(No Model.) 6 Sheets—Sheet 1.

J. GRESHAM.

AUTOMATIC VACUUM BRAKE APPARATUS.

No. 471,382. Patented Mar. 22, 1892.

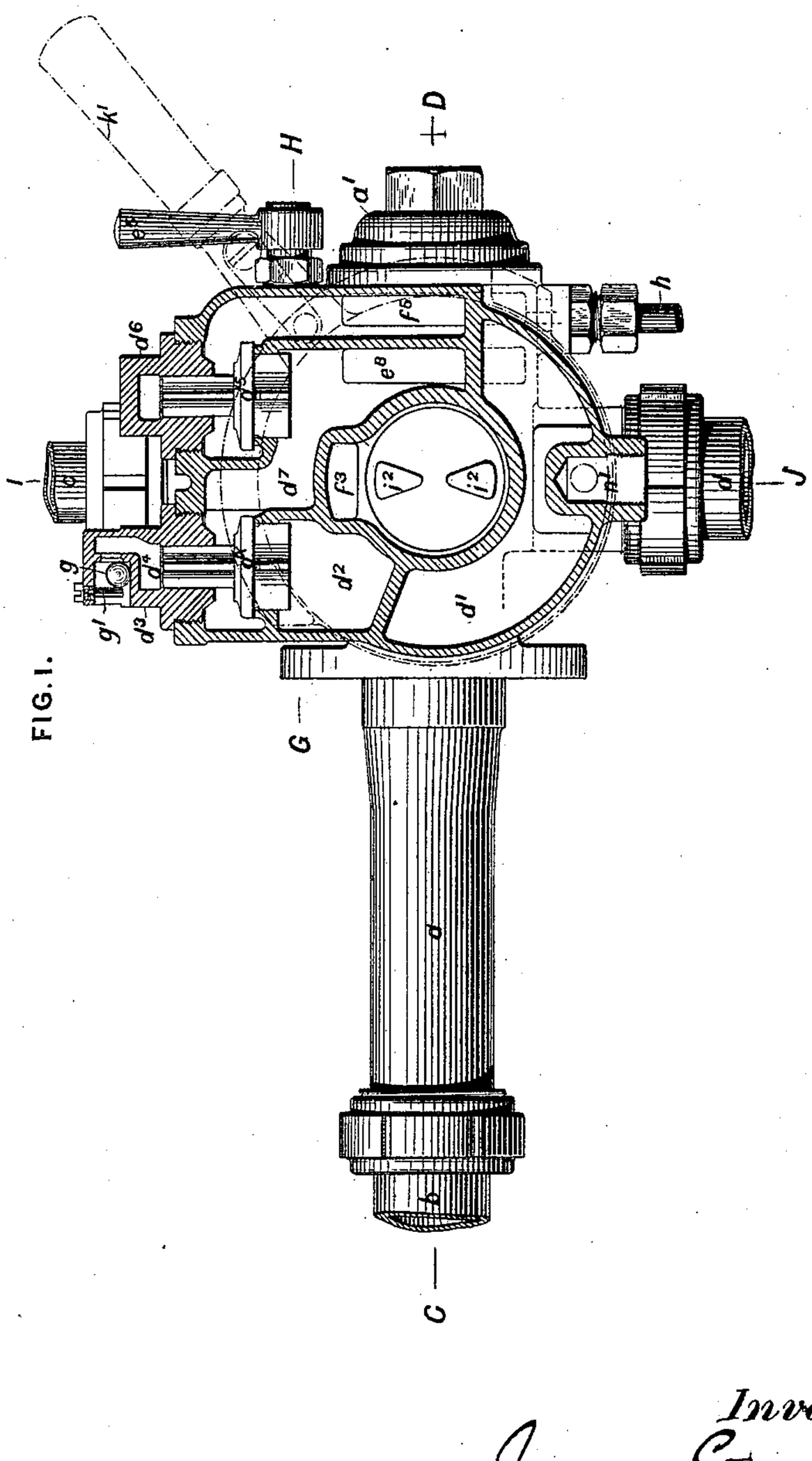

FIG. 1.

Witnesses:
Chas. A. Walsh
Mayer & Goldsmith.

Inventor:
James Gresham
By Henry Connett
Atty.

(No Model.) 6 Sheets—Sheet 2.

J. GRESHAM.

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FIG. 3.

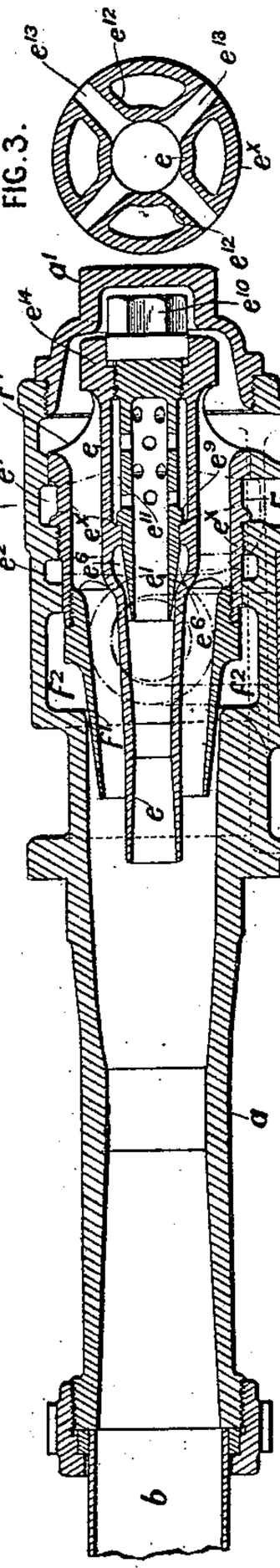
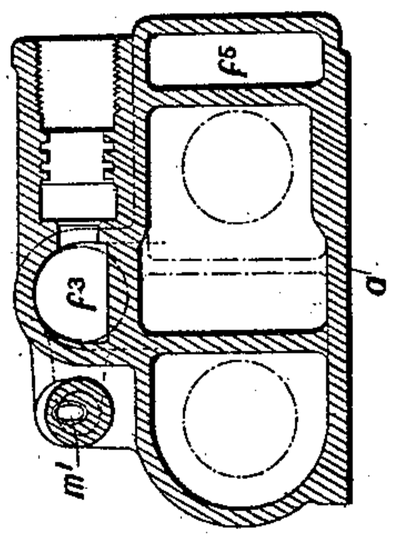


FIG. 4.



