No. 846,448. PATENTED MAR. 12, 1907.

S. BENSON.

MEANS FOR SEPARATING AND ELIMINATING SMOKE SUSPENDED MATTER.

APPLICATION FILED AUG. 17, 1904. RENEWED JULY 28, 1906.

2 SHEETS—SHEET 1.

Fig. 1.

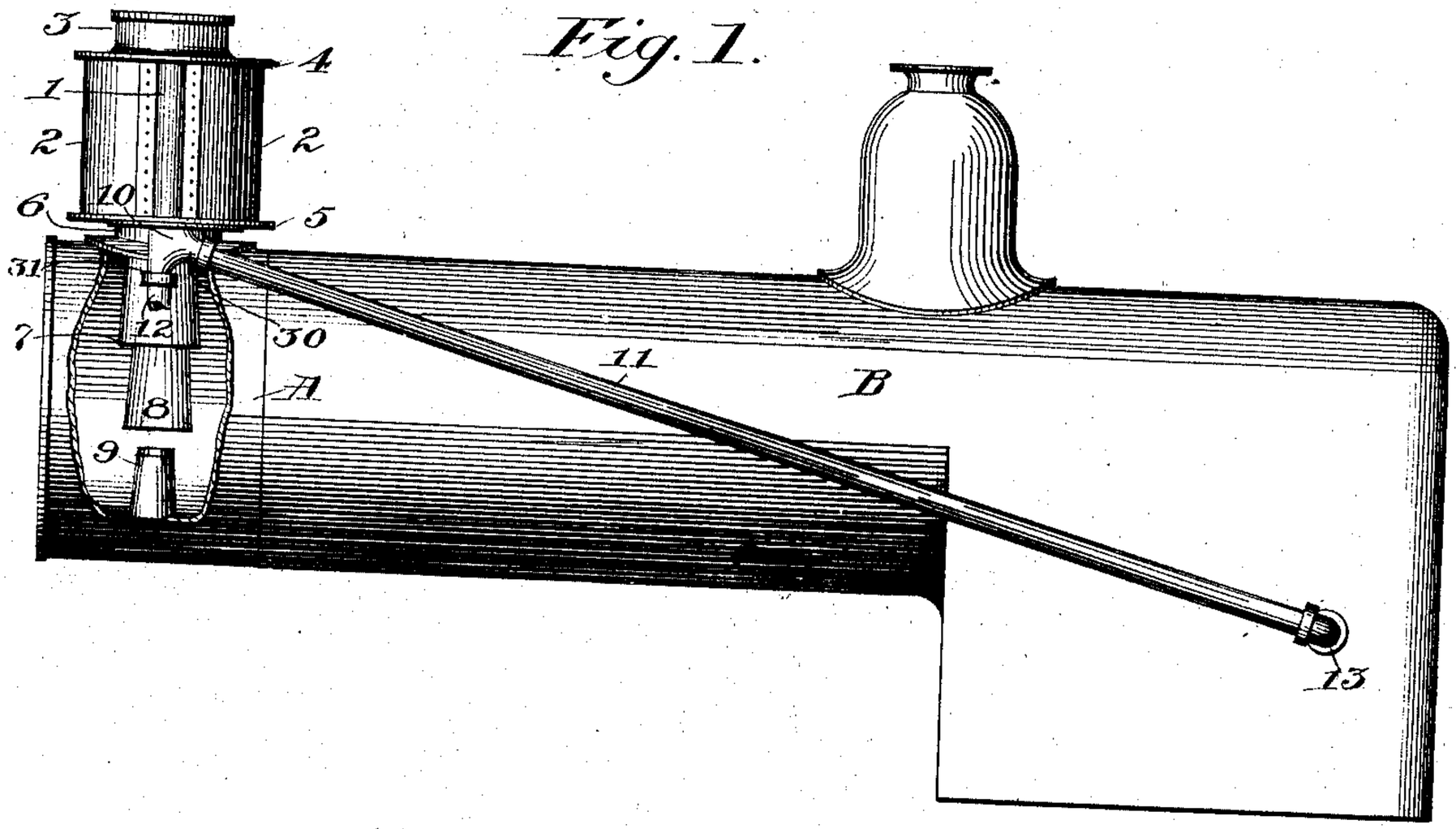
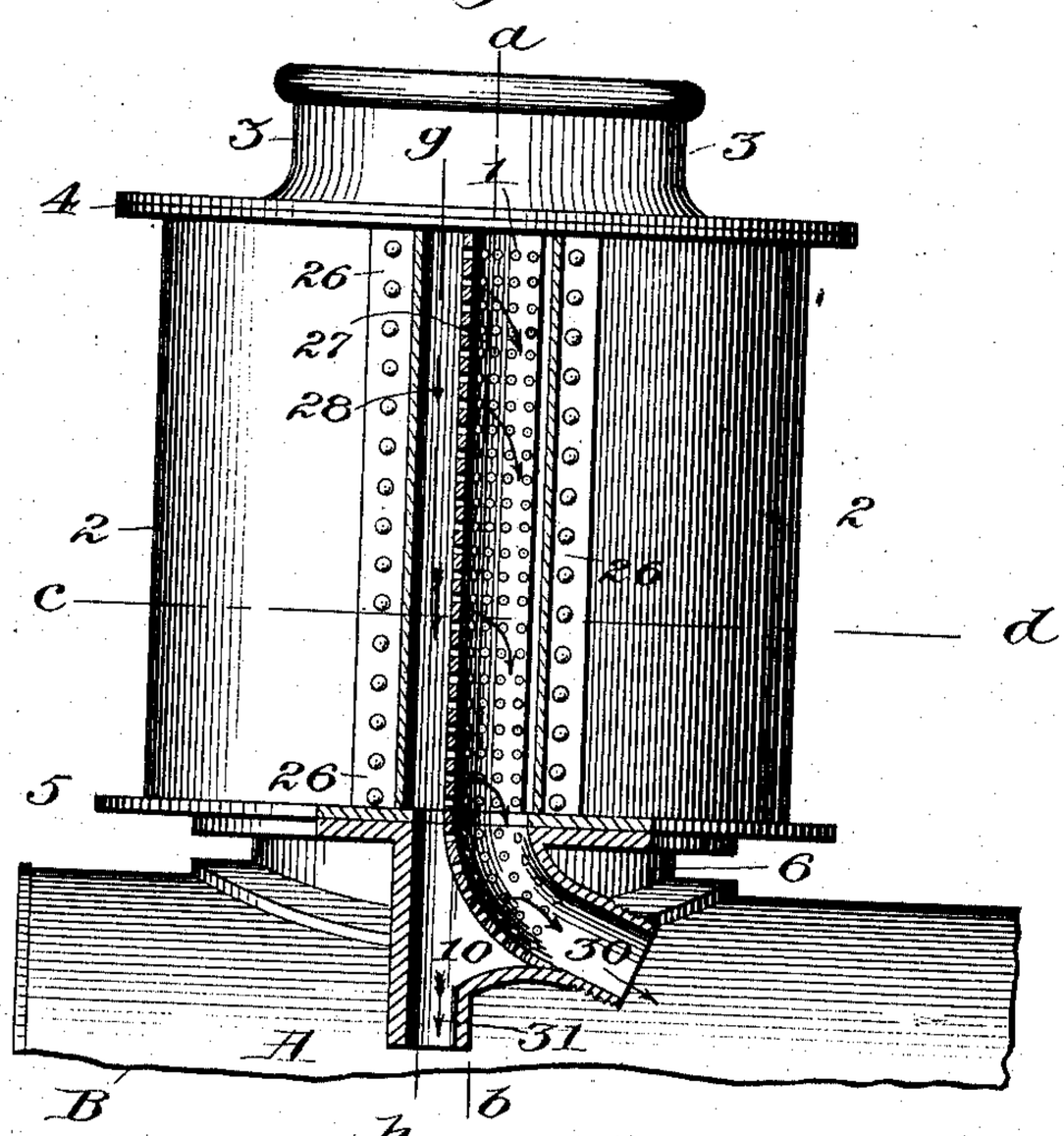


