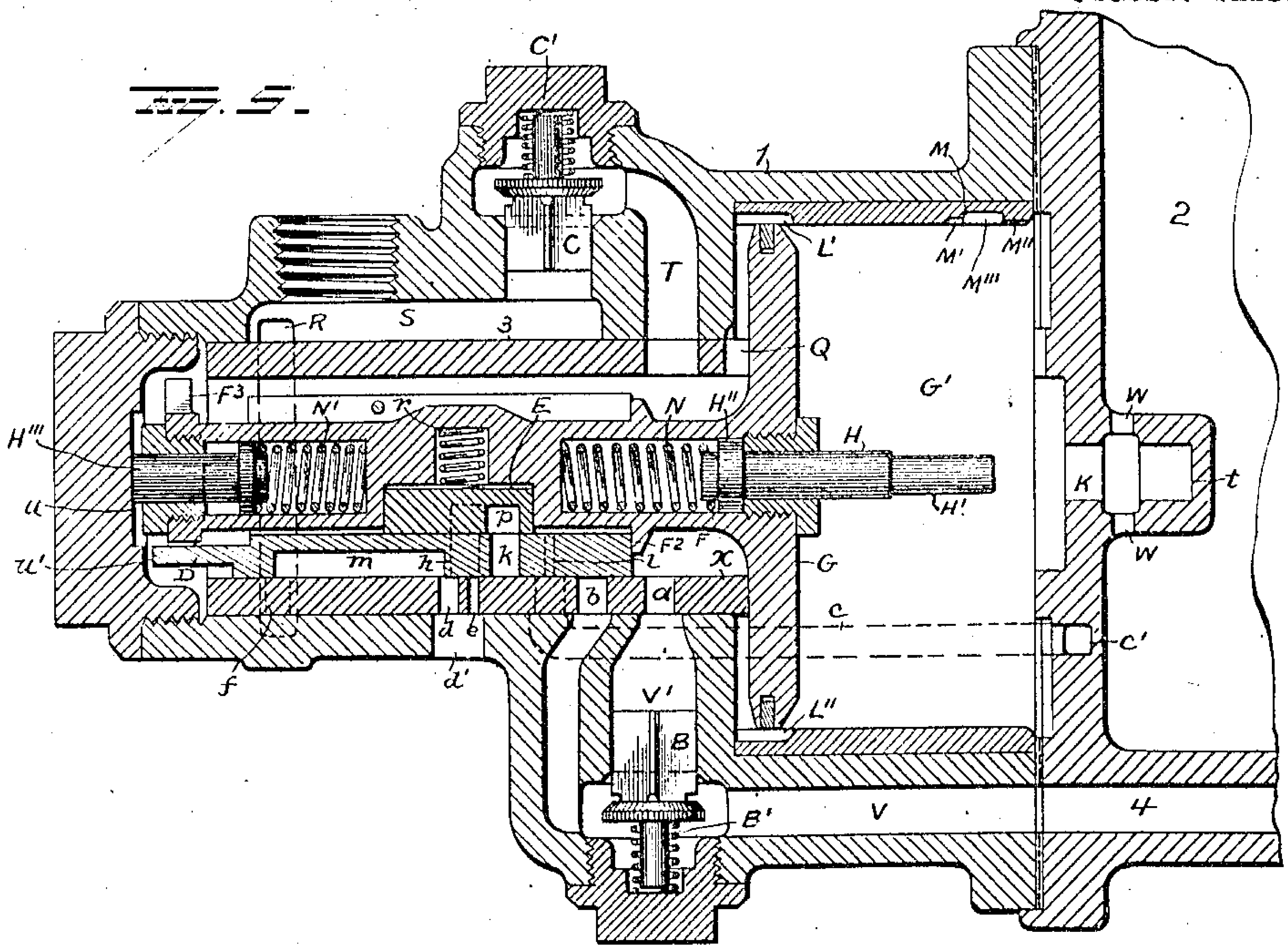
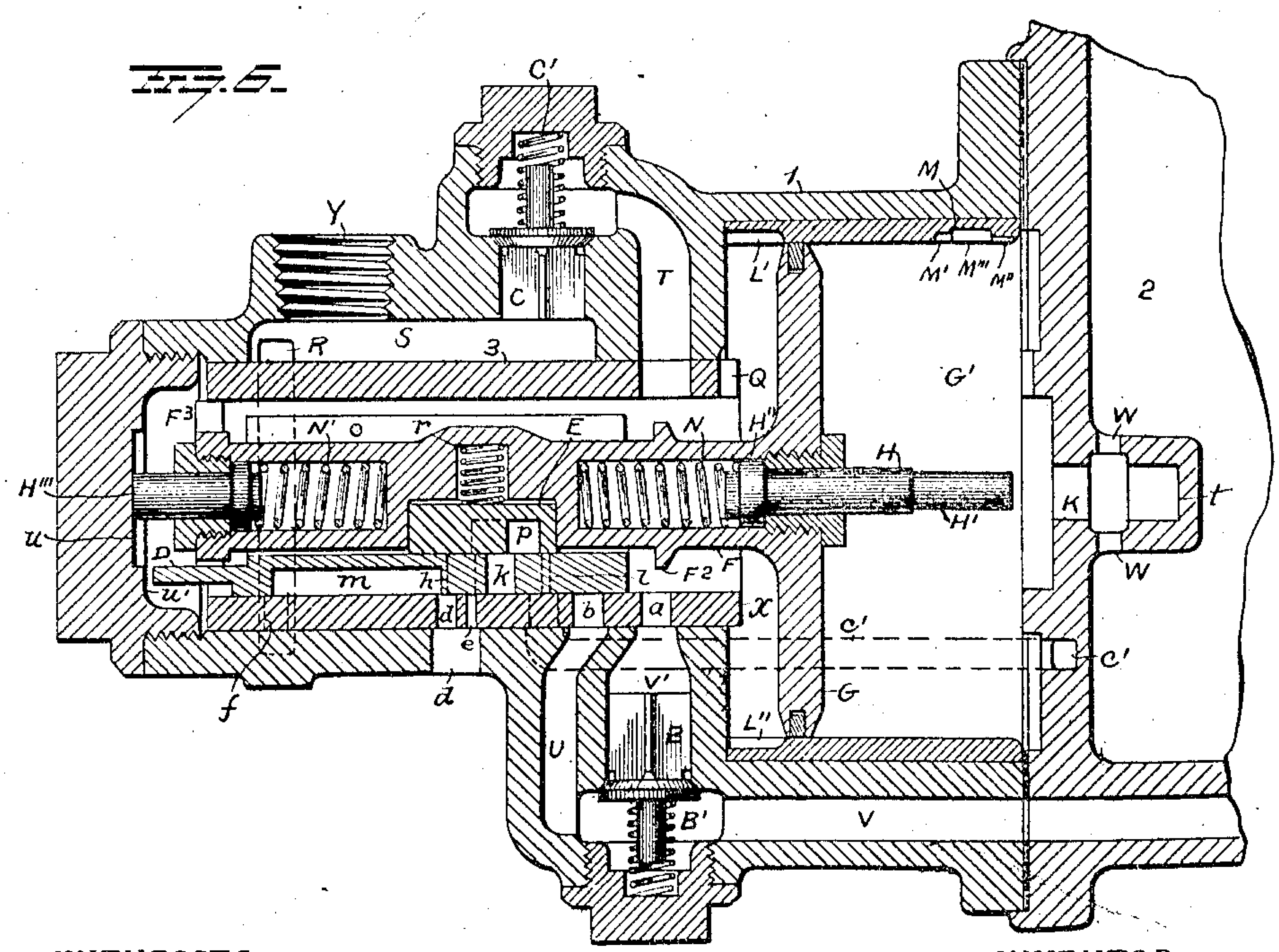


Fig. 6.