Witnesses:
Chas. A. Halsh
Mayer C. Goldman

Inventor:
James Gresham
By Henry Connett
Atty.

(No Model.) 6 Sheets—Sheet 3.

J. GRESHAM.

AUTOMATIC VACUUM BRAKE APPARATUS.

No. 471,382. Patented Mar. 22, 1892.

FIG. 7.

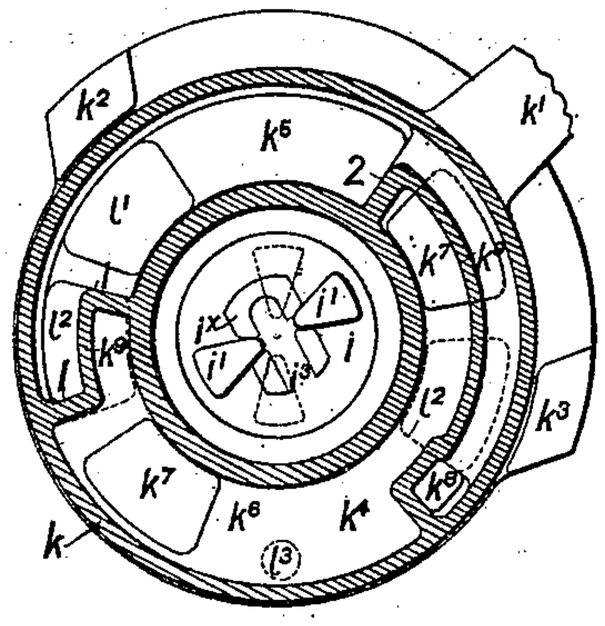
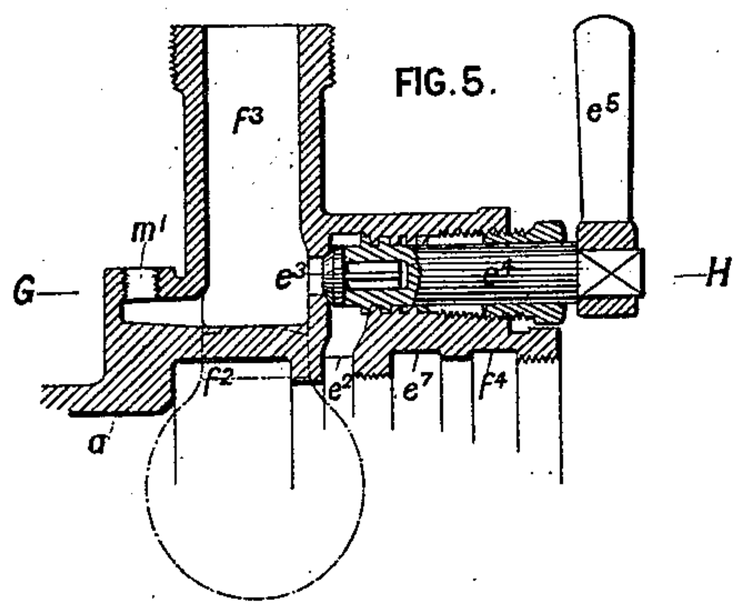


FIG. 5.



Witnesses:
Chas. A. Halsted
Mayer C. Goldman

Inventor:
James Gresham
By Henry Connett
Atty.