Fig. 2.



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2 SHEETS—SHEET 2.

Fig. 4.

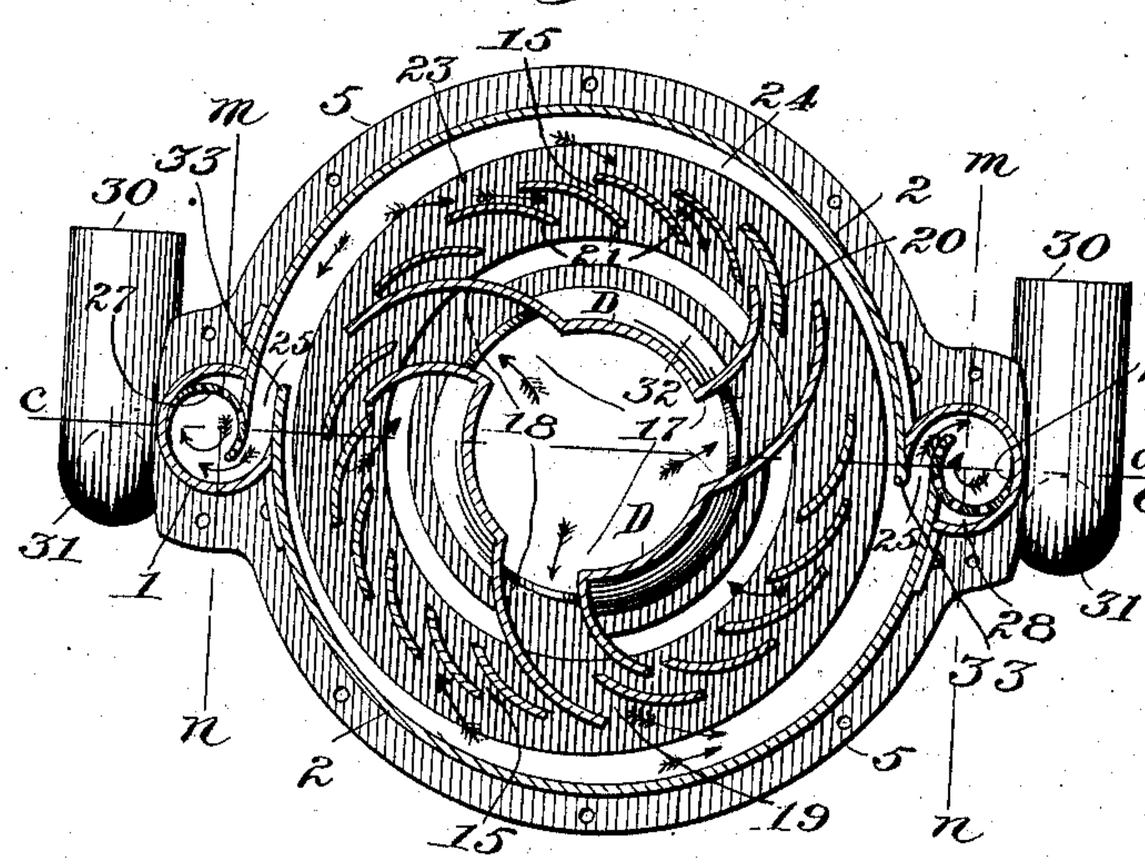


Fig. 6.

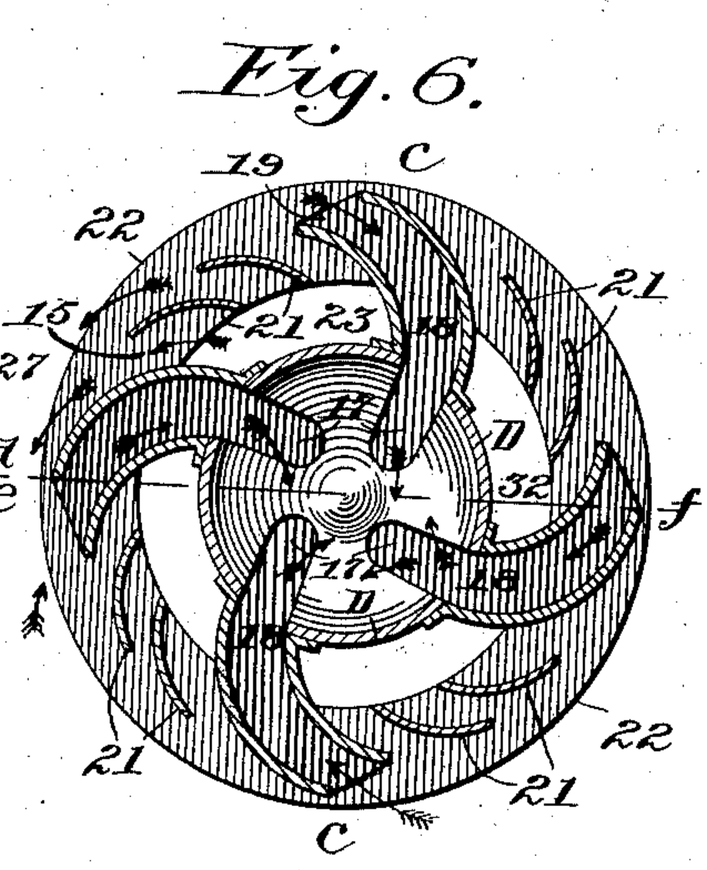


Fig. 3.

