(No Model.) 3 Sheets—Sheet 1.

J. Y. SMITH.

BLAST OR EXHAUST APPARATUS.

No. 386,502. Patented July 24, 1888.

Fig. 2.

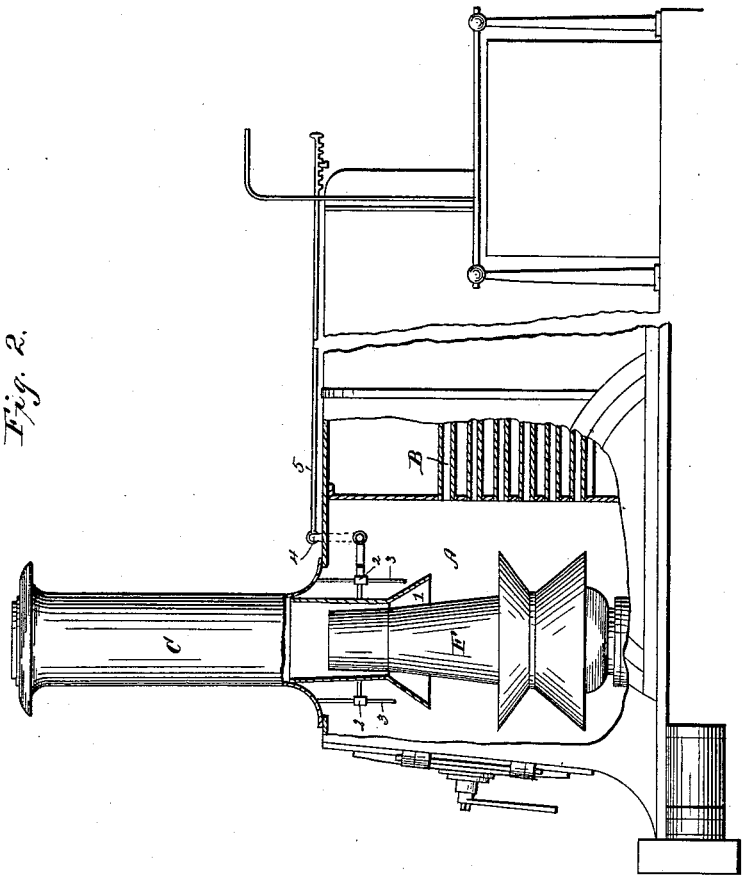
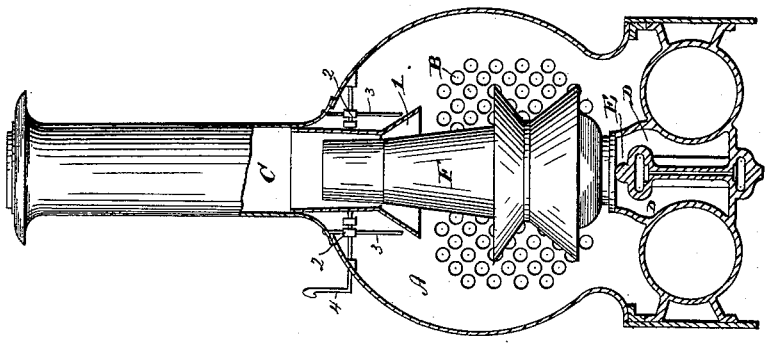


Fig. 1.



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his Attorneys.

(No Model.) 3 Sheets—Sheet 2.

J. Y. SMITH.

BLAST OR EXHAUST APPARATUS.

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Fig. 3.

