(No Model.) 2 Sheets—Sheet 1.

H. R. WALKER.

VARIABLE EXHAUST NOZZLE.

No. 490,000. Patented Jan. 17, 1893.

Fig. 1.

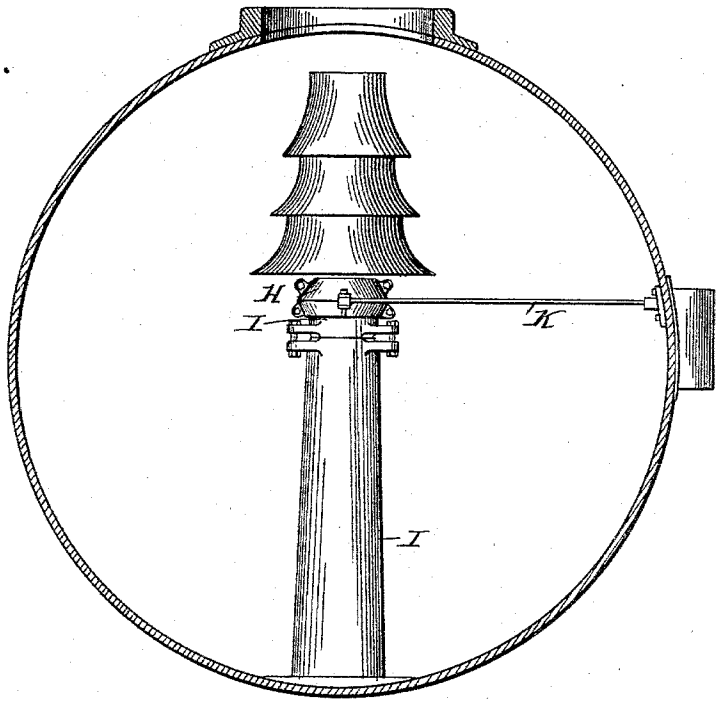
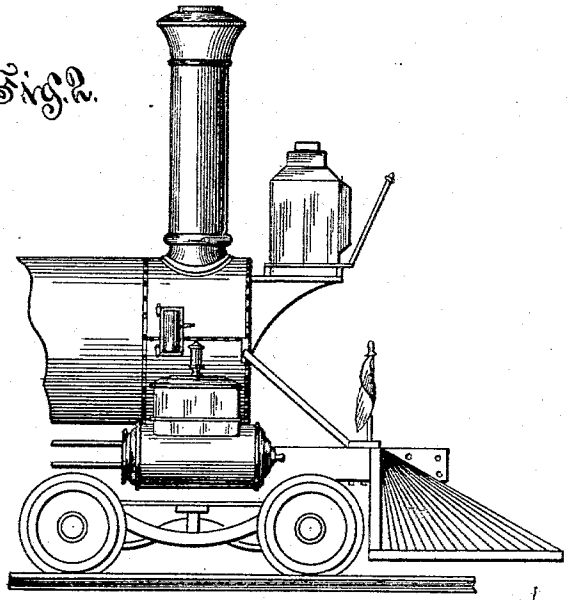


Fig. 2.



Witnesses.
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Elsie Nemett.

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(No Model.) 2 Sheets—Sheet 2.

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VARIABLE EXHAUST NOZZLE.