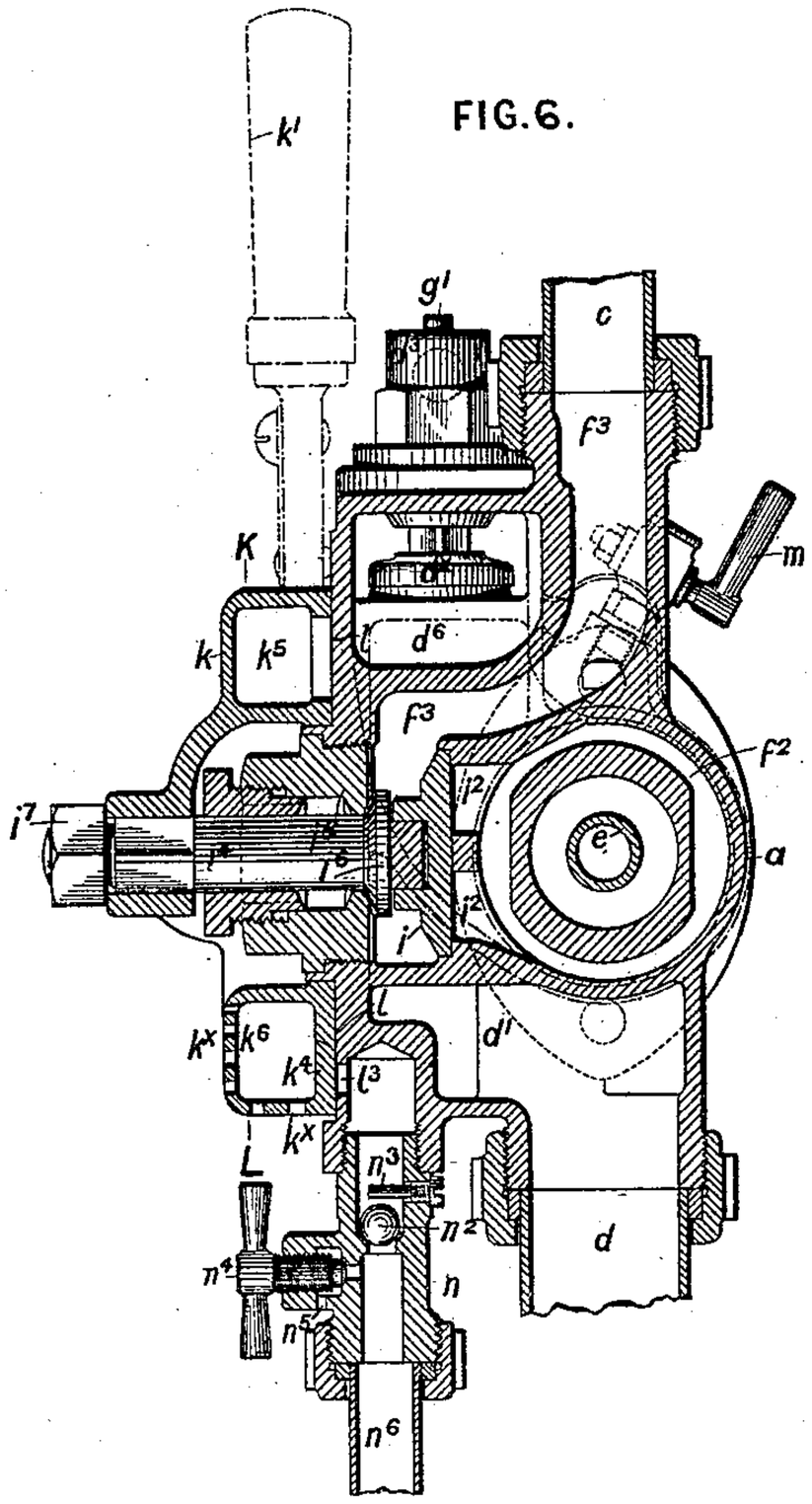
(No Model.) 6 Sheets—Sheet 4.

J. GRESHAM.

AUTOMATIC VACUUM BRAKE APPARATUS.

No. 471,382. Patented Mar. 22, 1892.

FIG. 6.



Witnesses:
Chas. A. Walsh
Mayer C. Goldman

Inventor:
James Gresham
By Henry Connett
Atty.

(No Model.) 6 Sheets—Sheet 5.

J. GRESHAM.

AUTOMATIC VACUUM BRAKE APPARATUS.

No. 471,382. Patented Mar. 22, 1892.

FIG. 8.