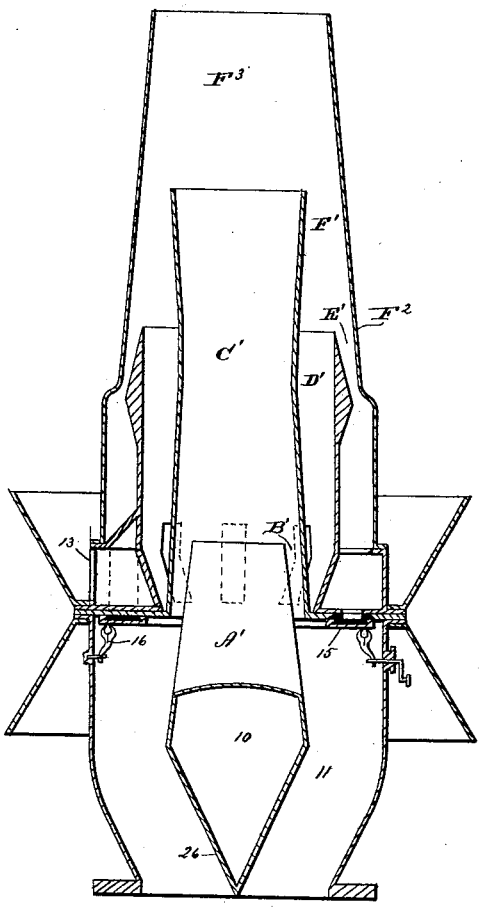
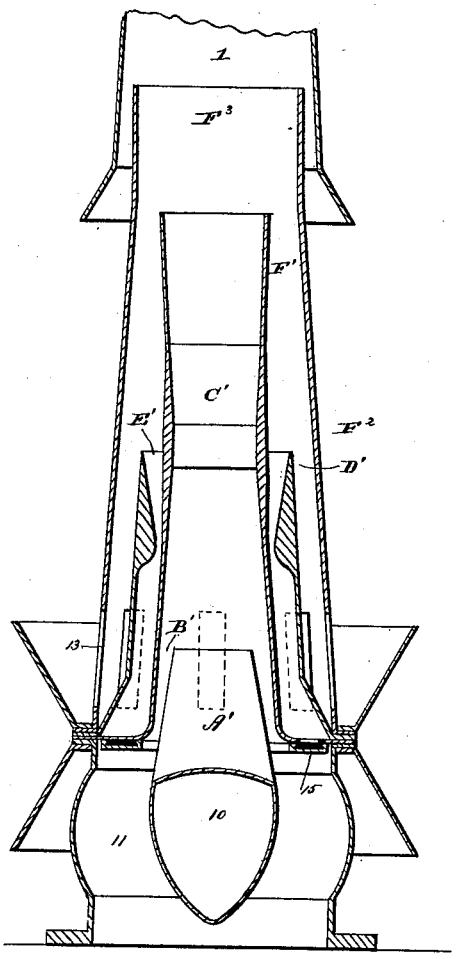


Fig. 4.



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(No Model.) 3 Sheets—Sheet 3.

J. Y. SMITH.

BLAST OR EXHAUST APPARATUS.

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Fig. 6.

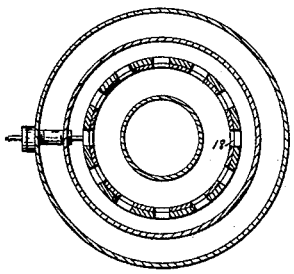


Fig. 7.

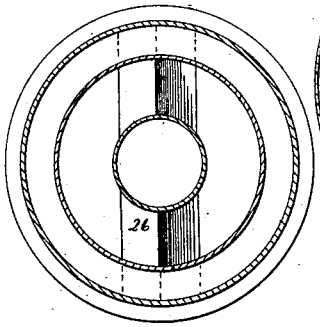


Fig. 9.

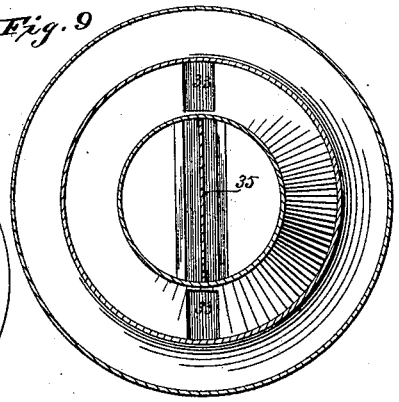


Fig. 5.