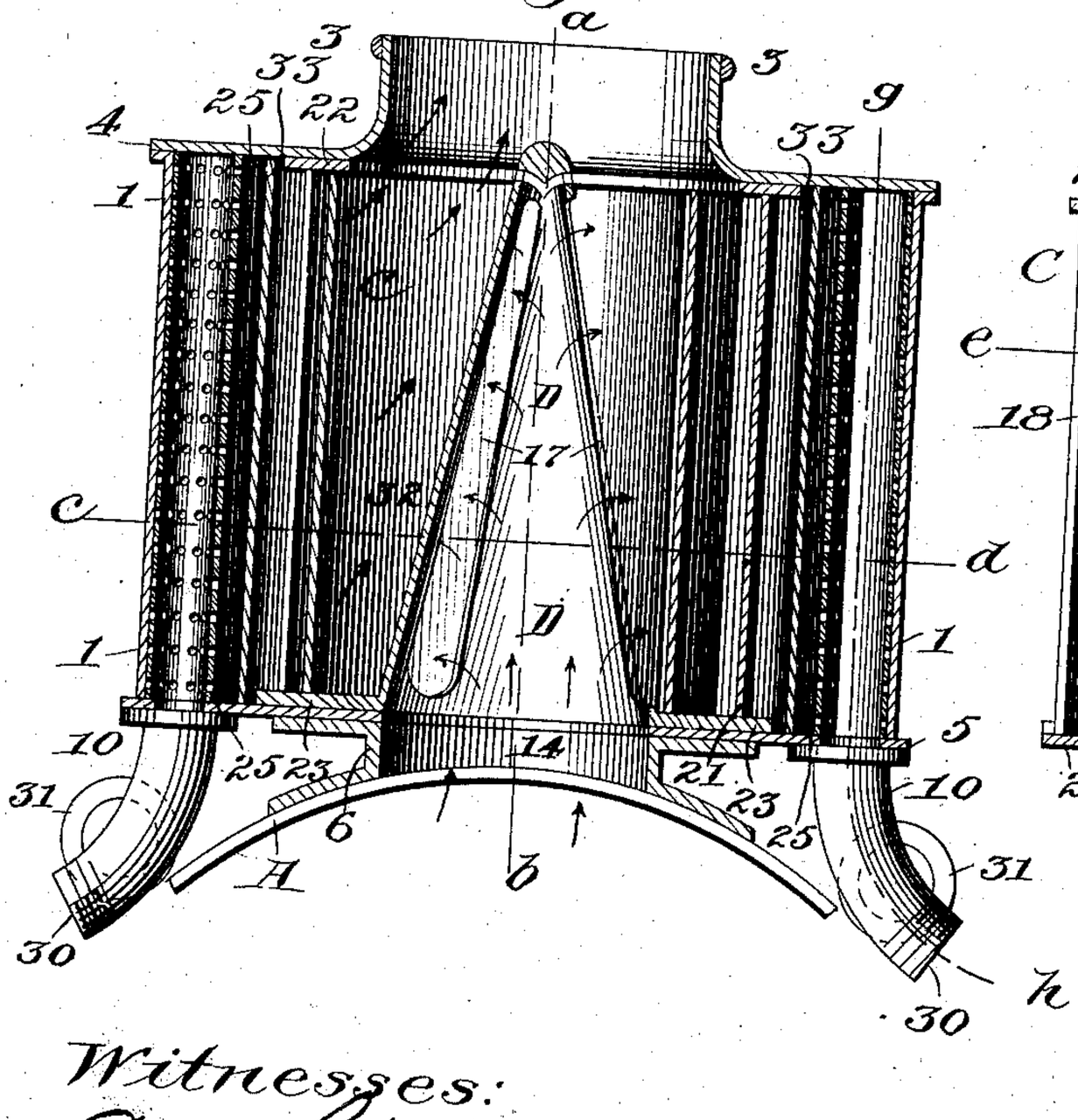
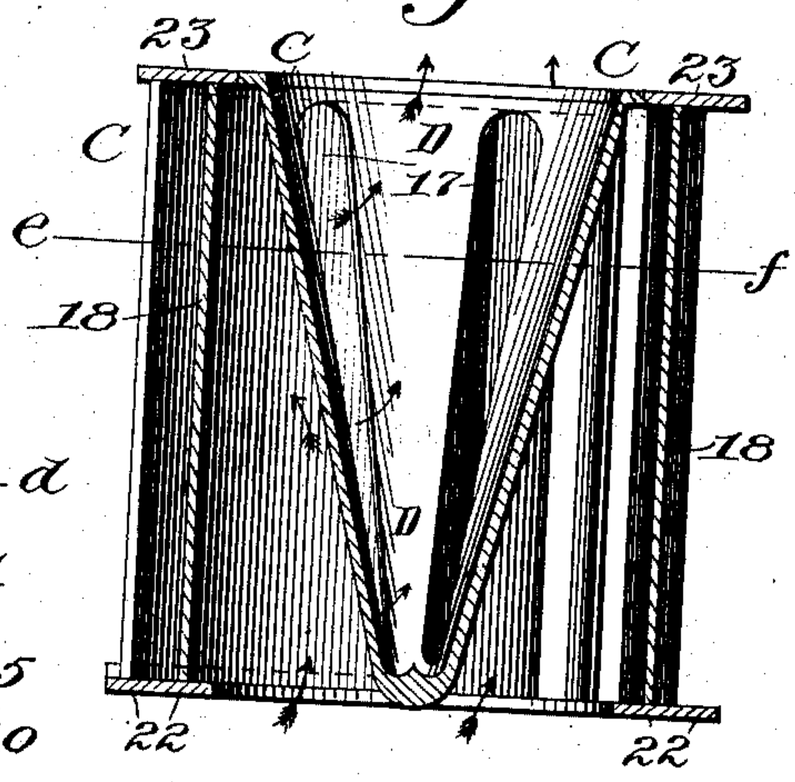


Fig. 5.



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MEANS FOR SEPARATING AND ELIMINATING SMOKE-SUSPENDED MATTER.

No. 846,448. Specification of Letters Patent. Patented March 12, 1907.