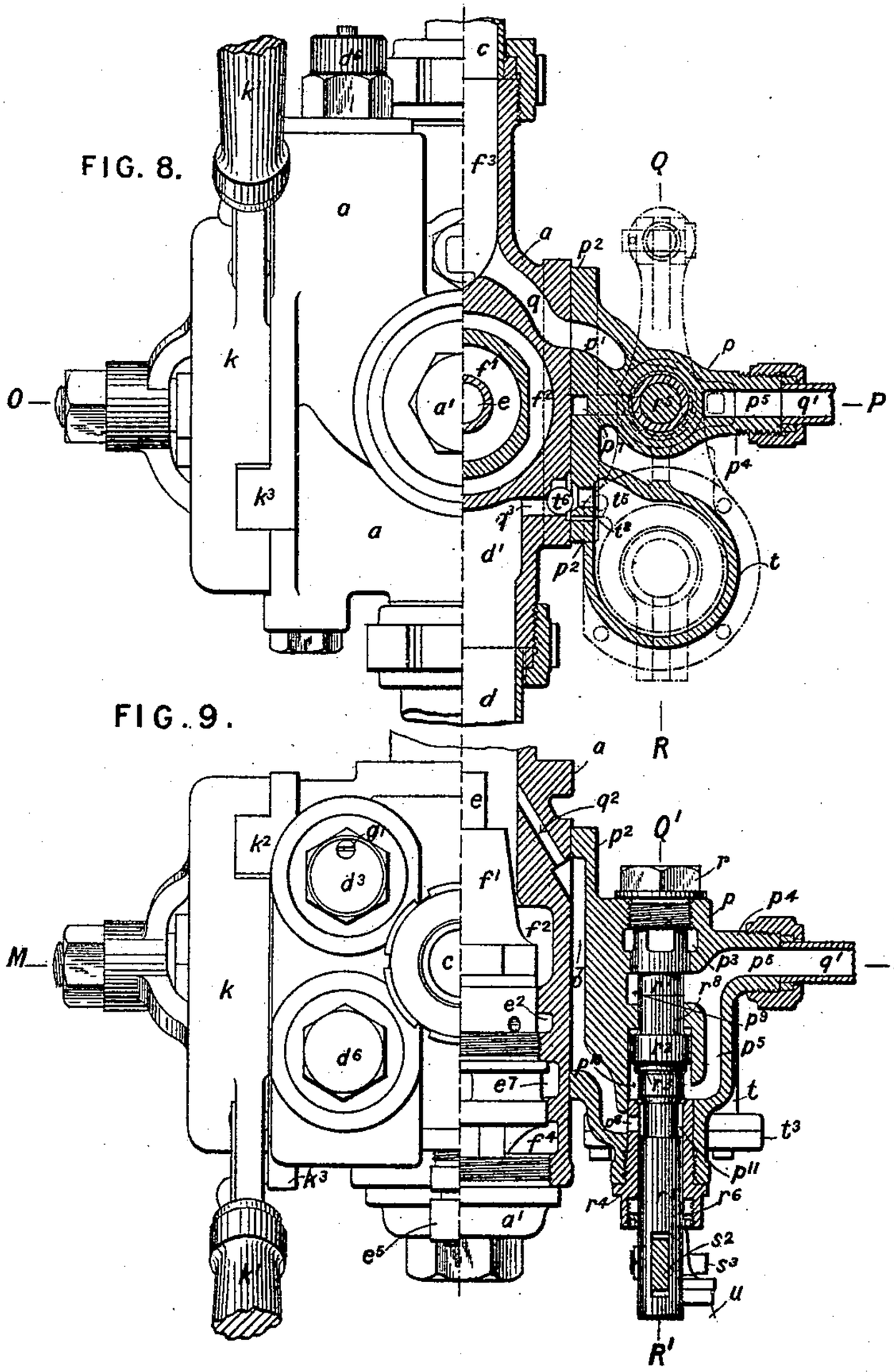


FIG. 9.

Witnesses:
Chas. A. Walsh
Mayer C. Goldman

Inventor:
James Gresham
By Henry Connett
Atty.

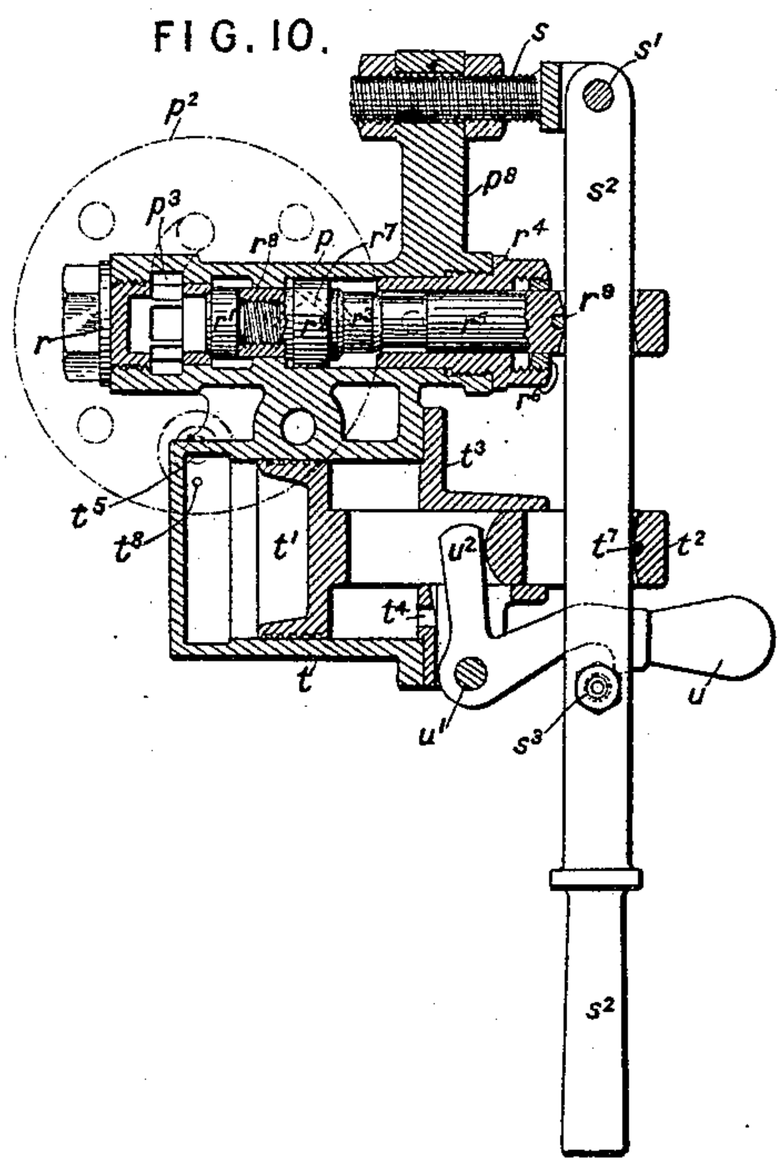
(No Model.) 6 Sheets—Sheet 6.

J. GRESHAM.

AUTOMATIC VACUUM BRAKE APPARATUS.

No. 471,382. Patented Mar. 22, 1892.

FIG. 10.



Witnesses:
Chas. A. Walsh
Mayer Goldman

Inventor:
James Gresham
By Henry Connett
Atty.

UNITED STATES PATENT OFFICE.

JAMES GRESHAM, OF MANCHESTER, ASSIGNOR TO THE VACUUM BRAKE COMPANY, LIMITED, OF LONDON, ENGLAND.

AUTOMATIC VACUUM-BRAKE APPARATUS.

SPECIFICATION forming part of Letters Patent No. 471,382, dated March 22, 1892.

Application filed May 26, 1891. Serial No. 394,184. (No model.)

To all whom it may concern:

Be it known that I, JAMES GRESHAM, engineer, a subject of the Queen of Great Britain and Ireland, of the firm of Gresham & Craven, Limited, of Craven Iron Works, Salford, Manchester, in the county of Lancaster, England, have invented new and useful Improvements in or applicable to Automatic Vacuum-Brake Apparatus, having reference more especially to the ejector and brake-controlling mechanism, of which the following is a specification.