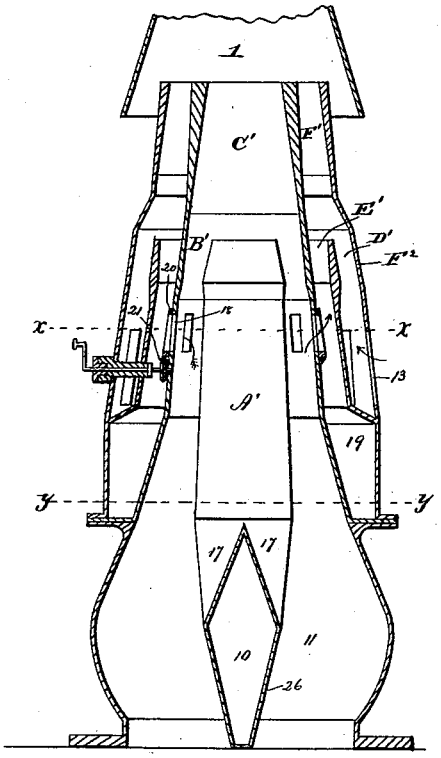
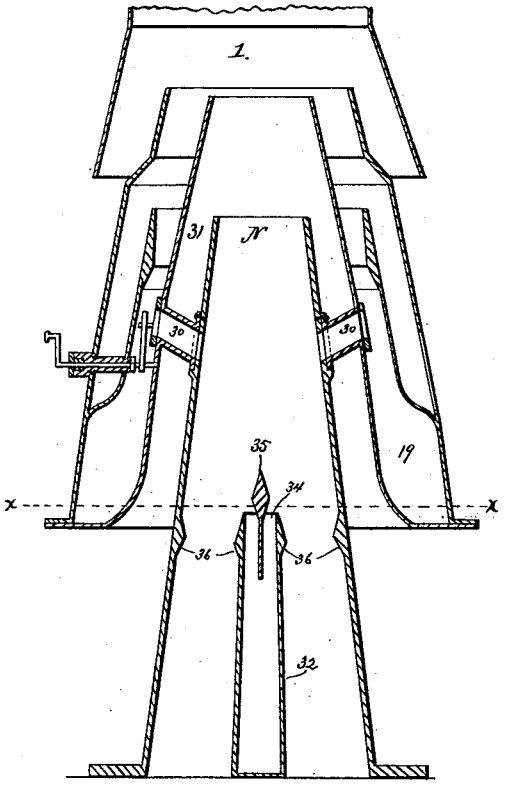


Fig. 8.



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UNITED STATES PATENT OFFICE.

JOHN Y. SMITH, OF DOYLESTOWN, PENNSYLVANIA.

BLAST OR EXHAUST APPARATUS.

SPECIFICATION forming part of Letters Patent No. 386,502, dated July 24, 1888.

Application filed January 11, 1888. Serial No. 260,404. (No model.) Patented in England November 14, 1887, No. 15,573.

To all whom it may concern:

Be it known that I, JOHN Y. SMITH, of Doylestown, in the county of Bucks and State of Pennsylvania, have invented certain new and useful Improvements in Blast or Exhaust Apparatus, (for a portion of which I have obtained a patent in Great Britain, No. 15,573, bearing date November 14, 1887;) and I do hereby declare the following to be a full, clear, and exact description of the same, reference being had to the accompanying drawings, forming a part of this specification, and to the figures and letters of reference marked thereon.

This invention relates to a new and improved blast or exhaust apparatus designed more especially for use in connection with locomotive and other boilers or furnaces for inducing, maintaining, and regulating the draft; and my said invention embraces certain modifications in, improvements upon, and additions to the apparatus disclosed in my application, No. 250,929, filed September 28, 1887, Patent No. 378,340.

The principal and distinguishing elements of my present invention may be briefly stated as follows: First, the employment of independent confining-chambers for the inner and outer ejectors; second, the addition of a third confining flue or chamber into which the inner and outer ejectors discharge, either directly or through an intervening mingling chamber or passage, with inlet-openings so arranged and disposed as to form a third ejector; third, a movable section or damper interposed between the ejector and the escape-orifice leading to the smoke-stack or chimney, said damper or movable section forming part of or made separate from the ejector and operating to control the escape of the products of combustion from the smoke-box or uptake into the chimney or smoke-stack, whereby said products may be admitted directly into the chimney or compelled to pass in whole or in part through the ejector; and, fifth, the employment of a compression-chamber communicating with the steam-passage below the jet opening or nozzle for preventing back-pressure in the exhaust-chamber and for prolonging or supplementing the direct action of the blast.

The invention also includes certain other and minor improvements relating to the construction, arrangement, and combination of parts, as hereinafter more fully described, and pointed out in the claims.

In the accompanying drawings, wherein my said inventions are illustrated, Figures 1 and 2 are end and side views, respectively, partly in section, showing the location and arrangement of the ejecting apparatus within the smoke-box or uptake of a locomotive-boiler. Fig. 3 is a longitudinal vertical section through an ejector illustrating the application of a portion of my present improvements. Fig. 4 is a similar view illustrating slight modifications in the construction and arrangement of the parts. Fig. 5 is a longitudinal vertical section through an ejector embodying features common to the ejectors, Figs. 3 and 4, and in addition thereto illustrating the application and use of the compression-chamber. Figs. 6 and 7 are transverse horizontal sections on lines $x\,x$ and $y\,y$, Fig. 5. Fig. 8 is a longitudinal vertical section through an ejector, illustrating a modification of my invention to adapt it for use in connection with a solid as distinguished from an annular central steam-jet. Fig. 9 is a section on line $x\,x$, Fig. 8.