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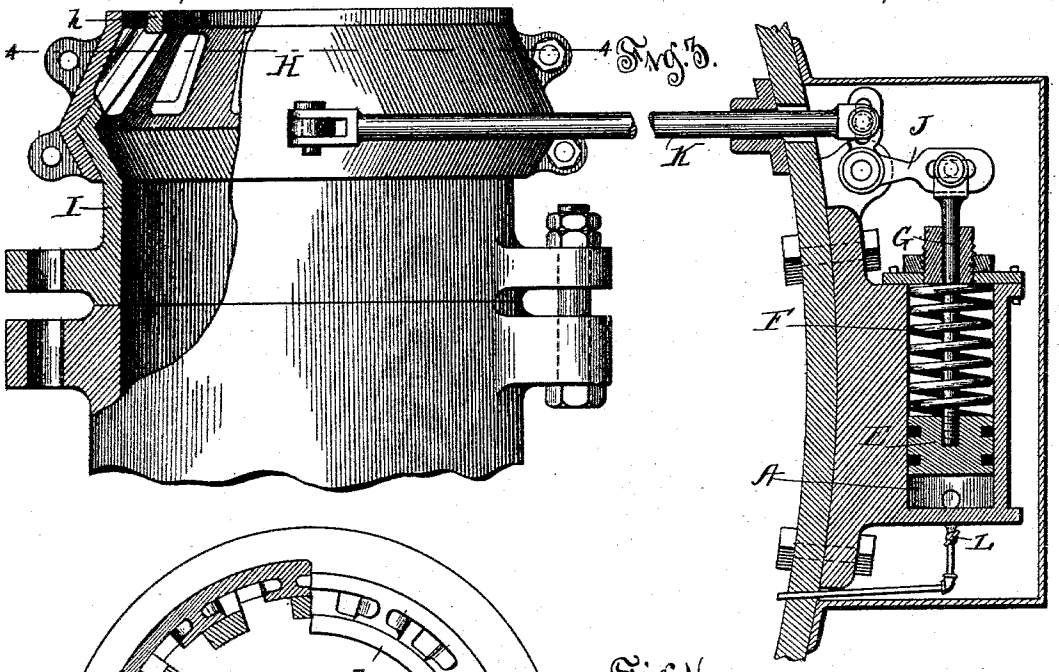


Fig. 3.

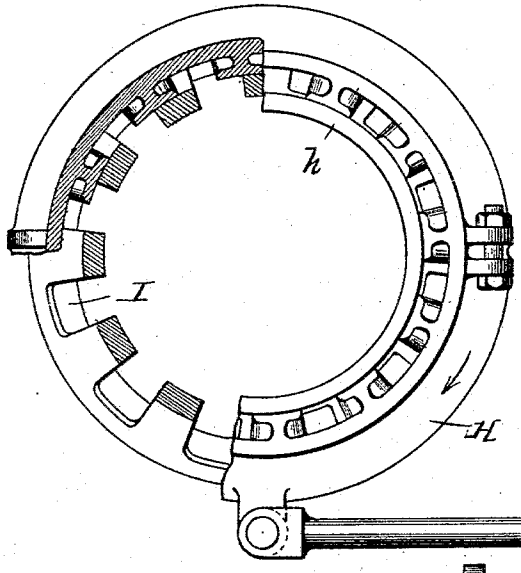


Fig. 4.

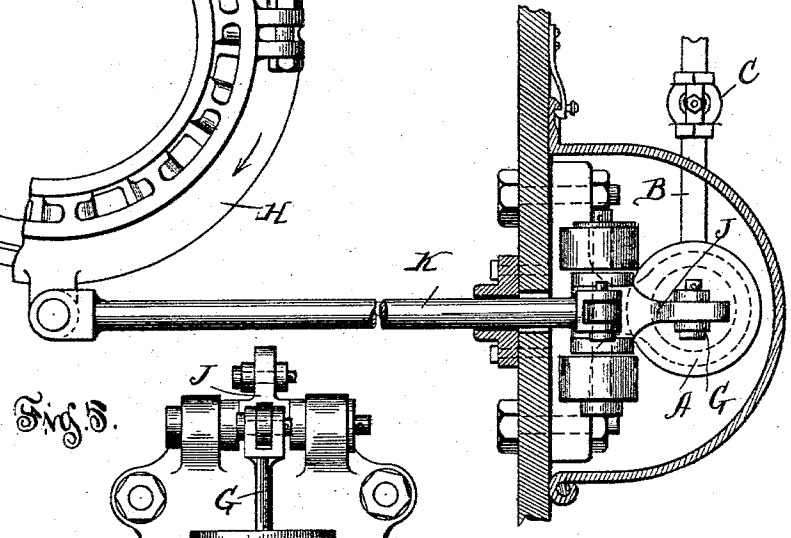
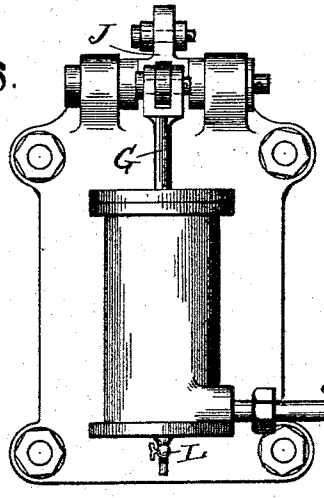
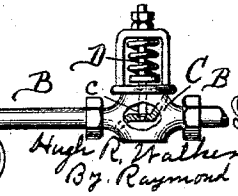