In ordinary automatic vacuum-brake apparatus any water or moisture which may get into the train-pipe (with the atmospheric air which enters by leakage) is quickly educed and passes away through the continuously-acting ejector, and water or condensed steam which may get into the train-pipe from steam-leakage through the steam-valves and stop-valves or from the chimney of the locomotive is prevented entering the train-pipe when the apparatus is not in use, and (the rules for working being observed) air is admitted to the train-pipe, thus destroying the vacuum. When, however, these rules are not attended to or the apparatus has been neglected or damaged, the valves may become leaky, condensed steam or water might then enter the train-pipe when the vacuum is left therein, though such moisture would be speedily removed when the ejector or ejectors is or are properly started to work again—that is, if no ice has been formed, so as to stop the passage of air through the train-pipe; but it should be noted that condensed steam leaking from or past the ejector does not enter the train-pipe and cannot become frozen, so as to block it, if a water-trap be used, as in the ordinary arrangement when properly fitted up. The water collects in the trap and is dischaged when the brakes are fully applied, at which time the air enters the train-pipe and the valve of the trap opens and allows the condensed steam or water to pass away, the valve closing again immediately, a vacuum or partial vacuum is re-formed in the train-pipe. In ordinary ejector mechanism the valve for preventing the admission of air from the small ejector when not in action to the train-pipe is arranged axially, and that for preventing air from passing from the large ejector when not in action is a hinged flap-valve placed within the casing below the ejectors. These valves are termed "stop-valves."

The present invention has for its object an improved arrangement and construction of the parts of the ejector and brake-controlling mechanism with the view, mainly, of guarding against inattention, negligence, or oversight on the part of those in charge of the apparatus.

In carrying out this invention the stop-valves preferably employed are lifting or mushroom valves having seats in the casing above the ejectors, the guiding-stem of each valve being formed in a plug which screws into the upper side of the casing, thus giving easy access to the valves. The passages are so arranged that when both ejectors are in operation the air from the train-pipe first passes through the valve for the small ejector and then through that for the large ejector. Condensed water from any steam which may leak past the steam-valves cannot readily ascend to and pass through stop-valves thus placed above the ejectors. The screw-plug for the small ejector stop-valve contains a ball-valve normally open to the atmosphere, but which is closed by being forced by atmospheric pressure against its seat when the small ejector is at work. When the small ejector is not at work, the ball-valve is kept by gravity away from its seat, communication between the atmosphere and the space above the stop-valve being thus opened. When the ball-valve is open, there can be no "vacuum" above the stop-valve to draw leakage steam from the steam-valves or from the chimney of the locomotive into the passages communicating with the train-pipe. A pipe is provided to take away any condensed steam from the steam-valve pertaining to the large ejector, so that such condensed steam is discharged before it can ascend to the air-stop valve for the large ejector. The stuffing-box for the steam-valve spindle is screwed into the casing and may be readily inserted or removed. A ball-valve is used in the auxiliary pipe communicating with the brake-cylinders upon the engine and tender (when used) to prevent leakage past the brake-controlling

valve from destroying the vacuum in the brake-cylinders. Near this ball-valve there is a screw-plug valve arranged so that, if desired, air may be admitted into the brake-cylinders upon the engine and tender.

When the engine and tender are provided with steam-brakes, the vacuum-brake-controlling and ejector mechanism may be combined with the steam-valves pertaining to such steam-brakes, so that both the automatic vacuum-brakes and the steam-brakes may be simultaneously controlled by one handle. The steam-brake valves may, however, be controlled independently when the large and small ejectors are arranged separately upon the engine.

In the accompanying drawings, Figure 1 is a view, partly in side elevation and partly in section, of the improved ejector mechanism, the section being taken on the line A B in Fig. 2. Fig. 2 is a horizontal section on the line C D in Fig. 1. Fig. 3 is a transverse section on the line E F in Fig. 2, showing the hollow arms or webs for enabling air and steam to pass from the annular spaces inside the main casing to the annular spaces round the steam-nozzle of the small ejector. Fig. 4 is a horizontal section on the line G H in Fig. 1. Fig. 5 is a vertical section on the line G H in Fig. 1. Fig. 6 is a transverse section on the line I J in Fig. 1. Fig. 7 is a vertical section on the line K L in Fig. 6 Fig. 8 is a view, partly in end elevation and partly in transverse section, showing the combination of the improved ejector mechanism with the valve mechanism for the steam-brakes on the engine or engine and tender, the section being taken on the line M N in Fig. 9. Fig. 9 is a corresponding view, partly in plan and partly in horizontal section, the section being taken on the line O P in Fig. 8. Fig. 10 is a longitudinal vertical section on the line Q R in Fig. 8 or Q′ R′ in Fig. 9.

The main casing a of the apparatus is formed in one casting, and is secured by preference in front of the fire-box of the locomotive-boiler, its long axis being horizontal.

b is the pipe used for conveying exhaust steam and air to the chimney of the locomotive.

c is the pipe for supplying live steam.

The pipe d is connected to the train-pipe.