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

Referring more particularly to Figs. 1 and 2, A represents the smoke-chamber; B, the flues; C, the smoke-stack or chimney; D D, the chambers or passages into which exhaust-steam is delivered from the cylinders; E the bridge-wall or partition between said exhaust-chambers; and F, the ejector or exhaust apparatus opening into the base of the smoke-stack.

Between the upper or eduction end of the blast apparatus and the opening into the smoke-stack an adjustable hood or confining-flue, 1, is interposed, so arranged that it can be moved to cover or uncover the opening into the smoke-stack. In the present instance the flue 1 is shown supported by eyes 2 upon vertical rods 3, a bell-crank or other lever, 4, engaging the flue and attached to a connecting-rod, 5, extending back to the cab in position to be manipulated by the engineer, serving as a ready and convenient means for effecting the vertical adjustment.

The upper end of the flue 1 is adapted to fit against or within the opening in the base of the smoke-stack, and its lower end, preferably provided with a flaring mouth or deflecting-

plate, is formed with an opening somewhat larger than the external diameter of the ejector or blast apparatus F, a space or passage being formed between the flue and ejector communicating with the smoke-box. As thus arranged, and by making the flue 1 vertically adjustable, it is made to perform two distinct functions, inasmuch as it serves both as a damper and as a part of the supplemental ejector; hence it may properly be regarded as an embodiment of or illustration of two different features, the one a movable damper interposed between the mouth of the ejector or blast apparatus for controlling the passage between the smoke-box and chimney, and the other as a portion of a supplemental blast apparatus or ejector, the gases and steam under pressure as delivered from the ejector F within said flue serving to draw the gases or air through the passage between the flue and exterior of the ejector and force it into the smoke-stack.

It will be observed that the flue 1, acting in its capacity as a damper, is supported in a manner to permit of a vertical movement, so that when lowered it will uncover the entrance to the smoke-stack and permit the heated products of combustion to pass from the smoke-box directly into the chimney where it is impelled either by natural or forced draft or both combined; but when said flue is elevated, as shown in the drawings, it will cut off or close the direct-draft opening and compel the gases and products of combustion to pass through and be acted upon by the blast apparatus or some portion thereof before entering the smoke-stack.

As before stated, an annular or other shaped opening or passage is formed between the exterior of the blast apparatus and the flue 1, through which the gases are drawn by the action of the blast within said flue, the latter constituting a confining-chamber for receiving the gas or air and steam as delivered from the blast apparatus F. While this supplemental air-passage is desirable, as enlarging the capacity of the draft-inducing device, it is not essential to the complete operation of the invention in other respects, as will presently appear.

The special application or use of the movable flue 1, regarded as a damper or valve for directing the products of combustion, or a portion thereof, into the chimney or smoke-stack, either wholly or partially through the blast or exhaust apparatus, is to secure a more regular and even draft and prevent back pressure in the smoke-stack or uptake.

As is well known, the blast or exhaust apparatus heretofore employed on locomotive-boilers is usually located within the smoke-box and with its jet-orifice in line with the opening in the smoke-stack, but removed at some distance from the walls of the latter, and the supply of steam is taken from the exhaust-ports of the cylinders. Consequently the blast is delivered in the form of successive jets or blasts of steam under great pressure.

The steam issuing from the jet-orifice is driven or propelled into and against the column of rarefied gaseous matter within the smock-stack, and, moving at a high rate of speed, drives a certain portion of the gaseous matter before it into and through the smoke-stack.

Each blast of steam may be regarded as a separate piston traversing the smoke-stack at a high rate of speed, while at the same time it expands laterally, thereby increasing in area, its maximum speed and minimum area coinciding at the point of entrance into the smoke-stack and its maximum area and minimum speed at point of exit therefrom.

The area of the blast of steam as compared with the opening in the smoke-stack and the high velocity at which the steam is driven are such that not only is a very large portion of the available power of the exhaust-steam wasted, but the fluctuations in pressure due to the intermitting action of the blast are reproduced with increased violence in the flues and furnace. This defective action is due, in a measure, to the manner of applying the blast as well as to the character of the blast or exhaust apparatus employed.