Fig. 5.





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UNITED STATES PATENT OFFICE.

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VARIABLE-EXHAUST NOZZLE.

SPECIFICATION forming part of Letters Patent No. 490,000, dated January 17, 1893.

Application filed November 9, 1891. Serial No. 411,281. (No model.)

To all whom it may concern:

Be it known that I, HUGH R. WALKER, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Variable-Exhaust Nozzles, of which the following is a specification, reference being had to the accompanying drawings.

My invention, as herein shown, is applied to a locomotive such being the principal use for which it is designed. It is adapted, however, to any situation in which the fire of the boiler-furnace is urged by the exhaust from the engine.

The object of my invention is to provide means for automatically varying the effective area of the tip of the nozzle so that it will be as large as is consistent with the production of a sufficient draft to maintain steam-pressure. It is well known that a considerable waste of fuel and of power results from the use of too small a nozzle, the greater intensity of blast resulting from the reduction of the size of the nozzle causing the fire to be torn up and the back pressure upon the piston to be increased.

By the device herein shown, the nozzle will be increased in effective area as the steam pressure rises within the boiler and will be automatically diminished in area as the steam-pressure sinks, thus tending to maintain, at all times, a proper relation between the demand upon the boiler, and the intensity of the blast by which the fire is urged.

In carrying out the main object of my invention I have devised a form of nozzle which will allow of a variation in its effective area by a comparatively small circumferential movement thereof which adapts it especially for automatic control.

In the drawings: Figure 1 is a cross section of the smoke-arch of a locomotive-boiler showing the nozzle in place. Fig. 2 is a side elevation of the front part of a locomotive showing the position of the nozzle-operating devices with reference to the boiler. Fig. 3 is a view on a larger scale of the nozzle-tip and its operating-devices. Fig. 4 is a plan view of the same, the nozzle being shown partly in section; and Fig. 5 is a side view of the nozzle-operating cylinder and its connections.

A (Figs. 3 and 4) is a cylinder most conveniently located upon the side of the smoke-arch. It is provided at the bottom with a pipe B for the admission of steam. Said pipe B is connected to the boiler and at some intermediate point is provided with a valve C. The valve proper, *c*, has a stem of the same size as the valve and is kept closed by a spring D (*vide* Fig. 5) the pressure on said spring being adjustable in any suitable manner. Over the piston E within the cylinder A is a spring F which tends to force the piston to the bottom of the cylinder. The piston-rod G is connected to the movable ring H of the exhaust-nozzle I by means of a bell-crank lever J and rod K.

The construction of the ring H and the tip I is clearly shown in Figs. 3 and 4. The tip I is slotted at its top so as to form a series of openings occupying about half the circumference. The slots may or may not extend to the extreme end of the tip, it being, for the sake of strength, desirable to leave the small ring *h* at the top. Surrounding the tip I is the movable ring H which has a number of grooves formed upon the inner surface of its conical top. These grooves correspond in number to the slots in the tip and their width at the inner surface of the ring H is equal to the width of the slots. They are deeply undercut toward their bottom so that they are separated only by a thin web of metal. The divisions between them thus have a T-shape as seen in the section at the upper left-hand part of Fig. 4 which is on the line 4, 4, of Fig. 3.