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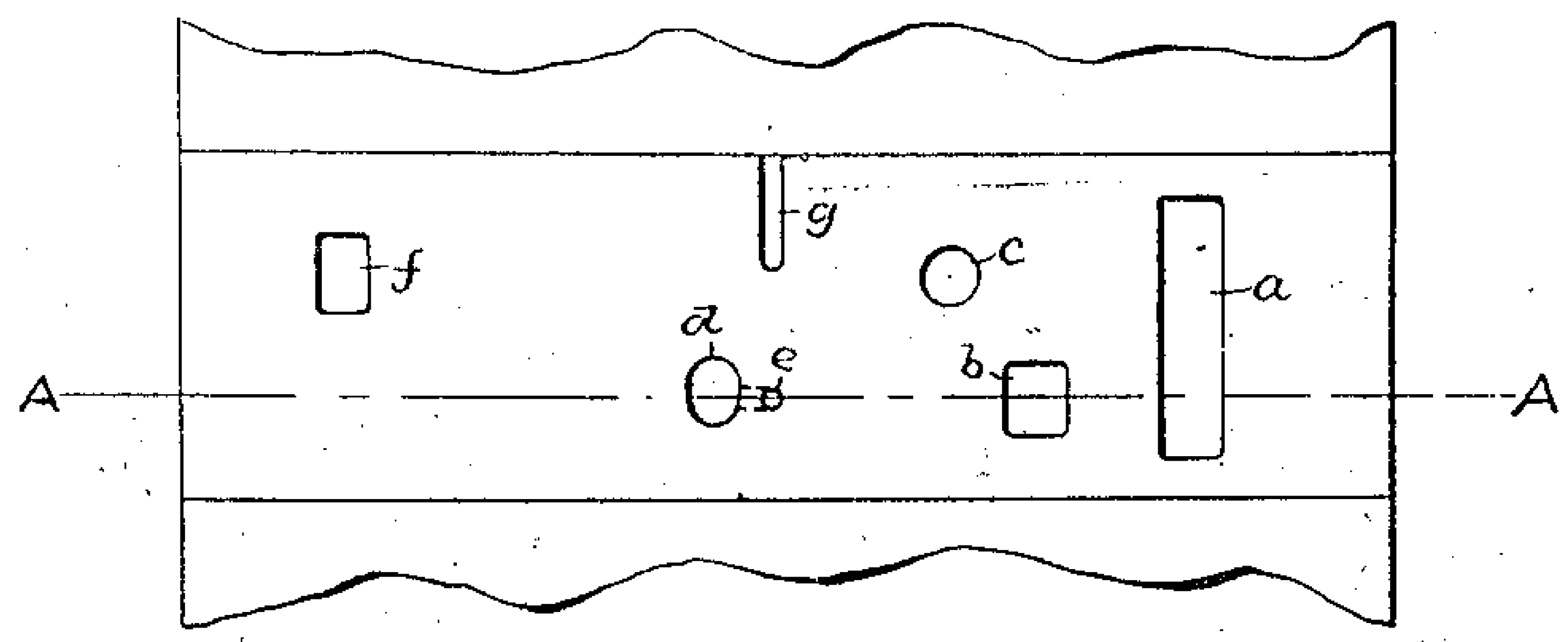


Fig. 7.

Fig. 8.

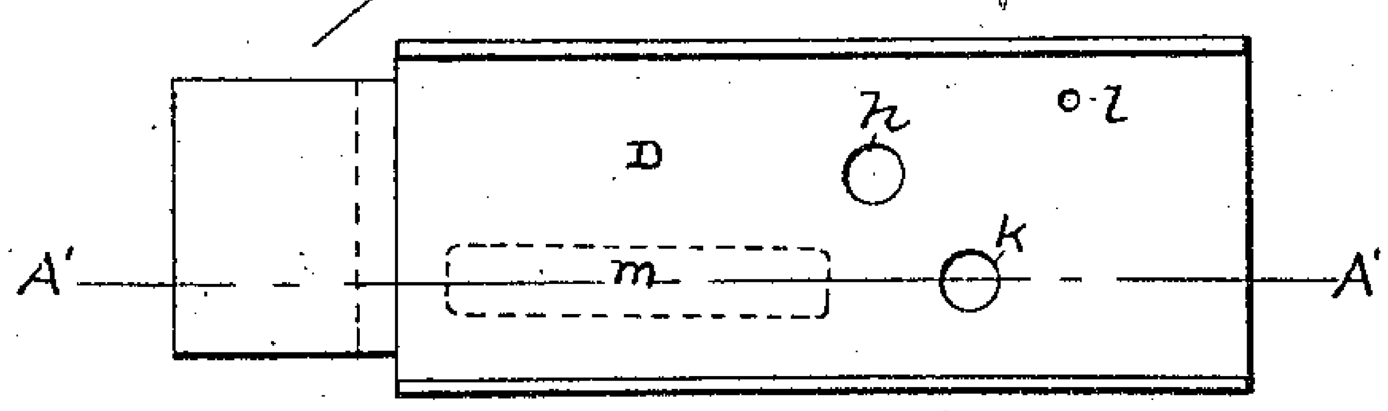


Fig. 9.

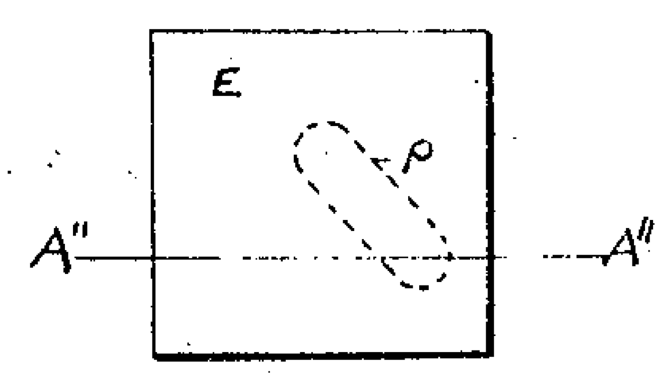


Fig. 10.

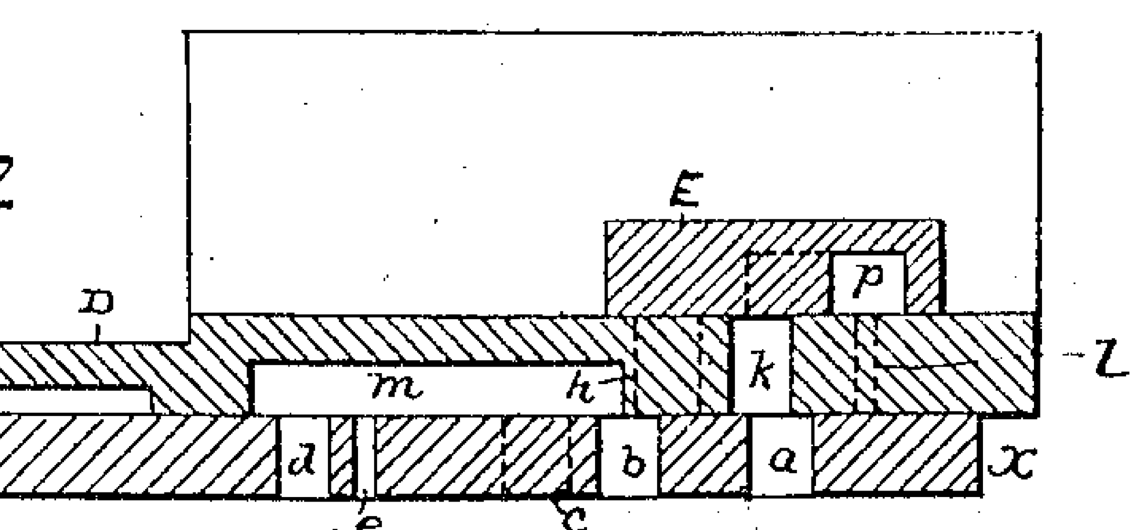


Fig. 11.