The relatively small jet or blast of steam when projected into the much larger column of highly-heated gaseous matter operates mainly by displacement, and forces the gaseous matter to one side, thereby forming eddies and interfering currents within the smoke-box; and as the jet or blast of steam in its passage through the smoke stack acts largely by friction against the gases contained therein, while its speed diminishes in proportion as it nears the exit end of the smoke-stack, its effective action upon the body of gas in the smoke-box is not only diminished, but it sometimes happens that between successive blasts a partial return or downward movement takes place in the smoke-stack, the influence of which is felt in the smoke box, flues, and furnace. It is for the purpose of in a measure overcoming or diminishing these defects that the flue 1 is interposed between the blast or exhaust apparatus and the opening in the smoke-stack, whereby all the products of combustion may be diverted into and brought under the direct influence of the blast apparatus, thereby increasing the effective action of the steam and at the same time preventing the formation of eddies and counter-currents in the smoke-box and smoke-stack, such as are produced by lateral displacement when a blast of steam is discharged into the column of heated gases and beneath the open end of the smoke-stack. Moreover, by making the flue 1 movable vertically, instead of laterally, it can be employed as a damper to more or less completely close the passage between the smoke-stack and smoke-box without materially interfering with its action as part of the supplemental ejector, whereby the force of the draft may be regulated while the steam is freely escaping through the ejector and with-

out producing back-pressure; and by dropping the flue 1 so as to entirely uncover the opening into the smoke-stack the furnace can be run by natural draft, as when starting up the fire or when the engine is standing.

Blast or exhaust apparatus of various forms and constructions may be employed for inducing a draft up and through the smoke-stack, but I prefer to use an exhaust apparatus of the character shown in the drawings and belonging to the particular type described in my before-mentioned prior application—that is to say, an apparatus provided with two separate ejectors so combined and united as to form a single exhaust or blast apparatus, and with induction-ports located at different levels within the smoke-box or relatively to the flue. Such an apparatus is illustrated in Figs. 3, 4, and 5, wherein A′ designates the central air-tube or inlet-passage communicating through induction-passage 10 with the space surrounding the apparatus; B′, the annular steam space or nozzle communicating through passage or chamber 11 with the steam-chest; C′, the confining flue or passage into which the blast of steam from nozzle B′ is delivered, and acting upon and against the column of air draws the latter through opening A′ and forces it into and through said flue C′. The parts A′ B′ C′ together constitute what is herein termed the "inner ejector" or "exhaust apparatus." Surrounding the inner ejector and extending to or beyond the mouth of its confining-flue C′ is a wall or casing, F^2, between which latter and said flue C′ is formed a second confining flue or passage, F′, into which opens an air passage or inlet, D′, and an annular steam passage or nozzle, E′. The parts F′ D′ E′ constitute the outer ejector.

It will be observed that in each case the blast devices of the inner and outer ejectors are provided with and deliver into independent confining chambers or passages, and that both of said passages C′ and F′ open or deliver into the interior of flue 1, either directly, as in Fig. 5, or through an intermediate mingling chamber or passage, F^3, formed by a prolongation of the outer wall, F^2, beyond the mouth of flue C′.

The air-passage D′ of the outer ejector communicates through inlet passages or ports 13 with the exterior of the apparatus at a point or points above the inlet 10 of the inner ejector, whereby the air and gases will be drawn from different levels and the draft distributed through the flues.

From an inspection of the drawings and a consideration of the mutual and co-operative relation of the several parts thus far mentioned, it will be obvious to one skilled in the art that when steam under pressure is admitted and caused to flow through the nozzles B′ and E′ the jets issuing therefrom will operate to draw the air and gases through passages A′ and D′, and that the air drawn through passage A′, as it is carried into flue C′, will be surrounded by and intimately mingled with the steam issuing from nozzle B′, while the air drawn through passage D′ will in like manner be intimately associated with the steam from nozzle E′, and that the materials, whether solid, liquid, or gaseous, issuing from the two ejectors will be associated together while retained under pressure and in motion, first in the mingling-chamber, when the latter is employed, and afterward in the confining-flue 1, into which an additional charge of air or gaseous matter is drawn through the passage between flue 1 and exterior of the ejector proper.