Application filed August 17, 1904. Renewed July 28, 1906. Serial No. 328,245.

To all whom it may concern:

Be it known that I, SAMUEL BENSON, a citizen of the United States, residing at 9114 Washington avenue, city of Chicago, county of Cook, and State of Illinois, have invented new and useful Improvements in Means for Separating and Eliminating Smoke-Suspended Matter for Use in Connection with Steam-Boilers, of which the following is a specification.

My invention relates to all steam-generators in which exhaust-steam is used to force the draft.

My object is, first, to automatically separate the gases from the solid products of combustion; second, to automatically return the latter to the furnace to utilize their fuel energy; third, to automatically separate the water resulting from condensation of exhaust-steam and to lead it away, and thus prevent dampening the fire and the formation and adhesion of pasty clots and consequent clogging of the return passages as a result of the water mixing with the solid matter. I attain these objects, primarily, by the application of centrifugal force induced and exerted by the impact of the exhaust-steam upon the smoke within a fixed duplex turbine-wheel, suitably constructed and arranged within the body of the stack, which imparts a rapid horizontal whirling movement to the gases escaping through the curved ports or slots provided around the periphery of the wheel, which is inclosed by a suitable outer casing, against which the heavier matter, water included, is whirled.

The smoke when thus centrifugally filtered is pushed back inwardly and escapes at the usual vent. The heavier matter is driven into a slot or slots provided in the outer casing, communicating with one or more parallel upright cylinders, preferably having an interior volute form, where any free water contained is separated by centrifugal force and the solid matter is led to the furnace and eliminated by combustion.

To avoid confusion with the numerous more or less interblending devices of this class of inventions, I will here briefly define the distinctive features of my invention.

First, the action is automatic throughout. Second, the movement of the deflected draft-currents carrying suspended matter from and to the fire-box is continuous. Hence no provision is made or required for any receptacles for sparks or cinders within or outside of the stack. Third, the usual straight stack beginning at the saddle is dispensed with, and this space is occupied by a cone approximately conforming in height to the outer stack-body, which forms a defining partition-wall between the ascending crude smoke on the inside and the ascending filtered gases on the outside of the cone, Figs. 3 and 4. Fourth, a series of lateral radial hollow arms open into the cone and discharge the crude smoke tangentially at the periphery into the annular space inside the outer cylindrical casing, resulting in a rapid whirl, inducing centrifugal action. Fifth, between the described hollow arms or spokes an alternately-disposed conforming series of deflecting-plates are provided at the periphery adapted to deflect ponderable matter outwardly and to afford suitable passage-ways to the smoke-outlet. Sixth, the cone and attached hollow arms and ports briefly described here, together with suitable attached base and top plates and suitable deflecting members, comprise a fixed duplex turbine-wheel. Seventh, the described turbine-wheel is adapted to distribute radially the crude smoke and discharge it tangentially within the described annular chamber and to impel and project it in a horizontal uniform whirl. Eighth, one or more supplementary centrifugal separating-cylinders conformably and outwardly disposed and secured to the outer stack-body and freely communicating with the whirl-chamber is provided to separate the water and conduct the solid matter toward the fire-box for combustion.

The enumerated and other features are elsewhere more definitely described.

The accompanying drawings illustrate the mechanism employed by me.

Figure 1 is a side elevation of a locomotive-boiler provided with the stack and separating devices, the smoke-box partly broken away to disclose the interior details of construction. Fig. 2 is an enlarged side elevation of the stack, showing in section the separator and a fragment of the boiler. Fig. 3 is a transverse section of Fig. 2 on the line *a b* and shows the interior construction and other details. A vertical mid-section of the separating-cylinder and distributing branch pipes disclosing their interior construction is shown on the lines *g h*, Figs. 2 and 3, corresponding with line *m n*, Fig. 4. Fig. 4 is a transverse section corresponding to Figs. 1, 2, and 3 as seen looking down from the lines

c d, Fig. 3. Fig. 5 is a vertical mid-section of a detached inverted turbine slightly modified, yet mainly corresponding to that shown in Figs. 3 and 4. Fig. 6 is a transverse section of the full figure of Fig. 5 as seen looking down from the line *e f*. It will be understood that the short description involving Figs. 3 and 4 and 5 and 6 applies mainly with direct reference to Figs. 3 and 4, like letters or figures referring to the same or similar parts in the different views.

Arrows show the direction of the draft-currents.

It will be understood that the accompanying simple drawings are intended to disclose and illustrate the novel elements and general scope and operation of my invention rather than as standard designs for an operative structure and that the lines are subject to such obvious modifications as a departure from the cylindrical to a coniform casing and conformable turbine-wheel or in the effacement of the projecting apexes of angles (when objectionable in contour or because obstructive to draft-currents (by the substitution of blending curves between converging lines or otherwise.