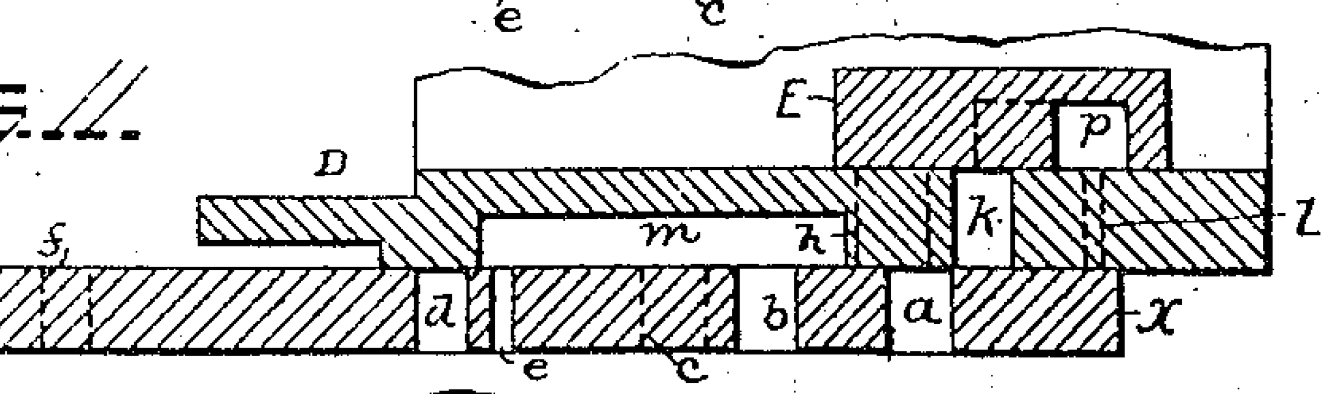


Fig. 12.

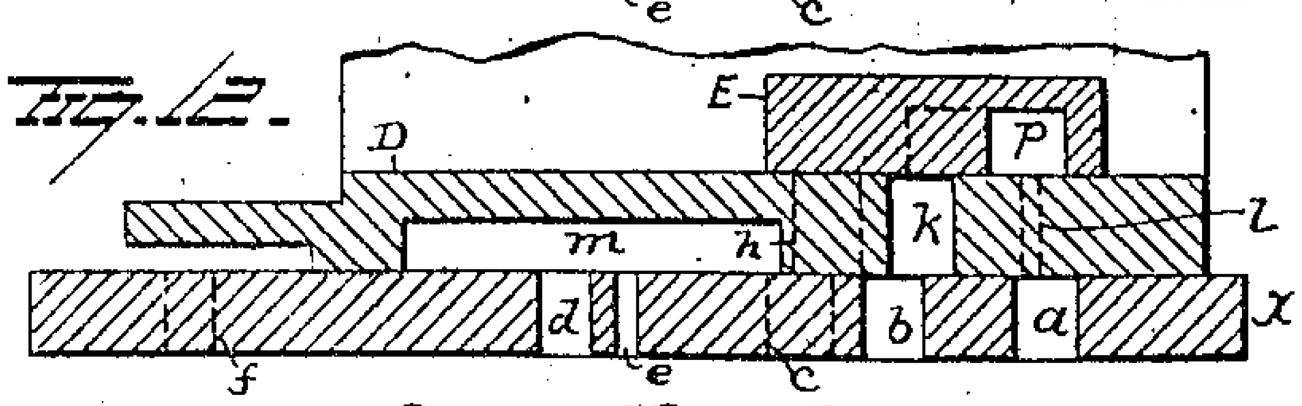


Fig. 13.

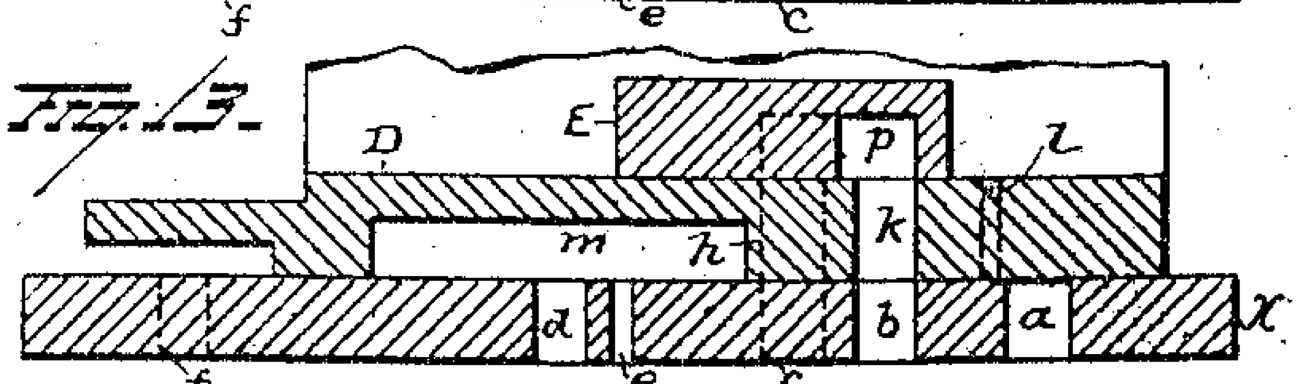
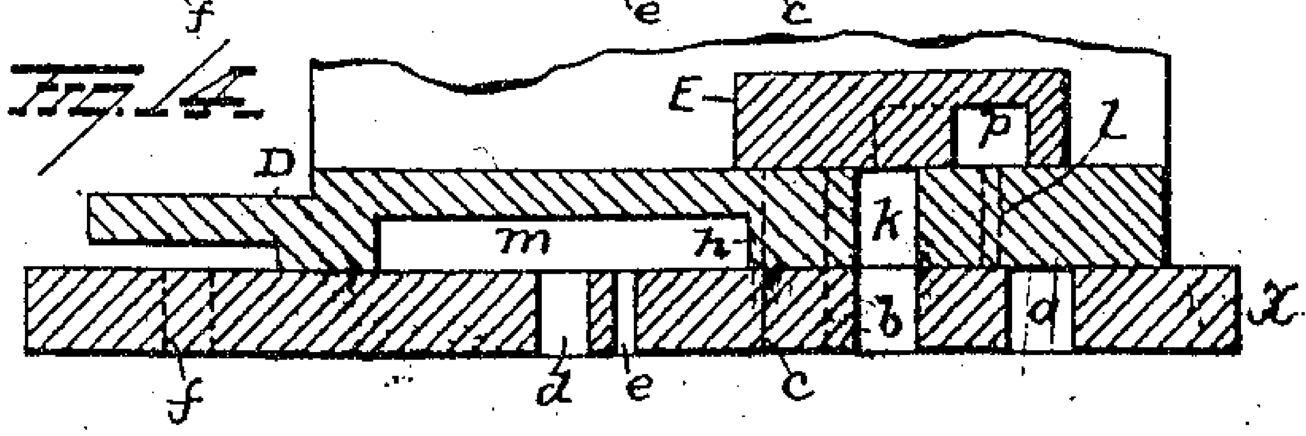


Fig. 14.



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UNITED STATES PATENT OFFICE.

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AIR-BRAKE APPARATUS.

No. 912,714. Specification of Letters Patent. Patented Feb. 16, 1909.

Application filed April 4, 1908. Serial No. 425,193.