It is to be understood that the area of the two nozzles B′ E′ is the same or may exceed that of the single nozzle heretofore commonly employed, so that a free escape for exhaust-steam is permitted. At the same time the effective action of the steam is increased by distributing it over a larger surface and causing it to operate upon the air and gases issuing from relative long and narrow openings, whereby a thin body of steam is brought in contact with a thin enveloping column of air or gas, so that a more intimate admixture takes place within the confining-chamber. This feature is of considerable importance as contributing to the extinguishment of sparks.

As it is sometimes desirable to modify the action of the blast, a valve, 15, is arranged to co-operate with the steam-ports leading to nozzle E′. Said valve may be annular in form and connected to pivoted links 16 by ball-and-socket or other flexible connections—such as will permit the valve to rotate, and in so doing will cause it to be reciprocated toward and from its seat by the toggle action of the links. In devices of this kind great difficulty is experienced in keeping valves clean and preventing sticking, and especially is this the case where, as in the present instance, the valves are subjected to the action of steam charged with oil or other lubricating material. Under the action of heat and pressure the oil supplied to the cylinders is partially decomposed by the steam, and the product being carried over by the exhaust deposits upon the valve and its seat, forming a thick obstructing coating, which not only interferes with the proper working of the valve by its mere presence, but forms an active corroding agent which attacks the metal and destroys the valve-surfaces, besides adding to the material of the interfering coating the products of the corrosive action on the metal. This has heretofore been regarded as such a serious defect as to cause engineers to discard and object to the employment of blast or exhaust apparatus wherein valves alone were employed or depended upon to regulate or adjust the draft. By the use of the compound or spirally-movable valve, sliding into contact with its seat, but entirely removed therefrom when the steam-ports are opened, some of these objections are overcome, but not such as are due alone to the corrosive action of the decomposed lubricants. To obviate this defect and increase the durability or life of the valve, I construct the wearing or contact sur-

faces of glass, asbestus, or other silicious material, which may be accomplished by the insertion of said materials within a groove or recess, as shown in Figs. 3 and 4.

The ejectors, Figs. 3 and 4, are included herein merely as illustrating certain modifications in form and improvements in the structure and operation of the ejector claimed in my prior application and for the purpose of showing the application thereto of the valve and the confining chamber of the outer ejector, and with the exceptions named no claim is made herein to the improvements in the construction and arrangement of parts, said subject-matter being reserved for another application, Serial No. 273,355.

The preferred—because the most complete and satisfactory—form or type of ejector is illustrated in Fig. 5.

The relative position and arrangement of the component parts of the inner and outer ejectors are substantially the same as that shown in the apparatus, Fig. 4, the principal changes made being the shortening of flue C′ and the lengthening of flue or air-pipe A′ to bring the steam and air nozzles nearer the center.

As is usual, the passages leading to, and in fact constituting, the nozzles B′ and E′, through which steam is injected, are preferably so formed that the contiguous walls or surfaces shall be caused to approach or be brought nearest together at a point somewhat below the ends of the psssages and diverge slightly, but uniformly, toward the mouth, in order that the steam may be slightly retarded and compressed at the contracted part of the passage, and emerging therefrom shall be conducted between the diverging surfaces to the mouth, where, by expansion and pressure, it acts most powerfully upon the inclosed column of air or gases to carry and force the latter into and through the confining-flue and deliver it into the smoke stack, either directly, or preferably through a supplemental flue, 1.

The two cylinders of a locomotive discharge their exhaust-steam alternately on opposite sides of the blast or exhaust apparatus, and where, as in the present case, the latter is designed and arranged to receive the exhaust from both cylinders it is essential, first, that a clear passage and free outlet for the steam should be provided, in order that the escape of the exhaust should meet with but slight resistance; and, second, that the exhaust from one cylinder should be prevented as much as possible from entering the exhaust-passage of the opposite cylinder, as in either case objectionable back pressure will be produced.