Fig. 1 shows the general external appearance of my improved smoke-stack, together with the separator-cylinder 1, the outer casing 2, the smoke-escape pipe 3, the cap-plate 4, the base ring-plate 5, the usual saddle 6, the common petticoat-pipes 7 and 8, and the ordinary exhaust-pipe 9, as seen through the broken-away shell of the smoke-box A. At 10 is shown a receiving-chamber, provided with two outlet branch pipes, having suitable couplings for pipes, the return-pipe 11 being secured thereto, the lower end of which opens into the fire-box through a common air-tube, as at 13 or otherwise. The branch pipe 12, shown broken off below the coupling, is provided to carry away the waste water of condensation and may lead to and discharge within the smoke-box or elsewhere, as required.

In Figs. 2 and 3 are shown a broken-away fragment of a steam-boiler B, upon which is mounted and secured the usual saddle 6, provided with a flange-plate 5, which rests upon and is secured to or may be integral with the usual upper flange of the saddle 6 and is adapted to form a base upon which to secure and include the reversible turbine C and the outer reversible casing 2.

The term "duplex" as herein applied to this turbine-wheel relates to the double and alternating series of passages, cutting through the face of the periphery and conducting oppositely-directed draft-currents, the described functions and construction being novel and essential elements of the general plan herewith disclosed.

The duplex turbine here shown is adapted to receive from the flue 14 the crude smoke and conduct and discharge it tangentially at and through the periphery, then to centrifugally filter and return inwardly the cleansed gases at and through the periphery through a series of suitable approximately radial passages disposed and arranged alternately between the outgoing discharge-passages and to further conduct and eject the gases to and through the outlet 3.

It will be understood that the reversible property of this duplex turbine-wheel is a normal incident, due to the formation and construction resulting from the required functions. Either end may be regarded as the top or head, and the wheel may be constructed and secured in either position, as preferred, the operation being substantially similar.

The cone D or its equivalent may be regarded as the hollow hub of the fixed duplex turbine-wheel C and is provided with hollow arms or spokes 18, conforming to, encircling, and adapted to make radially continuous the slots or ports 17 from the inside of the cone D to the periphery of the turbine C at 19 and vertically to occupy the space between the top and bottom plates 4 and 5 of the outer casing and stack. The hollow spokes or ports 18 are of course closed at the top and bottom and open freely to the inside of the cone D and terminate and open freely outwardly in a curve at the opposite end at and tangent to the periphery of the wheel.

In Fig. 4 three of these arms 18 are shown terminating at the periphery in divisional curved segments 20, extending from top to bottom of discharge-ports 19, providing therefor six discharge-vents.

In Fig. 6 four hollow spokes are shown, having single discharge-openings. Any reasonable number will be practicable, keeping in view necessary arrangement and areas to maintain satisfactory draft conditions and suitable deflecting-surfaces. This wheel may be built up of any obviously suitable materials, secured together, or any preferred group of members may be assembled and cast integrally as may be determined by specific conditions of use and manufacture.

The divisional curved segments 20 or other vertically-disposed members may be secured by flanges and rivets or in any other suitable manner (if not integral) to ring-plates 22 and 23 and are intended to better direct and deflect the draft-currents. The similar segments 21, arranged in series between the hollow spokes 18, as shown, conform in general to the uniform trend of all curves embraced within the orbit in which they are included. In extension, construction, or other particulars the same general description applies as given to segments 20. Between the adjacent curved faces spaces are provided forming ports 15 or other equivalents.

The outer casing 2 may consist of two concentric sheets, each somewhat exceeding a half-circle in circumference and so arranged and secured that the overlapping contiguous ends may have a narrow space between formed by adjacent walls of the opposing sheets 2, as shown at 25, Figs. 3 and 4. The slot 25 so formed will open inwardly toward the smoke-whirl and the open discharge-nozzles 19 of the turbine C. The halves of the outer casing 2 are held and secured in place by means of the flanges 26, which may form an integral part of the separating-cylinder 1, which corresponds in length to the casing 2 and may be riveted, and the whole secured together, as shown in Figs. 1, 2, and 4. The annular cap-plate 4 and base-plate 5 may be extended laterally to cover and include the ends of the cylinders 1 1, as shown.

In most cases one set of separating devices will suffice. In this case a single concentric sheet long enough circumferentially to provide for the overlapping ends to form the slot 25, having said adjacent overlapping ends sprung slightly apart and secured to and by the flanges 26 of the separating-cylinders described and shown in Figs. 1 and 2 and elsewhere may be employed.

The annular space 24 is provided as a raceway and separating-chamber, extending vertically between and closed at the ends by cap-plate 4 and ring-plate 5, the turbine C forming its inner boundary, and the inner wall of the outer casing being its outer limit.

The longitudinal slots 25 in the outer casing 2 open in a direction opposing the discharge whirl-nozzles 19, so as to receive and conduct the heavy suspended matter in the passing smoke-whirl into the separating-cylinder 1 as it is split off by the inner ends of the outer casing or its equivalent at 33.