The casing e $e^{\times}$ is made in one casting and serves for both the small ejector and the large ejector. The part e is bored out at one end to receive the steam-nozzle e' for the small ejector and is coned at the other end. A collar e^9, near the inner end of the steam-nozzle e', fits with a steam-tight joint against a flange in the interior of the casing e, as shown in Fig. 2. The outer end e^{10} of the steam-nozzle is provided with a screw-thread and screws into the part e. The nozzle e' is supplied with air from the annular space e^{11}, between the nozzle and the interior of the part e, the air passing through a series of holes in that part of the nozzle between its outer end e^{10} and the collar e^9. The arms e^{12} connect the exterior of the part e with the part $e^{\times}$. These arms contain two sets of passages, one set for air and the other set for steam. The steam-passages are marked e^{13} in Fig. 3. The exterior of the part $e^{\times}$ is turned and made to fit with air-tight and steam-tight joints against flanges projecting from the interior of the main casing a. The part $e^{\times}$ is screwed into place by a wrench which fits over the hexagonal part e^{14}. The end of the main casing a is closed by a screw-cap a'. The steam-nozzle f' for the large ejector screws into the part $e^{\times}$. There are four annular spaces f^2, e^2, e^7, and f^4 between the part $e^{\times}$ and the interior of the main casing a. The space f^2 extends round the steam-nozzle f', and is supplied with steam from the passage f^3, the communication being controlled by a disk-valve i. The annular space e^2 is also supplied with steam from the passage f^3, Figs. 4, 5, and 6, the communication being controlled by a valve e^3, the stem of which works in a hole in the end of a spindle e^4, screwed into the casing, Fig. 5. The spindle e^4 is made steam-tight by a gland-packing, and is rotated by a handle e^5. The steam flows from the annular space e^2 through the passages e^{13} to the annular space e^6, between the interior of the casing e and the small steam-nozzle e'. The annular space e^7 is in communication with the passage e^8, Fig. 1, which leads indirectly to the train-pipe d. The annular space f^4 is in communication with the passage f^5, which also leads indirectly to the train-pipe. The air from the train-pipe d goes by a passage d' to the cavity d^2, Fig. 1, and then past the mushroom-valve $d^{\times}$. The latter has its seat in the casing a. It is guided by wings on its lower side and by a flat-sided guiding-stem on its upper side, the guiding-stem working in a hole bored in the cap d^3, which is screwed into the main casing a. The guiding-stem is made with flat sides, so that there may be communication between the passages d^4 and d^7. On removing the cap d^3 the valve may be taken out. In the screw-cap d^3 there is a passage d^4, leading from the hole in which the guiding-stem works to a ball-valve g. The latter rolls to and from its seating horizontally, and is retained in position when away from its seating by the end of a screw-pin g'. When away from its seating, as in Fig. 1, there is communication between the passage d^4, and consequently the passage d^7 and the atmosphere, so that in case of leakage past the valve $d^{\times}$ while the ejectors are not working any partial vacuum between the valve $d^{\times}$ and the ejectors which would tend to draw leakage, steam, or vapor into the train-pipe is destroyed. When the ejector or ejectors is or are at work, there is a vacuum or partial vacuum in the passage d^4. Consequently the valve g is closed and kept closed by atmospheric pressure. The air from the train-pipe d, which passes the valve $d^{\times}$, goes along the passage d^7 to the passage e^8, leading to the annular space e^7, Figs. 2

and 5, whence it flows through passages (similar to passages e^{13}) in the arms e^{12} to the annular space e^{11}. The mushroom-valve d^5 is mounted similarly to the valve $d^\times$, the screw-cap d^6 being removable. Air from the train-pipe d may after passing the valve d^5 enter the passage f^5, which communicates with the annular space f^4.

Condensed steam cannot accumulate in the passages in the ejector-casing, as any that may be produced while the small ejector is at work passes through that ejector and is expelled by it. When the ejectors are not working, any condensed steam passes down the drip-pipe h, leading from the passage f^5, Fig. 1. The steam-valve for the large ejector f' is a disk i, having two ports i', Fig. 7, which when turned so as to come opposite the two ports i^2, Figs. 1 and 6, allow steam to pass to the large ejector. The disk i is formed with a U-shaped projection $i^\times$, Fig. 7, in the cavity i^3 of which the end of the spindle i^4 fits. On the spindle i^4 is a conical collar i^6, Figs. 2 and 6, which bears against a facing on the inside of the detachable stuffing-box i^5, the latter containing a gland and packing for the spindle. The box i^5 is screwed into the main casing a, the joint between the parts being steam-tight. The hollow annular disk valve k is secured upon the squared outer end of the spindle i^4 by a screw-nut i^7. When, therefore, the hollow disk valve k is turned by its handle k', the spindle i^4, and consequently the steam disk valve i, are also turned. The seat l for the disk valve k is formed on the main casing a. The handle k' is provided with a well-known device, by which it is caused to remain in the middle or "running" position, as in Fig. 7, or against either of the stops k^2 and k^3. When the handle k' is against the stop k^2, the brakes are "off," and when it is against the stop k^3 the brakes are "on." Consequently the steam disk valve i is open when the handle k' is against the stop k^2 and closed when the handle is in the middle position or against the stop k^3. The face k^4 of the valve k fits with an air-tight joint against its seat l. The valve k is divided by partitions k^9, Fig. 7, into two separate divisions k^5 and k^6. Atmospheric air can enter the division k^6 through a series of small holes $k^\times$, drilled through the shell of the valve. No air can pass into the division k^5 except that which passes through the ports in the valve and valve-seat. In the face k^4 of the valve k there are four ports, two marked k^7 in the division k^6, and two, one marked k^8, and the other extending between the points marked 1, 1, and 2 in the division k^5. Air can pass from the passage d' through the port l^2 into the division k^5 and thence through the port l' into the cavity d^2, past the stop-valve $d^\times$ and on to the ejectors. The two ports l^2 are in direct communication through the passage d' with the train-pipe d. The port l^3 is in direct communication with the auxiliary pipe n^6. In the middle or running position of the valve k no air can pass to the train-pipe from the division k^6 through the ports k^7 and l^2; but the small ejector (which is constantly at work) can draw air from the train-pipe d through the cavity d^2, the port l', the division k^5, the left-hand port l^2 in Fig. 7, and the passage d'. When the handle k' is against the stop k^3, the ports k^7 are opposite the ports l^2, and air rushes through the holes $k^\times$ into the division k^6, and thence through the ports k^7 and l^2 into the train-pipe d. The communication between the small ejector and the left-hand port l^2 is closed; but the small ejector is in communication with the auxiliary pipe n^6 through the narrow continuation of the division k^5 and the ports k^8 and l^3. When the handle k' is against the stop k^2, both the ports l^2 are closed against the admission of air to the train-pipe; but air can pass from the train-pipe through the left-hand port l^2 in Fig. 7, the division k^5, and the port l' to the two ejectors. The cock m, Fig. 6, screws into a hole m', Figs. 4 and 5. By means of this cock lubricant is supplied to the steam-passage f^3 and is carried by the steam to the face of the steam disk valve i. The hollow casting n, Fig. 6, is screwed into the hole n', Fig. 1, and is in communication with the port l^3. It contains a seat for a ball-valve n^2, the lift of which is limited by a pin n^3. Below this valve there is a projection tapped to receive a screw-threaded valve-plug n^4. The inner end of the plug is conical and fits against a conical seat in the casting n. When the end of the plug is withdrawn from its seat by unscrewing the plug, air can pass into the bore of the casting n through a series of small holes, one of which n^5 is shown in Fig. 6. The pipe n^6, coupled to the casting n, leads to the upper side of the diaphragm or piston of the brake-cylinder for actuating the brakes on the engine or tender. While the small ejector is at work and the plug n^4 closed a vacuum is maintained in the pipe n^6, so that any leakage which would take those brakes off is guarded against. The brakes just referred to may be readily released by unscrewing the cock n^4, and so admitting air into the auxiliary pipe n^6. This destroys the vacuum on the upper side of the diaphragm or piston, and the brakes fall off under the influence of the weight of the brake-piston and other unbalanced parts.