With a view to overcoming, or at the least greatly reducing, excessive back-pressure on the cylinders and their exhaust, the cross-piece 26, through which air is conducted to the inner ejector, is extended downward, so as to rest upon or co-operate with the bridge-wall or partition E in forming a division between the two exhaust-passages. (See Figs. 5 and 1.) The sides of the lower section or steam-chamber are curved or extended laterally, and the top edge of the cross-piece 26 is narrowed or beveled, so as to form two separate converging passages, 17, each communicating at one end with the exhaust passage or chamber leading to one of the cylinders, and both of said passages 17 converging toward and opening into the steam-space below the nozzle of the inner ejector, whereby a large open passage is provided for each exhaust, and the steam admitted through one of said passages is directed upward and away from the opposite passage and delivered directly into the nozzle. In this way the exhaust-steam from both cylinders is conveyed directly to and distributed throughout the whole area of the blast orifice or nozzle, where it is somewhat retarded in its escape by the contracted form of the opening. The blast of steam, moving at a high speed and under pressure, being thus suddenly checked or retarded in its movement toward the escape-orifice, will, unless prevented from so doing, react and by expansion be forced downward. or toward the exhaust-passage leading to the opposite cylinder, and meeting the steam therein will produce back-pressure on the exhaust. To prevent this very defective and objectionable action, common to most blast devices where two or more cylinders are caused to exhaust into a common ejector, and to increase the effective work of the ejector, I provide a compression-chamber to receive and hold the steam as it rebounds or is forced back by the walls of the contracted nozzle, said compression-chamber being maintained in open communication with the nozzle or blast-orifice, and serving both as a receptacle to receive and sustain, in part at least, the back-pressure, and as a reservoir for the storage of power which is expelled, as the pressure of the inducing-blast ceases or diminishes to sustain or supplement said blast, and thereby prolong or increase the power of the ejector.

The apparatus shown in Fig. 5 illustrates one embodiment of this feature of my invention. The ports 18, through which steam is admitted to the outer ejector, are formed near but below the nozzle of the inner ejector, so as to communicate both with the outer nozzle, E′, or the steam-passage leading thereto, and the compression-chamber 19. In the present instance this compression-chamber is located at the base of the outer ejector and below the ports 18, the latter controlled by a valve, 20, arranged to be actuated from the exterior by a rack-and-pinion connection, 21, or other equivalent devices. As thus arranged, when a blast of steam is delivered to the ejector through one of the exhaust-passages, and is directed toward the nozzle of the inner ejector, it flows through the ports 18, and as it is checked or retarded at the contracted mouths of the two ejectors a reaction at once takes place, and as there must be a preponderance of pressure in the central passage, due to the inertia of the larger body of steam, as well as the pressure of the lower end of the column,

the steam enters and is compressed within the chamber 19 until the pressure in the nozzles is diminished, as by the escape of steam therethrough, when it is permitted to escape into the nozzles, thus supplementing and prolonging the primary impulse.

The use of the compression-chamber is not restricted to the particular type of ejector illustrated in Fig. 5, but may be used in connection with a single steam-nozzle or a double ejector provided with a central solid as distinguished from an annular nozzle, as shown in Fig. 8. Here the outer ejector, in all respects substantially the same as that in Fig. 5, is constructed separately from and adapted to be detachably secured to a steam pipe or nozzle, N, steam being conducted to the outer ejector through passages 30, and a space or passage, 31, formed between said pipe N and the outer ejector, through which the gaseous matter is drawn by the central jet or column of steam. In order, however, to carry the exhaust-passages up nearer the nozzle, as well as to increase the capacity of the ejector, I prefer to add to or supplement the ordinary blast-pipe by the insertion of a hollow bridge-wall, 32, in the lower end of said pipe and above the bridge-wall of the exhaust-chamber, with inlet-openings 33 at the sides and an opening, 34, at the top and within pipe N. Extending across the mouth of opening 34, and parallel therewith, is a division-plate, 35, whose opposite edges are beveled or inclined toward the center to form an expanding passage on each side, while below said opening 34 the walls of the passages are slightly converged, as at 36. As thus arranged, the blast of steam from either side is caused to draw a portion of air or gases through the opening at the top of the bridge 32 and discharge into pipe N between the bridge-wall nozzle and passages 30.

The detachable outer ejector, with its compression-chamber, and the bridge-wall 32, with its divison-plate 35, can either or both be applied to the blast-pipes in common use, the only adaption necessary being the formation of suitable openings for the insertion of the bridge-wall and to communicate with passages 30.

Should it for any reason be desired to employ but a single ejector, the valve governing the ports leading to the outer ejector may be closed and the outer ejector removed by withdrawing the fastenings at the base, (see Fig. 5,) or the outer ejector, Fig. 8, can be lifted off and the openings closed by a ring or other suitable means.

Having thus described my invention, what I claim as new is—

1. In an exhaust apparatus of the character described, the combination, with the inner ejector, of a second or outer ejector arranged with its steam-nozzle in advance of the steam-nozzle of the inner ejector, said ejectors receiving steam from a chamber or passage common to both and delivering into a common passage or flue through independent confining-flues, substantially as described.