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.

One object of my present invention is to provide simple and efficient means for applying, holding and releasing brake cylinder pressure, the said mechanism being so situated and connected with the train pipe, auxiliary reservoir, and brake cylinder, that a reduction of pressure in the train pipe will result in an application of the brakes and so that a rise of train pipe pressure will, through the medium of the said valve mechanism, effect the release of the brakes and the recharge of the auxiliary reservoir.

A further object is to so construct the valve mechanism that it shall be very sensitive to variations of train pipe pressure in order to insure its proper operation on both long and short trains.

A further object is to embody, in a valve mechanism of the character to which my invention relates, means for venting a slight amount of train pipe fluid to the brake cylinder in service applications of the brakes in order to thus automatically transmit the reduction made (by manual means) throughout the train and thus insure the prompt and positive application of all the brakes of the train.

A further object is to embody in a triple valve mechanism, means for rapidly venting a large amount of train pipe air to the brake cylinders in emergency applications of the brakes and thus transmit the action throughout the train.

A further object is to provide means in a triple valve for effecting the normal release of the brakes and recharge of the auxiliary reservoir when the rise of pressure in the train pipe occurs at a moderate rate,—such as would obtain near the central or rear portion of a train of average length.

A further object is to provide means for restricting the release of the brakes and the recharge of the auxiliary reservoir when the rise of pressure in the train pipe occurs at a rapid rate,—such as would occur at the forward portion of a train,—in order to prevent the overcharge of the auxiliary reservoirs (there located) and to cause a more rapid flow of air toward the rear portion of the train, and to retain some of the pressure in the brake cylinders (on the forward cars) for a short period after the release is started, in order to make the release more uniform throughout the train and thus prevent the running out of the "slack" and thereby prevent the "jerking" of the cars.

A further object is to provide means for slightly restricting the recharge of the auxiliary reservoirs when the rise of pressure in the train pipe is very slow,—which may occur near the rear end of a very long train,—to facilitate the more rapid flow of train pipe fluid to the extreme rear of long trains in order to secure a prompt release of the brakes there located.

A further object is to so construct a triple valve mechanism that after the brakes have been fully applied, the brake cylinder pressure may be maintained at any desired degree by the engineer through the medium of the train pipe alone, without in any way interfering with the sensitive action of the valves.

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

In the accompanying drawings; Figures 1, 2, 3, 4, 5, and 6 are sectional views of the mechanism showing the movable parts in various positions; Fig. 7 is a plan view of the seat for the main slide valve; Fig. 8 is a top plan view of the main slide valve; Fig. 9 is a top plan view of the secondary or graduating valve; Figs. 10, 11, 12, 13 and 14 are sectional views of the graduating valve, main slide valve and slide valve seat, showing the registration of ports in various positions of the valves not illustrated in Figs. 1 to 6.

The various sectional views, of the valves and their seats are taken on the line A—A of Fig. 7; the line A^1 A^1 of Fig. 8, and the line A^2—A^2 of Fig. 9.

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. The train pipe duct S also communicates with a large duct T and at the juncture of these ducts a check valve 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 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 valve B (held to its seat by a light spring B^1) is located, so as to prevent brake cylinder fluid from entering the said duct, from the duct V.

From an inspection of Figs. 1 to 6 of the drawings, it will be seen that the ducts R and S are in free communication at all times with the train pipe, although, under certain conditions, as indicated in Figs. 4, 5 and 6, the port *f* is closed by the valve D.

The main slide valve seat, X, contains, in addition to the ports already mentioned, ports *d* and *e*, the latter being much smaller than the former, and both of these ports are connected with the atmosphere by 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 the chamber G^1 at the right of the piston G therein. A groove *g* is formed in the face of valve seat X (as shown in Fig. 7) and extends to a side edge thereof, for the purpose of providing means for balancing the graduating valve under certain conditions.

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 is comparatively light and 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 valve H—H^1, which latter is intended to regulate the flow of fluid through a duct K from ducts W communicating with the auxiliary reservoir 2, said duct K terminating at one end in a face *t*. The ducts K and W may be formed in the head of the auxiliary reservoir, which also forms the head of the chamber G^1 as shown in the drawings, or in a separate head on said chamber, as before intimated, and the ducts W piped in any suitable manner to the auxiliary reservoir.

The main valve D contains a cavity *m* for establishing communication under certain conditions between the exhaust ports *d* and *e* and the port *b*, and this cavity performs no other functions at any time except to cause the valve 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 and also with the groove g in said seat. 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 valves, that the ports h and k are never uncovered by the graduating valve E.

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 port K, the latter being controlled by the valve H—H^1.

Throughout a portion of the operation of my improved valve mechanism, I rely upon a law of physics which, though well established in principle, is novel in its application for the purposes contemplated by me, and hence I will here advert to it before explaining the mode of operation of my improvements, to the end that the same may be more readily and thoroughly understood. The physical law above alluded to relates chiefly to the flow of gaseous fluids through orifices and may be stated as follows:—When a compressed gas is admitted to a small chamber through an opening of any given size from a source of supply, and is simultaneously exhausted from said chamber through an opening not greatly exceeding the area of the entrance opening, into a tank or other medium where the pressure is somewhat lower than that of the supply fluid,—the pressure attained in the small chamber will be approximately equal to that of the supply fluid. As a practical and familiar illustration of this principle, the following may be cited: On moderately long trains, when the engineer's brake valve is left in "release" position, it is impossible to secure the application of the brakes on the cars near the locomotive if a "service" reduction be made from the rear end by gradually opening an angle cock, and when a "full service" reduction has been made at the rear by this means, continuing to open the cock until the train pipe is wide open to the atmosphere. Under these conditions, the train pipe at the forward end of the train constitutes a small chamber having compressed air admitted to it from a source of supply through an opening of a given area, *i. e.* the release port of the engineer's valve,—and exhausting from it into a lower pressure medium, *i. e.*—the train pipe to the rear of the portion considered,—through a large opening (that of the hose coupling), and the result is known to be that the pressure in the train pipe at the forward portion of the train retains so nearly its normal valve,—*i. e.*, that of the source of supply from the engineer's valve,—that none of the triple valves there located will apply the brakes of the cars to which they are attached.

Keeping the principle of physics above outlined in mind, the following description of the operation of my improved valve mechanism under the various conditions in which it may be employed, will be readily understood.

It is apparent from an inspection of the drawings that fluid from the train pipe may enter at Y and flow freely into and out of the valve chamber R^1 and piston chamber G^1 through the duct R and port f as long as the latter is uncovered by the slide valve D, which is the case while the latter is in its "release" and "service" positions. The valve D is adapted to close the port f only after uncovering the port a for reasons which will hereinafter appear. It will be observed therefore, that with my improved mechanism, the valves employed for both releasing and applying the brakes are normally subject to train pipe pressure, instead of to auxiliary reservoir pressure as in "triple valve" mechanisms as heretofore constructed and operated. 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 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 which 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 trains. 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 G was forced by this rise of train pipe pressure, toward the right (the train pipe fluid entering the valve chamber R^1 and the piston chamber G^1 by the duct R, port *f* or by duct T or by both), drawing the valves D and E with it, through the medium of the rod F, said piston finally arrived at such position that the restricting valve H—H^1 was inserted into the port K, through which latter up to this time, auxiliary reservoir fluid had free access to the right hand side of piston G. Continuing its motion, the piston uncovered the groove or passage M^1 and, because of the restricted outlet through the duct K, the pressure acting against the right hand side of the piston G, instantly rose to a point intermediate that of the train pipe pressure and the auxiliary reservoir pressure, but the rise of train pipe pressure is, in this case, assumed to be sufficient to still cause the motion of the piston to continue. This motion of the piston causes the end of the valve H—H^1 to meet the face *t* and consequently to compress the light spring N, and finally cause the piston to assume the position shown in Fig. 1. In this position, the large passage M^3 of the duct M forms a by-pass around the piston G and permits air to flow into the chamber G^1 to the right of the piston so rapidly that, because of the restriction of the port K by the valve H, the pressures acting against the two sides of the piston become so nearly equalized that their difference is no longer sufficient to overcome the friction of the moving parts and they will assume the positions shown in Fig. 1. It will be observed that before the end of the valve rod H meets the face *t*, the passage M^1 is uncovered by the piston G and during the subsequent movement of the latter, the pressure acting against its right hand side is therefore no longer auxiliary reservoir pressure, but is a pressure having a value intermediate the same and train pipe pressure.