A semicircular suitably-perforated strip of sheet metal 27 is secured along and parallel to the vertical edge or end of the casing 2, forming one side of the volute slot 25, the opposite corresponding edge of the perforated strip being secured to the wall of the cylinder 1, leaving a semicrescent-shaped opening 28 between the screen 27 and the cylinder 1 for the passage of waste water, as shown in Figs. 2 and 4.

The outward circular circumferential extension of the slots 25 and their boundary-walls assume a volute form adapted to maintain a rapid rotary whirl of the smoke and suspended matter under the continuous impulse of the whirl from the chamber 24 and the suction from the fire-box through return-pipe 11.

In Fig. 4 it will be noticed that the whirl in chamber 24 is from right to left, while in the separating-chambers 1 1 the whirl will be opposite, or from left to right.

A suitable port or passage-way corresponding to the inside of the engaging end of cylinder 1 is provided in the base-ring 5. Secured to the under side of ring 5 is a distributing-chamber 10, Figs. 1, 2, 3, and 4, provided with a cinder-return nozzle 30 and a waste-water nozzle 31 with means for coupling-pipe extensions as required, and also provided with an elbow extension of the screen 27, which thus forms a continuous transverse and longitudinal screened partition from the cap-plate 4 to the nozzle 30.

The operation will be understood from the following explanation: The products of combustion, consisting mainly of gases holding in suspension sparks, cinders, ashes, soot, and steam, more or less condensed, and filling the space above and contiguous to the exhaust-nozzle 9 receive the impact of the exhaust-steam in the usual manner. The lighter matter, comprising particles of ashes, dust, and soot, absorb the cooling steam and tend to collect together, forming denser masses sensitive and responsive to the general laws of motion. These, together with the cinders and any uncombined water, are driven forcibly upward with the draft-current established in the usual manner. The upwardly-diminishing space defined by the impinging walls of cone D tend to compress the confined fluids, which on reacting from this wedge-like lateral thrust against the cone are driven horizontally and radially outward through the slots 17 into and through the hollow spokes 18, and thence escape tangentially through the curved vertical ports 19 into the whirl-chamber 24, as shown in Figs. 3 and 4. Under substantially similar conditions of impulsion, compression, and reaction the crude smoke and suspended matter will enter the whirl-chamber 24 through the curved vertical ports 15 of this duplex turbine-wheel when in the inverted position shown in Figs. 5 and 6. When under the impulse of the tangential rush of crude smoke and suspended matter from the described curved discharge-ports a rapid uniform horizontal whirl results extending from the top to the bottom within the entire free space of the whirl-chamber 24, thus facilitating the combination of the cooling steam with the dust and soot, at the same time inparting therewith an intense centrifugal impulse to any suspended ponderable matter tending to throw it outwardly in a whirling rubbing contact with the inner walls of the outer casing 2. The slightly inwardly projecting vertical edge of the open volute port 25 splits off the dense-matter-laden outer stratum from the whirl, which flashes through said port or slot into the separating-cylinder 1, where under the acquired impulse of the described whirl and the contributory volute form of the impinging walls, together with the downpull of gravity and the draft suction through the return-pipe 11, (or other suitable conduit having free communication with the interior of the fire-box,) a strong downward

spiral whirl will be established within the separating-cylinder 1, tending to scour and clean its inner walls and to throw off tangentially. by centrifugal impulse any uncombined water through the perforated partition-screen 27, which will drain off through the space 28 and nozzle 31, said nozzle to be provided with pipe extensions and fittings, as may be required. The retained solid matter impelled as described will pass downwardly through the nozzle 30, thence will enter the fire-box through the return-pipe 11, as shown in Fig. 1, (or other preferred return-passage,) thus eliminating the combustible matter and utilizing its fuel value.

Having traced the course of the heavier smoke-suspended matter outwardly and downwardly, referring mainly to Figs. 3 and 4, the smoke having let go of its load, as described, and thus released from the intense centrifugal strain, it is steadily forced inwardly by the constant inrush of dense matter-laden smoke, which forms a horizontally-whirling ring, filling the entire transverse and vertical space in the annular chamber 24, said smoke ring inwardly impinging upon suitable peripheral deflecting-surfaces of the wheel arranged and adapted to deflect retained matter into the outer whirl and being thus filtered and clarified enters the escape-ports 15 or their equivalent and passes inwardly through them toward and through spaces 32 between the hollow arms 18 to the usual vent of the stack, as at 3, Figs. 3 and 4.

The individual constituent members of this device may be readily assembled in preferred groups or modified so as to be formed into single castings or may be made up wholly or in part of any suitable sheet metal or castings and constructed and arranged in such relative proportions, position, number, and dimensions as varying sizes or special conditions may determine. Therefore I do not specifically show, claim, or limit myself in the details set forth and reserve the right to use such materials and methods as are in common every-day use in similar work.