The operation is as follows: When the steam-pressure within the boiler has risen to a predetermined limit, say five pounds of the blowing-off point, the valve *c* will open and admit steam to the cylinder A. Owing to the fact that the stem of the valve *c* is the same size as the valve itself, it will remain open, notwithstanding the accumulation of pressure in the pipe B beyond the valve *c* and in the cylinder A, so long as the pressure requisite to open the valve is maintained. The effect of the admission of steam to the cylinder A will be to raise the piston E against the force of the spring F and by so doing to turn the ring in the direction of the arrow thereon. This causes the grooves in the ring H to

coincide with the slots on openings in the tip I and thereby increase the effective area for the escape of the exhaust steam by the area of the said slots and grooves. The force of the blast and the back pressure in the cylinders will thus be moderated so long as the high pressure of steam in the boiler is maintained. The enlarged area of nozzle thus afforded is more efficient in urging the fire because the steam issuing from the grooves assists rather than retards the blast from the central tip I. As a consequence, the restricted area of nozzle will not be called into use so often, thus effecting a material economy. The form and position of the grooves are such that they are in effect tubes and the steam within them has no room to expand until it reaches the top end of the nozzle; it is directed in the same course as the steam from the central tip and assists in maintaining the draft. If, however, the pressure should sink below the point necessary to keep the valve *c* open, the closure of said valve would allow the spring F to preponderate and by the depression of the piston E move the ring H to a position in which its grooves no longer coincide with the openings in the tip I. When said openings are closed, the area of the nozzle is simply that included within the small circle *h*, and the blast is accordingly intensified.

By making the spring F of such a strength as to nearly balance the steam-pressure, a gradual rising of the piston E and the correspondingly gradual opening of the additional area of the nozzle would be effected by the increasing steam-pressure, but, although sometimes desirable, this is not always necessary as, if a weaker spring be provided, the ring H will move to its extreme open position as soon as steam is admitted by the valve *c* to the cylinder A. In the latter case the nozzle would always be at one extreme or the other, being either fully opened or reduced to its smallest area. This is desirable in some sorts of nozzle, the one illustrated being the example.

In order to provide for the escape of the steam or condensed water from the cylinder A a small drain-cock L is inserted in the bottom of the cylinder and is left very slightly open. It is not absolutely necessary to have this, however, as there will be sufficient leakage past the piston E to permit of the gradual closing of the nozzle.

What I claim as new and desire to secure by Letters Patent is as follows:

1. The combination of an exhaust nozzle of variable area; a boiler-furnace whose fire is urged thereby; a steam cylinder connected to the movable portion of said exhaust nozzle and having a spring loaded piston; a steam pipe connecting said cylinder and said boiler; and a loaded valve in said pipe cutting off the admission of steam to said cylinder when the pressure is below a predetermined limit, and adapted to be opened and held open by the steam pressure when it exceeds such limit, substantially as described.

2. The combination of an exhaust nozzle of variable area; a boiler-furnace whose fire is urged thereby; a steam cylinder connected to the movable portion of said exhaust nozzle and having a spring loaded piston; a steam pipe connecting said cylinder and said boiler; and a loaded valve in said pipe having the valve proper and its stem of the same diameter whereby it cuts off the admission of steam to said cylinder when the pressure is below a predetermined limit and is held open by the steam pressure when it exceeds such limit, substantially as described.

3. The combination with an engine and boiler, of a variable exhaust-nozzle by which the furnace fire is urged, comprising a tip having a series of openings near its end and a ring surrounding said tip and having a series of grooves on its inner surface corresponding to the openings in said tip; forming tubular passages for the steam extending to the upper end of the nozzle and means for revolving said ring on said tip, substantially as described.

4. The combination of the nozzle-tip I having a series of openings near its upper end; the ring H having a series of grooves on its inner surface corresponding to the openings in the tip I forming tubular passages for the steam extending to the upper end of the nozzle; the cylinder A connected by the pipe B to the boiler; the piston E in said cylinder connected to said ring H and having a spring F by which it is depressed and the valve C controlling the admission of steam to said cylinder A, substantially as described.

HUGH R. WALKER.

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