The purpose of the spring N is to return the piston G across the large passage M^3 of duct M after the complete equalization of pressures on the two sides of piston G and in the auxiliary reservoir, in order to prevent an excessive back flow of air from the auxiliary reservoir to the train pipe when it is desired to again apply the brakes, but it is equally important not thus to return the piston so as to close the passage M^1, because train pipe leaks, in conjunction with a poorly operating train pipe feed valve, might then cause the undesired application of the brakes.

It will now be readily seen that with the parts in the positions shown in Fig. 1, the auxiliary reservoir is receiving a supply of compressed air through the ducts W and the now restricted port K 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 train pipe through the passage M^3 of duct M, the port K, and passage M^3 being so proportioned that the ultimate flow of air into the auxiliary reservoir is fairly rapid. As this will be the most usual charging position of the valve, 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*, *d* and *e* 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. In this position, the slide valves also perform the function of keeping port *f* open and of closing ports *a* and *c* completely. When the pressures on both sides of the piston G and in the auxiliary reservoir are completely equalized, the light spring N will operate to move the piston to the position shown in Fig. 2 (the main slide valve of course remaining in the position shown in Fig. 1 because of the lost motion between it and the rod F), the large by-pass M^3 thus being cut off, but the smaller passage M^1 still being uncovered.

Now let it be assumed that after an application of the brakes, a release is made and that the rate of rise of train pipe pressure is considerably slower than that in the case just explained,—that is to say, that the rate of rise of pressure is such as would usually obtain between the central and rear portions of a very long train. In this case, the piston G would be forced toward the right of the chamber G with only a very slight excess of force above that necessary to overcome the friction of the moving parts so that after the valve H has restricted the port K and the piston G has opened the passage M^1 and before the rod of valve H—H^1 has met the face *t*, the resulting approximate equalization of pressures on the respective sides of the piston will so reduce the force acting on said piston that it will no longer be able to overcome the friction of the moving parts, and the valves will assume the positions shown in Fig. 10. The piston, as previously stated, has just uncovered the passage M^1, and the flow of air through this passage is capable of building up the pressure on the right hand side of the piston to approximately train pipe pressure, because of the slight rise of the latter above that in the auxiliary reservoir and because of the restriction of port K by the valve H—H.' It will now be seen that the rate of feed of fluid to the auxiliary reservoir, when the parts are in this position which may be called the "compensating recharge and free release" position, is somewhat slower than if the larger passage M^3 were open. 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. In this position of the mechanism, it will be noted from an inspection of Figs. 7, 8 and 10, that the cavity *m* of the valve D establishes a free connection between ports *b* and *d*, thus permitting a free and rapid discharge of brake cylinder air. The valves D and E perform the same additional functions in this position as in the "normal 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 is 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 valve 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 supply train pipe fluid rapidly enough to the right hand side of piston G in order, with the coöperation of the restricted port K, 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 valve to the position shown in Fig. 1.

It may 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 motion of the piston to the right will be so rapid and the difference between the train pipe pressure and that in the auxiliary reservoir will be so great that not only will the kinetic energy of the moving parts tend to carry them to the extreme right, but also the intermediate pressure (built up by the coöperation of the passages M^1 and M^3 with the restricted port K) acting on the right hand side of the piston G, will be sufficiently lower than that of the train pipe to still cause sufficient force to act on the piston to continue to overcome the friction of the moving parts and the piston will be carried up against the end of its chamber or cylinder G^1, moving the valves to the positions shown in Fig. 11. In this position of the mechanism, air will be permitted to flow to the auxiliary reservoir from the chamber G^1 through the restricted port K as in the other release positions; but in this case, the right hand end of the chamber G^1 is supplied 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 a prompt release of the brakes there located. In this position of the mechanism, which may be termed the "restricted recharge and restricted release" position (as shown in Fig. 11) the cavity *m* of the valve D will connect the port *b* with only the small exhaust port *e*, the port *d* being closed. The release of brake cylinder pressure will thus be restricted or retarded to a considerable extent and consequently tend to produce a more uniform release of the brakes throughout the whole train, (those toward the rear of the train having an unrestricted release as previously described) and thus the severe running out of "slack" between the cars which attends the release of ordinary forms of triple valves, will be prevented. The additional functions of the slide valves in this position are the same as in the other release positions,—viz., to close ports *a* and *c* completely and to keep port *f* open. When the pressures acting against the respective sides of the piston G and that in the auxiliary reservoir are entirely equalized, the light spring

N will (as in the case of the "normal recharge and free release") return the piston G across the by-pass groove M^3. The positions assumed by all the moving parts under these conditions are shown in Fig. 2; wherein it will be noted that a small amount of lost motion still exists between the right hand shoulder F^2 of rod F and the slide valve D, thus permitting the piston G to move out beyond the passage M^1, when traveling toward its "service position", before engaging the slide valve D, that is to say; before meeting with any appreciable resistance, to its motion and thus insuring the sensitive response of the mechanism to slow reductions of train pipe pressure.

It will be readily seen from the foregoing description of the action of the mechanism in releasing the brakes, that by providing means controlled by the motion of the piston G toward its "release" position, for subjecting the side of said piston opposite to that which is acted upon by train pipe pressure, to a pressure intermediate that existing in the train pipe and that in the auxiliary reservoir, it is possible to cause the moving parts of the mechanism to assume any one of three separate "release" positions, the advantages of which have been hereinbefore outlined, and the accomplishment of which has not been heretofore provided for by any other triple valve.

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 to the train pipe through the port *f* and ducts R and S. As the restricted port K is of equal or greater capacity than even the large by-pass duct M^3, practically full auxiliary reservoir pressure will act on the right hand side of the piston G, as the flow of air is now from the auxiliary reservoir to the train pipe, and consequently, regardless of what release position the piston may occupy, it will be forced to the left as the train pipe pressure is reduced. (Under normal conditions, the piston will be in its "compensating recharge" position for the reasons previously stated and the small groove M^1 will materially aid in the maintenance of approximately full auxiliary reservoir pressure on the right hand side of the piston G). The piston G having been forced to the left, the duct M will be closed and the larger portion H of the restricting valve will be drawn out of the port K, but the smaller portion H^1 of said restricting valve will be left in said port, for a purpose which will be hereinafter explained. After taking up the lost motion between the rod F and valve D, the rod F will cause said valve to move with it to the left and because of pushing (instead of pulling) of this valve by the rod F, the graduating valve E will be in its extreme left hand position with respect 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 the port *b*. It will thus be seen, as shown in Fig. 3, that auxiliary reservoir air entering the chamber G^1 behind the piston through the partially restricted port K, 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 object of partially restricting the port K at this time is to permit the ports and ducts conveying the fluid from the rear of the piston to the brake cylinder to bring about a sufficiently rapid reduction of pressure behind the piston to cause it to become approximately balanced and thus prevent its further motion to the left. 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. 12. 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. 13) 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. 14,—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 positions illustrated in Fig. 4, wherein it is shown that the further motion to the left of the moving ports is opposed by the spring N^1, as the end of the rod H^3 has now come into contact with an abutment at u. This position of the mechanism may be termed "equalization lap and maintaining position." It will be observed 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 first, the ports c and b were completely closed and then the port a was slightly opened; after which the port f was 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 of closing the ports b and c before uncovering the port a is to prevent any flow of air from the train pipe (when the pressure is subsequently raised in said pipe) through port a, ducts V^1 and U and ports b, k, h and c and cavity p and duct c^1 to the auxiliary reservoir, as this would obviously interfere with the proper release of the brakes. 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 where the piston is in the position indicated in Fig. 4 and 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 and flowing through the ducts S and T and port 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. 5. The port *f* is now closed and the port *a* is wide open. The ports *b*, *c* and *e* 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. In this position of the main slide valve, the port *h* therein registers with the small groove *g* (see Fig. 7) and thus insures the complete balancing of the graduating valve E, the cavity of which connects with the port *h* at this time, by admitting the same pressure beneath it that exists above it. As the valve moves beyond its service positions toward that shown in Fig. 5, 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.