In Figs. 8, 9, and 10 the main casing a of the air-brake apparatus is so modified that the mechanism for automatically actuating the steam-brakes on the engine and tender is combined therewith, thus permitting the air-brakes and the steam-brakes to be simultaneously operated by the same handle. The mechanism for actuating the steam-brakes shown in the accompanying drawings is similar to that described in the specification to British Letters Patent No. 1,494 of 1881.

The main casing p of the mechanism for actuating the steam-brakes is secured to the casing a by screws passing through the flange p^2. The passage q in the casing a is for ef-

fecting communication between the steam-supply passage f^3 and the steam-passage p' in the casing p. The passage p' leads to an annular recess p^3 in the bore of the casing p. One end of the bore is stopped by a hollow screw-plug r, having openings, through which the steam from the annular recess p^3 passes into its interior. The inner end of the plug r forms a seat for a valve r', which is screwed into the end of a piston r^2, the latter being formed on the spindle r^5 and working in an enlarged part of the bore, as shown in Figs. 9 and 10. On the spindle r^5, near the piston r^2, is formed a conical valve r^3, the seat for which is made upon the end of a bush r^4, screwed into the bore. The spindle r^5 works through the bush r^4. A stuffing-box is formed for the spindle r^5 in the outer part of the bush r^4, r^6 being the stuffing-box gland. A small hole, (shown in dotted lines in Fig. 10 and marked r^7,) is drilled diagonally from one side of the piston r^2 to a reduced part of the spindle r^5 beyond the valve r^3, in order to allow any steam which may leak past the flange r^8 to escape. The pipe q', which conveys steam to and from the steam-brake cylinder, is connected by a union to the nozzle p^4. One branch from the passage p^5 is in communication with the annular chamber p^9 round the steam-inlet valve r', the other branch leading to the annular chamber p^{10}, round the exhaust-valve r^3. The annular chamber p^{11} communicates through a hole p^6 in the side of the bush r^4, with the passage p^7, formed in the inner face of the flange p^2. From this passage p^7 the exhaust-steam flows through a hole q^2, drilled obliquely in the side of the combining-cone of the large ejector, and is finally carried away with the steam and air from the ejectors. A screw s is passed through a hole in the end of an arm p^8, and is secured in position by a nut on each side of the arm. The forked end of the screw s carries the fulcrum-pin s' of the lever s^2, which passes through a slot in the outer end of the spindle r^5. The lever s^2 also passes through a slot in the piston-rod t^2 of a piston t', which works in a cylinder t, forming part of the casing p. The cylinder-cover t^3, which need not make an air-tight joint, forms a guide for the piston-rod t^2. Air is freely admitted to the outer side of the piston t' through a hole t^4 in the cylinder-cover. The passage t^5, Fig. 8, leads from the cylinder t to a ball-valve t^6, having its seat formed in the face of the flange p^2, a cavity for the ball being formed in the side of the casing a. From this ball-valve there is a passage q^3 in the casing a leading to the passage d', and so communicating with the train-pipe. The cylinder-cover t^3 carries a fulcrum-pin u' for the two-armed lever $u\,u^2$. The arm u is provided with a handle and with a hook, the latter engaging, when required, with a pin s^3 in the lever s^2. When the hook is in engagement with the pin s^3, the lever s^2, acting upon the spindle r^5, presses the inlet steam-valve r' closely against its seat. The other arm u^2 enters a slot in the piston-rod t^2. When the piston t' is in the position shown in Fig. 10, the outer end of the slot is in contact with the arm u^2 and has moved the arm u so as to lift the hook out of engagement with the pin s^3. This takes place when a vacuum is formed in the train-pipe d. The lever s^2 bears against a steel pin r^9, passed through the spindle r^5. The piston-rod t^2 is furnished with a steel pin t^7, which bears against the lever s^2.

The action of the combined apparatus is as follows: When the vacuum-brakes are taken off, the steam-brakes on the engine and tender are also taken off. Likewise, when the vacuum-brakes are put on the steam-brakes are also put on. When the brakes are off there is a vacuum or partial vacuum in the train-pipe d, and air is exhausted from the cylinder t through the ball-valve t^6. This causes atmospheric pressure to act upon the outer side of the piston t', thus pulling in the lever s^2, which, acting through the spindle r^5, closes the steam-inlet valve r' and opens the steam-outlet valve r^3, so that any steam in the steam-brake cylinder or any leakage of steam past the inlet-valve r' has free access to the exhaust, and the steam-brakes are withdrawn.