2. In combination with the smoke-box and the chimney or smoke-stack, an exhaust apparatus, and an adjustable flue interposed between the delivery end of the exhaust apparatus and the passage or opening into the smoke-stack, and co-operating with the latter to close or open direct communication between the smoke-box and smoke-stack, substantially as described.

3. In combination with the smoke-stack and blast or exhaust apparatus, a movable flue interposed between the delivery end of the exhaust apparatus and the opening in the smoke-stack, said flue co-operating with the blast apparatus to form a supplemental ejector, and with the smoke-stack to act as a damper, substantially as described.

4. In combination with the smoke-box or uptake and the smoke-stack of a locomotive-boiler, a blast apparatus receiving steam from the cylinders and containing an inner and an outer ejector, and a vertically-movable flue surrounding the delivery-end of the two ejectors and interposed between the latter and the opening into the smoke stack, substantially as described.

5. In a locomotive-boiler, and in combination with the exhaust apparatus located within the smoke-box, a movable flue interposed between the delivery end of the exhaust apparatus and the opening into the smoke-stack, and co operating with the latter to control the direct draft or passage from smoke-box into the smoke-stack, and adjusting devices convenient to the engineer for actuating said movable flue, substantially as described.

6. In an exhaust apparatus for locomotive and other similar boilers, located within the smoke-box and delivering into the smoke-stack, said exhaust apparatus comprising an inner injector with an inlet opposite the lower series of flues, an outer ejector having its air-inlet above the inlet of the inner ejector, a supplemental confining-chamber into which both ejectors deliver, and an air-inlet to said chamber opening into the upper portion of the smoke-box, substantially as described.

7. In an apparatus such as described, the combination of an inner and an outer ejector, each provided with a separate confining-flue, said confining-flues opening into a flue or passage common to both ejectors, substantially as described.

8. In an apparatus such as described, the combination of an inner ejector provided with air and steam nozzles and a confining-flue, a second ejector surrounding the first-mentioned ejector and provided with an independent air-supply, steam-nozzle, and confining tube or passage, and a confining tube or flue common to both of said ejectors, substantially as described.

9. In an exhaust apparatus such as described, the combination, with an inner ejector com-

municating directly with the steam-supply passages, of a second or outer ejector detachably secured to said inner ejector and receiving steam therefrom, substantially as described.

10. In an ejector or blast apparatus, and in combination with the steam-nozzle thereof, a compression-chamber communicating with the steam-passage below or in rear of the nozzle, substantially as described.

11. In an ejector or blast apparatus wherein exhaust-steam from a cylinder or steam in successive blasts is projected into a passage leading to a nozzle or escape-orifice, and in combination with the latter, a closed compression-chamber communicating with the steam-supply passage, substantially as and for the purpose set forth.

12. In an exhaust apparatus such as described, and in combination with the inner and outer ejectors, their steam passages and nozzles, the compression-chamber communicating with both of said nozzles, substantially as described.

13. In an exhaust apparatus such as described, the combination, with an inner ejector communicating with the exhaust-steam passages, of an outer ejector receiving steam through ports in said inner ejector, a valve controlling said ports, and a compression-chamber connected to said outer ejector below or in rear of said steam-ports, substantially as described.

14. In combination with the cylinders of an engine, and the exhaust-steam passages leading therefrom, an exhaust or blast apparatus such as described, provided with two or more separate ejectors, a steam-passage common to all the ejectors, a hollow bridge or wall intermediate said steam-passage, and the exhaust-steam passages leading to the cylinders, substantially as described.

15. In combination with the two passages or chambers into which the exhaust-steam from the cylinders is delivered, an ejector whose lower or receiving end is divided by a hollow wall into two sections, each communicating with one of the steam-passages leading to the cylinders, and both opening into a common passage leading to the steam-nozzle, substantially as described.

16. In an exhaust apparatus such as described, the combination, with the annular steam-nozzle and central air-tube, of the cross-piece or bridge containing an air-passage communicating with the central air-tube, said cross-piece being provided with inclined upper edges and co-operating with the partition between the exhaust-chambers of the cylinders to convey the exhaust-steam from each cylinder directly to the nozzle, substantially as described.

17. In an exhaust apparatus such as described, and in combination with the inner and outer ejectors and a compression-chamber, separate passages for receiving the exhaust-steam and delivering it directly to the nozzle, substantially as described.

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Witnesses:

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