From an inspection of Fig. 5, it will be observed that the movement of the piston G is limited by the end of the bushing 3 and that any over-travel of the main slide valve D is prevented by the abutment w^1 in the nut closing the left hand end of the casing. In Fig. 5, it is also shown that the portion H^1 of the restricting valve has been removed by the piston from the port K and consequently a free flow of air from the auxiliary reservoir is permitted through the ports W and K, around the piston G 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 cylinder; it being evident as previously pointed out that a free path is provided in the emergency position (as there illustrated) 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 equalized, the moving parts will assume the positions shown in Fig. 6,—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 as clearly indicated in Fig. 6. The object of balancing the graduating valve as previously described is now apparent,—viz.—to insure the least possible resistance to the backward motion of the piston G, in order to make its return by the spring N^1 positive under all conditions, and thus insure the easy and sensitive release of the brakes, when the train pipe pressure is subsequently built up, by cutting off all communication (through the grooves L^1 and L^2) between the auxiliary reservoir and the train pipe in this position of the piston.

When it is desired to release the brakes at any time when the port *f* is closed by the main slide valve D, it is evident that the train pipe fluid may pass freely by the check valve C into the chambers R^1 and G^1 and thus act on the piston G and force it at once toward its release positions.

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

1. The combination in a triple valve mechanism, of a valve for controlling the application and release of the brakes, a piston connected with said valve, a chamber in which said piston is contained, means for normally admitting auxiliary reservoir fluid into said chamber at one side of the piston, means for permitting a flow of train pipe fluid into the

controlling space at the other side of said piston, means for permitting a flow of fluid from said controlling space to the train pipe under certain conditions, and means for preventing the flow of fluid from said controlling space to the train pipe under other conditions.

2. The combination in a triple valve mechanism, of a valve for controlling the application and release of the brakes, a piston connected with said valve, a chamber in which said piston is contained and constituting at one side of the latter a controlling space, means for normally admitting auxiliary reservoir fluid into said chamber at the other side of the piston, means providing two paths for train pipe fluid into said controlling space and means for preventing at all times the passage of fluid from said controlling space to the train pipe through one of said paths.

3. The combination in a triple valve mechanism, of a valve for controlling the application and release of the brakes, a piston connected with said valve, a chamber in which said piston is contained and constituting at one side of the latter a controlling space, means for normally admitting auxiliary reservoir fluid into said chamber at the other side of the piston, means providing two paths for train pipe fluid into said controlling space and means for preventing at all times the passage of fluid from said controlling space to the train supply through one of said paths, and means for opening and closing the other of said paths between train pipe supply and said controlling space.

4. The combination in a triple valve mechanism, of a valve for controlling the application and release of the brakes, a piston connected with said valve, a chamber in which said piston is contained and constituting at one side of the latter a controlling space, means for normally admitting auxiliary reservoir fluid into said chamber at the other side of the piston, means providing two paths for train pipe fluid into said controlling space and means for preventing at all times the passage of fluid from said controlling space to the train pipe through one of said paths, and means controlled by the movements of said valve for opening and closing the other of said paths.

5. The combination in a triple valve mechanism, of a valve for controlling the application and release of the brakes, a piston connected with said valve, a chamber in which said piston is contained and constituting at one side of the latter a controlling space, means for normally admitting auxiliary reservoir fluid into said chamber at the other side of the piston, means providing two paths for train pipe fluid into said controlling space and means for preventing at all times the passage of fluid from said controlling space to the train pipe through one of said paths, and means controlled by said valve to close the other path when said valve has passed its "service" position in its movement toward its "emergency" position.

6. The combination in a triple valve mechanism, of a valve for controlling the application and release of the brakes, a piston connected with said valve, a chamber in which said piston is contained and constituting at one side of the latter, a controlling space, means for normally admitting auxiliary reservoir fluid into said chamber at the other side of the piston, means controlled by the movement of the piston for permitting a flow of fluid from said controlling space to the train pipe under certain conditions, and means controlled by the movement of the piston for preventing the flow of fluid from said controlling space to the train under other conditions.

7. In a triple valve mechanism, the combination with a casing, a piston therein, the space at one side of said piston constituting a controlling space, means for normally admitting auxiliary reservoir fluid at the other side of said piston, of valve devices for controlling the application and release of the brakes, located in said controlling space and connected with said piston, means for permitting a flow of train pipe fluid into said controlling space, means for permitting a flow of fluid from said controlling space to the train pipe under certain conditions, and means for preventing flow of fluid from said controlling space to the train pipe under other conditions.

8. In a triple valve mechanism, the combination with a casing, a piston therein, the space at one side of said piston constituting a controlling space, means for normally admitting auxiliary reservoir fluid at the other side of said piston, of valve devices for controlling the application and release of the brakes, located in said controlling space and connected with said piston, means for permitting a flow of train pipe fluid into said controlling space, means for permitting a flow of fluid from said controlling space to the train pipe under certain conditions, and means for preventing flow of fluid from said controlling space to the train pipe under other conditions, said casing having means of communication with the brake cylinders, and said valve devices provided with means operative under certain conditions to permit a flow of fluid from said controlling space to the brake cylinders.

9. In a triple valve mechanism, the combination with a casing, a piston therein, the space at one side of said piston constituting a controlling space, means for normally admitting auxiliary reservoir fluid at the other side of said piston, of valve devices for controlling the application and release of the brakes, located in said controlling space and connected with said piston, means for per-

mitting a flow of train pipe fluid into said controlling space, means for permitting a flow of fluid from said controlling space to the train pipe under certain conditions, and means for preventing flow of fluid from said controlling space to the train pipe under other conditions, said casing having means of communication with the brake cylinders, and means in said valve devices operative in one position to permit the flow of a small amount of fluid to the brake cylinders, and in another position acting to cause a large amount of fluid to flow to the brake cylinders.

10. In a triple valve mechanism, the combination with a casing, a piston therein, the space at one side of the piston constituting a controlling space, means for normally admitting auxiliary reservoir fluid to the other side of the piston, and ducts for brake cylinder fluid, of a main slide valve in said controlling space, a lost-motion connection between said valve and the piston, a graduating valve mounted on the main slide valve and movable by the piston a limited distance independently of the movements of the main valve, said main valve and its seat having means for exhausting air from a brake cylinder duct, a duct for conveying auxiliary reservoir fluid to said main valve, both of said valves having passages coöperating to direct such auxiliary reservoir fluid to the brake cylinder duct, means for permitting a flow of train pipe fluid into said controlling space, means for permitting a flow of fluid from said space to the train pipe under certain conditions, and means for preventing a flow of fluid from said controlling space to the train pipe under other conditions.