If the vacuum-brakes be applied, air rushes into the train-pipe d and closes the ball-valve t^6, which acts to prevent the air from the train-pipe d passing too suddenly into the cylinder t. When the ball-valve t^6 is upon its seat, air can only pass slowly from the train-pipe to the cylinder t through the hole t^8 in the flange p^2, thus providing for the steam-brakes and the vacuum-brakes being applied at about the same time. When the vacuum or partial vacuum has been destroyed in the cylinder t, there is no pressure acting on the lever s^2 to keep the steam-inlet valve r' closed. The latter therefore lifts by the pressure of the steam until the exhaust-steam valve r^3 comes against its seat, whereupon the steam, being unable to escape from the passage p^5, goes along the pipe q' to the steam-brake cylinder and acts upon its piston to apply the steam-brakes. When the locomotive is running by itself or working without the vacuum-brakes being in operation, the steam-brakes are prevented from operating by pressing the lever s^2, so as to cause the hook on the arm u to engage with the pin s^3.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. In braking mechanism for trains, the combination, with the mechanism of a vacuum-brake apparatus, comprising ejectors and their valves, a casing a, inclosing said ejectors and provided with necessary inlets, ports, and passages for air and steam, the air-controlling and steam-controlling valves mounted on said casing, and the steam-pipe c and train-pipe d, connected with said casing, of the mechanism of a steam-brake apparatus pertaining to the engine or locomotive, comprising a casing p, secured to the casing a and having its valve-chamber connected by a pas-

sage with the steam-supply passage of said casing a, a valve-spindle mounted in the valve-chamber of the casing p, said spindle carrying valves which control the admission of steam to the brake-cylinder, a lever for operating said valve-spindle, a cylinder open to the train-pipe, a piston in said cylinder adapted to be displaced when a partial vacuum is formed in the train-pipe, and intermediate mechanism, substantially as described, so that the movement of said piston is communicated to the lever which operates said valve-spindle, whereby the vacuum-brakes and steam-brakes are put on or thrown off at the same time, as set forth.

2. In a braking mechanism, the combination of a casing p, having a steam-inlet and a steam-outlet, a valve-spindle r^5, carrying valves mounted in the casing and controlling the inlet and outlet, a cylinder t, open to the atmosphere at one end and to the train-pipe at the other end, a piston in the cylinder adapted to be displaced by the formation of a vacuum in the train-pipe, the train-pipe, and the rod of the piston, said rod and the valve-spindle being coupled together, whereby when said piston is moved it will displace the valve-spindle, as set forth.

3. In an automatic vacuum-brake apparatus, the combination, with the small and large ejectors and the casing inclosing them, of stop-valves in the air-passages, substantially as described, situated above the said ejectors, for the purpose set forth.

4. In an automatic vacuum-brake apparatus, the combination, with the small and large ejectors and their respective stop-valves, of the casing inclosing said ejectors and valves, having an air-passage controlled by the stop-valve of the small ejector, and a normally-open automatic valve which controls the admission of air to the passage behind that stop-valve, whereby when the small ejector is not in operation the vacuum behind the said stop-valve is destroyed by the opening of the automatic valve, as set forth.

5. In an automatic vacuum-brake apparatus, the combination, with the small and large ejectors and the casing inclosing them provided with air and steam passages, of the respective stop-valves $d^\times$ and d^5, pertaining to the said ejectors, the stop-valve $d^\times$ preventing the passage of air both from the small ejector and from the large ejector, and the stop-valve d^5 preventing the passage of air from the large ejector, substantially as and for the purposes set forth.

6. In an automatic vacuum-brake apparatus, the combination, with the small and large ejectors, the casing inclosing them, provided with connected air-passages d', d^2, and d^7, controlled by a stop-valve $d^\times$, which opens to the passage d^7, the stop-valves $d^\times$ and d^5, and the train-pipe d, connected with the passage d', of the screw-cap d^3 in the casing behind the valve $d^\times$, and the normally-open gravity-valve g, which controls an air-inlet in the said screw-cap and which is adapted to be closed automatically by atmospheric pressure when the small ejector is in operation, substantially as and for the purposes set forth.

7. In an automatic vacuum-brake apparatus, the combination, with the small and large ejectors, the train-pipe and the casing inclosing the said ejectors provided with a series of connected passages d', d^2, d^7, e^8, e^7, f^5, and f^4, of the stop-valve $d^\times$, arranged over the said ejectors and preventing the flow of air from the passage d^7 to passage d^2, and the stop-valve d^5, arranged above the said ejectors and preventing the flow of air from the passage f^5 to the passage d^7, substantially as and for the purposes set forth.

8. In a vacuum-brake apparatus, the combination, with the ejectors, their inclosing casing provided with ports and passages for the air and the train-pipe, of the hollow annular disk valve k, mounted rotatively on a seat on the casing over the air-ports therein, said valve having its hollow partitioned, substantially as and for the purposes set forth.

9. In a vacuum-brake apparatus, the combination, with the ejectors, their inclosing casing provided with ports, inlets, and passages for air and steam, and the steam-pipe and train-pipe connected with said casing, of the hollow annular disk valve k, mounted rotatively on a seat on the casing over the air-ports therein, and the steam disk valve i, mounted rotatively on a seat in the casing and controlling the steam-ports therein, said valves i and k being coupled, so that both rotate together, substantially as set forth.

JAMES GRESHAM.

Witnesses:
A. ED. GEO. ELLIS,
JAMES M. TOLLEY.