11. In a triple valve mechanism, the combination with a casing, a piston therein, the space at one side of the piston constituting a controlling space, means for normally admitting auxiliary reservoir fluid to the other side of the piston, and ducts for brake cylinder fluid, of a main slide valve in said controlling space, a lost-motion connection between said valve and the piston, a graduating valve mounted on the main slide valve and movable by the piston a limited distance independently of the movements of the main valve, said main valve and its seat having means for exhausting air from a brake cylinder duct, a duct for conveying auxiliary reservoir fluid to said main valve, both of said valves having passages coöperating to direct such auxiliary reservoir fluid to the brake cylinder duct, means for permitting a flow of train pipe fluid into said controlling space, means for permitting a flow of fluid from said space to the train pipe under certain conditions, and means for preventing a flow of fluid from said controlling space to the train pipe under other conditions, and means controlled by the valves for affording a free flow of train pipe fluid to the brake cylinders in emergency applications and a restricted flow of train pipe fluid to the brake cylinders in service applications of the brake.

12. In a triple valve mechanism, the combination with a casing, a piston therein, the space at one side of said piston constituting a controlling space, and means for normally admitting auxiliary fluid at the other side of the piston, of valve devices connected with said piston, for controlling the application and release of the brakes, means for permitting a flow of train pipe fluid into said controlling space, means for permitting a flow of fluid from said controlling space to the train pipe under certain conditions, means for preventing a flow of fluid from said controlling space to the train pipe under other conditions, and means operating to prevent a flow of fluid from the brake cylinders to the controlling space at all times.

13. In a triple valve mechanism, the combination with a casing, a piston therein, the space at one side of said piston constituting a controlling space, and means for normally admitting auxiliary reservoir fluid at the other side of the piston, of valve devices connected with said piston, for controlling the application and release of the brakes, means for permitting a flow of train pipe fluid into said controlling space, means for permitting a flow of fluid from said controlling space to the train pipe under certain conditions, means for preventing a flow of fluid from said controlling space to the train pipe under other conditions, a brake cylinder duct, a duct communicating with said brake cylinder duct and having a port controlled by said valve devices, and a check valve in the duct which connects the valve devices with the brake cylinder duct and operating at all times to prevent fluid from flowing from the brake cylinder duct to the controlling space in the valve casing.

14. In a triple valve mechanism, the combination with a casing, of a piston therein, the space at one side of said piston constituting a controlling space, means for admitting auxiliary reservoir fluid at the other side of the piston, and a brake cylinder duct, valve devices connected with and controlled by the movements of said piston, said valve devices having ports and passages coöperating to close direct communication between the auxiliary reservoir and the brake cylinders when the brake cylinder and auxiliary reservoir pressures are approximately equal and as long as the pressure in said controlling space is approximately equal to the auxiliary reservoir pressure.

15. In a triple valve mechanism, the combination with a casing, of a piston therein, the space at one side of said piston constituting a controlling space, means for admitting auxiliary reservoir fluid at the other side of

said piston, valve devices connected with said piston for controlling the application and release of the brakes, two paths for train pipe fluid to said controlling space, a check valve in one of said paths, means coöperating with said valve devices to close the other of said train pipe fluid paths and to fully open communication between the auxiliary reservoir and the brake cylinder, and spring-actuated means operating to actuate said valve devices to close communication between the brake cylinders and auxiliary reservoir.

16. In a triple valve mechanism, the combination with a casing, of a piston therein, means for subjecting one side of said piston to auxiliary reservoir pressure, the space at the other side of said piston constituting a controlling space, means for admitting train pipe fluid to said controlling space, brake cylinder connections, valve devices connected with said piston, said valve devices provided with means for opening communication between said controlling space and the brake cylinder connections, and establishing communication between the auxiliary reservoir and the brake cylinder connections, and a spring tending to effect the closing of communication between the brake cylinder connections and the auxiliary reservoir.

17. In a triple valve mechanism, the combination with a casing, of a piston therein, means for subjecting one side of said piston to auxiliary reservoir pressure, the space at the other side of said piston constituting a controlling space, means for admitting train pipe fluid to said controlling space, brake cylinder connections, ducts controlled by the movement of said piston for admitting auxiliary reservoir fluid to said controlling space, valve devices connected with said piston, said valve devices provided with means for opening communication between said controlling space and the brake cylinder connections and establishing communication between the auxiliary reservoir and brake cylinder connections, a check valve in said brake cylinder connections permitting a flow of fluid through the latter from the controlling space, and a spring tending to operate the piston to close communication between the brake cylinder connections and the auxiliary reservoir.

18. In a triple valve mechanism, the combination with a casing, of a piston therein, the space at one side of said piston constituting a controlling space, means for subjecting the other side of said piston to auxiliary reservoir pressure, brake cylinder connections, means for establishing communication between the train pipe and said controlling space and means controlled by said piston for establishing communication between said controlling space and the brake cylinder connections.

19. In a triple valve mechanism, the combination with a casing, of a piston therein, the space at one side of said piston constituting a controlling space, means for subjecting the other side of said piston to auxiliary reservoir pressure, brake cylinder connections, means permitting a flow of train pipe fluid at all times to the controlling space, means controlled by the piston for opening communication between the controlling space and the brake cylinders, means constituting another path between said controlling space and the train pipe, and means controlled by the piston for closing said last-mentioned path after communication between the controlling space and the brake cylinders has been opened.

20. In a triple valve mechanism, the combination with a casing, a piston therein, and valve devices controlled by said piston to control the application and release of the brakes, of means for subjecting one side of said piston to train pipe pressure, means for admitting auxiliary pressure to the other side of the piston, means controlled by the movements of the piston to control the admission of auxiliary reservoir fluid to the chamber containing the piston, and a duct controlled by said valve devices for conveying fluid from the side of the piston at which auxiliary reservoir fluid enters, to the brake cylinders.

21. In a triple valve mechanism, the combination with a casing, a piston therein, and valve devices controlled by said piston to control the application and release of the brakes, of means for subjecting one side of said piston to train pipe pressure, means of communication for the passage of auxiliary reservoir fluid to the other side of said piston, and means controlled by said piston for restricting said means of communication of auxiliary reservoir fluid, and a duct controlled by said valve devices for conveying fluid from the side of the piston at which auxiliary reservoir fluid enters, to the brake cylinder.

22. In a triple valve mechanism, the combination with a casing, a piston therein, and valve devices controlled by said piston for controlling the application and release of the brakes, of means for subjecting one side of said piston to train pipe pressure, a duct for admitting auxiliary reservoir fluid to the other side of said piston, and a valve device controlled by said piston for varying the degree of flow of auxiliary reservoir fluid through said duct, and a duct controlled by said valve devices for conveying fluid from the side of the piston at which auxiliary reservoir fluid enters, to the brake cylinders.

23. In a triple valve mechanism, the combination with a casing, a piston therein, and valve devices controlled by said piston for controlling the application and release of the brakes, of means for subjecting one side of

said piston to train pipe pressure, a duct for admitting auxiliary reservoir pressure to the other side of said piston, a rod carried by said piston and movable through said duct, said rod having a diameter appreciably less than that of said duct, whereby said duct is restricted, and a duct controlled by said valve devices for conveying fluid from the side of the piston at which auxiliary reservoir fluid enters, to the brake cylinders.

24. In a triple valve mechanism, the combination with a casing, a piston therein, and valve devices controlled by said piston to control the application and release of the brakes, of means for subjecting one side of said piston to train pipe pressure, a duct for conducting auxiliary reservoir fluid to the other side of said piston, and a rod carried by the piston and adapted to enter said duct for restricting the same, said rod having a plurality of portions differing in size from each other, the greatest size of said rod being appreciably less than the size of said duct, and a duct controlled by said valve devices for conveying fluid from the side of the piston at which auxiliary reservoir fluid enters, to the brake cylinders.

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

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

27. In a triple valve mechanism, the combination with a casing, a piston therein, and valve devices controlled by said piston for controlling the application and release of the brakes, of means for subjecting one side of said piston to train pipe pressure, means for normally introducing auxiliary reservoir fluid at the other side of said piston, and means for subjecting said piston at the side thereof at which auxiliary reservoir fluid is normally introduced after the piston and valve devices have reached positions to effect the release of the brakes, to a pressure intermediate train pipe pressure and auxiliary reservoir pressure.

28. In a triple valve mechanism, the combination with a casing, a piston therein, and valve devices controlled by said piston, said piston and valve devices movable to a plurality of "release" positions, of means for subjecting one side of said piston to train pipe pressure during its movement toward its "release" positions, means for subjecting the other side of said piston to auxiliary reservoir pressure until the first "release" position of said piston has been reached, means for then subjecting this last mentioned side of the piston to a pressure intermediate auxiliary reservoir and train pipe pressures, and means for augmenting the degree of said intermediate pressure during the movement of said piston toward its second "release" position.

29. In a triple valve mechanism, the combination with a casing, a piston therein and valve devices controlled by said piston for controlling the application and release of the brakes, means for subjecting one side of said piston to train pipe pressure, means for normally introducing auxiliary reservoir fluid at the other side of the piston, means controlled by the piston for subjecting the side of the piston at which auxiliary reservoir fluid is normally introduced, to a pressure intermediate that of train pipe pressure and auxiliary reservoir pressure and means coöperating with said last-mentioned means for charging the auxiliary reservoir at a slightly restricted rate.

30. In a triple valve mechanism, the combination with a casing, a piston therein and valve devices controlled by said piston for controlling the application and release of the brakes, of means for subjecting one side of said piston to train pipe pressure, means for normally introducing auxiliary reservoir fluid at the other side of the piston, means controlled by the piston for subjecting the side of the piston at which auxiliary reservoir fluid is normally introduced, to a pressure intermediate that of train pipe pressure and auxiliary reservoir pressure, and means coöperating with said last-mentioned means for charging the auxiliary reservoir at a slightly restricted rate, and simultaneously-operating means controlled by said valve devices to freely open the brake cylinder exhaust.

31. In a triple valve mechanism, the combination with a casing, a piston therein, and valve devices controlled by said piston, said piston and valve devices being movable to a plurality of "release" positions, of means for subjecting one side of said piston to train pipe pressure during its movement toward its "release" positions, means for subjecting the other side of said piston to auxiliary reservoir pressure until the first "release" posi-

tion of the piston has been reached, means for subjecting this last mentioned side of the piston to a pressure intermediate auxiliary reservoir and train pipe pressure, means for augmenting the degree of said intermediate pressure during the movement of said piston toward its second "release" position, and means coöperating with said last-mentioned means for charging the auxiliary reservoir at the normal rate.

32. In a triple valve mechanism, the combination with a casing, a piston therein, and valve devices controlled by said piston, said piston and valve devices being movable to a plurality of "release" positions, of means for subjecting one side of said piston to train pipe pressure during its movement toward its "release" positions, means for subjecting the other side of said piston to auxiliary reservoir pressure until the first "release" position has been reached, means for subjecting this last mentioned side of the piston to a pressure intermediate auxiliary reservoir and train pipe pressures, means for augmenting the degree of intermediate pressure during the movement of the piston toward its second "release" position, means coöperating with said last-mentioned means for charging the auxiliary reservoir at the normal rate, and means for materially restricting the rate of charging of the auxiliary reservoir when the piston moves beyond its second "release" position.

33. In a triple valve mechanism, the combination with a casing, a piston therein, and valve devices controlled by said piston, said piston and valve devices being movable to a plurality of "release" positions, of means for subjecting one side of said piston to train pipe pressure during its movement toward its "release" positions, means for subjecting the other side of said piston to auxiliary reservoir pressure until the first "release" position has been reached, means for subjecting this last mentioned side of the piston to a pressure intermediate auxiliary reservoir and train pipe pressures, means for augmenting the degree of intermediate pressure during the movement of the piston toward its second "release" position, means coöperating with said last-mentioned means for charging the auxiliary reservoir at the normal rate, and means for materially restricting the rate of charging of the auxiliary reservoir when the piston moves beyond its second "release" position, and means for restricting the brake cylinder exhaust when the piston moves beyond its second "release" position.

34. In a triple valve mechanism, the combination with a casing, a piston therein, and valve devices controlled by said piston, said piston and valve devices movable to a plurality of "release" positions, of means for subjecting one side of said piston to train pipe pressure during its movement toward its "release" positions, means for subjecting the other side of said piston to auxiliary reservoir pressure until the first "release" position of said piston has been reached, means for then subjecting this last mentioned side of the piston to a pressure intermediate auxiliary reservoir and train pipe pressures, means for augmenting the degree of said intermediate pressure during the movement of said piston toward its second "release" position, and simultaneously operating means controlled by said valve devices to freely open the brake cylinder exhaust.

35. In a triple valve mechanism, the combination with a casing, a piston therein, and valve devices controlled by said piston, said piston and valve devices being movable to a plurality of "release" positions, of means for subjecting one side of said piston to train pipe pressure during its movement toward its "release" positions, means for subjecting the other side of said piston to auxiliary reservoir pressure until the first "release" position of the piston has been reached, means for then subjecting this last mentioned side of the piston to a pressure intermediate auxiliary reservoir and train pipe pressures, means for augmenting the degree of said intermediate pressure during the movement of said piston toward its second "release" position, means coöperating with said last-mentioned means for charging the auxiliary reservoir at the normal rate, and simultaneously-operating means controlled by said valve devices to freely open the brake cylinder exhaust.

36. In a triple valve mechanism, the combination with a casing, a piston therein, and valve devices controlled by said piston for controlling the application and release of the brakes of means for subjecting one side of said piston to train pipe pressure, a duct for normally introducing auxiliary reservoir fluid at the other side of the piston, and means for subjecting the side of the piston at which auxiliary reservoir fluid is normally introduced, to a pressure intermediate that of train pipe pressure and auxiliary reservoir pressure, said last-mentioned means comprising a valve device controlled by the movements of the piston to restrict the auxiliary reservoir fluid duct, and a passage controlled by said piston to permit train pipe fluid to pass to the side of the piston at which auxiliary reservoir fluid is normally admitted.

37. In a triple valve mechanism, the combination with a casing, a piston therein, and valve devices controlled by said piston for controlling the application and release of the brakes, of means for subjecting one side of said piston to train pipe pressure, a duct for normally introducing auxiliary reservoir fluid at the other side of the piston, means for subjecting the side of said piston at

which auxiliary reservoir fluid is normally introduced, to a pressure intermediate that of train pipe pressure and auxiliary reservoir pressure, said last-mentioned means comprising a valve device controlled by the movements of the piston to restrict the auxiliary reservoir fluid duct, and passages controlled by said piston to permit train pipe fluid to pass to the side of the piston at which auxiliary reservoir fluid is admitted.

38. In a triple valve mechanism, the combination with a casing, a piston therein, valve devices controlled by said piston for controlling the application and release of the brakes, of means for subjecting one side of said piston to train pipe pressure, a duct for normally introducing auxiliary reservoir fluid to the other side of said piston, means carried by the piston for restricting said duct, and a series of communicating passages controlled by said piston, one of said passages being larger than the others, said passages constituting means of communication between respective sides of said piston.

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

HOWARD M. P. MURPHY.

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