Having thus described my automatic centrifugal separator, with means for the separation and elimination of smoke-suspended matter, what I claim as new, and desire to secure by Letters Patent, is—

1. In an apparatus of the class described, a combustion-chamber, means for the escape of products of combustion therefrom, means for centrifugally separating solid particles from the escaping gases, means for separating liquid from the solid particles and fluid-pressure means for returning said solid particles to the combustion-chamber.

2. In an apparatus of the class described, a combustion-chamber, a smoke-box in communication therewith, an exhaust-pipe located in said smoke-box, a casing in communication with said smoke-box and having a smoke-outlet at its top, a separating-cylinder secured exteriorly to the casing and in communication therewith, a fixed turbine-wheel within and spaced away from the casing to form an annular whirl-chamber, said wheel comprising a hollow cone provided with outwardly-extending hollow arms or spokes, the outlet thereof being tangential to the periphery of the wheel said arms forming passage-ways communicating with the smoke-box and the whirl-chamber, a series of deflecting-segments located between the cone and the wall of the casing and means of communication between the separating-cylinder and the combustion-chamber.

3. In an apparatus of the class described, a combustion-chamber, a smoke-box in communication therewith, a casing having an outlet at its top in communication with the smoke-box, a separating-cylinder secured exteriorly to the casing, the ends of the casing-wall and the walls of the separating-chamber being arranged to form a communicating volute slot adapted to cause a whirling motion in the separating-cylinder, a perforated partition screen or wall in the separating-cylinder, means of communication between one side of said wall in the said cylinder and the combustion-chamber and means of communication from the other side of said wall to a suitable offtake and means for producing a rapid rotary or spiral motion of the products of combustion within the said cylinder.

4. In an apparatus of the class described, a combustion-chamber, a smoke-box in communication therewith, an exhaust-pipe arranged in said smoke-box, a casing provided with a smoke-outlet secured to said smoke-box and in communication therewith, a fixed turbine-wheel within and spaced away from the casing, said wheel comprising a hollow cone provided with hollow arms or spokes extending radially and curved tangentially at the periphery, said arms being in communication with the smoke-box and whirl-chamber, annular top and bottom plates in said casing, a series of circumferentially-arranged deflecting members secured between said plates in the spaces between the hollow arms and a separating-cylinder exteriorly secured to the casing and in communication therewith and with the combustion-chamber.

5. In an apparatus of the class described a combustion-chamber, means for the escape of the products of combustion therefrom, a casing associated therewith and provided with a smoke-outlet, smoke-whirling means in said casing, a separating-chamber secured exteriorly to the casing the ends of the casing-wall and the walls of the separating-cylinder being so connected and arranged as to form a volute passage between them, a screen in the separating-cylinder forming a continuation of the said passage, said screen dividing the said separating-chamber into a water-drain

space provided with a suitable outlet and a cinder-chamber and means of communication between said cinder-chamber and the combustion-chamber.

6. In an apparatus of the class described, a combustion-chamber, a smoke-box in communication therewith, an exhaust-pipe in said smoke-box, a casing in communication with the smoke-box, a fixed turbine-wheel within said casing, said wheel comprising a hollow central body provided with outwardly-extending curved hollow arms, said wheel being spaced away from the casing to form an annular whirl-chamber, said hollow arms being in communication with the smoke-box and whirl-chamber, annular top and bottom inclosing plates, spaced plates located therebetween and forming passageways leading from the whirl-chamber to the smoke-outlet therefrom, an approximately cylindrical chamber secured exteriorly to the casing and in communication therewith, means for giving products of combustion a spiral motion therein and means of communication between the said chamber and the combustion-chamber.

7. In an apparatus of the class described, a combustion-chamber, a smoke-box in communication therewith provided with an exhaust-pipe, a casing in communication with said smoke-box having a slot in its side, a separating-chamber provided with a slot in its side secured to the said casing so that the said slots register, said slots establishing communication between the casing and the separating-chamber, means of communication between said separating-chamber and the combustion-chamber, a reversible duplex turbine-wheel within and spaced away from the wall of the casing, said wheel being capable of operation in either fixed vertical position and means of communication between the smoke-box and the smoke-outlet from the casing.

8. In an apparatus of the class described, a combustion-chamber, a smoke-box in communication therewith, a fluid-pressure jet in said smoke-box, one or more petticoat-pipes located in proximity to the said jet, a casing communicating with said pipes having a slot in its side and a smoke-outlet at its top, a separating-chamber provided with a corresponding slot in its side and secured to the casing so that the said slots register, thereby establishing communication between the casing and the separating-chamber, a fixed duplex turbine-wheel within and spaced away from the wall of the casing to form an annular whirl-chamber, primary centrifugal separating means within said chamber, secondary centrifugal separating means within said separating-chamber, communicating tubular draft means connecting the separating-chamber and the combustion-chamber for eliminating combustible matter, tubular means connected with the separating-chamber for the elimination of water, draft means for conducting crude smoke from the combustion-chamber through the turbine-wheel member to the whirl-chamber and draft means for discharging purified smoke through said wheel member and outlet, substantially as described.

9. In an apparatus of the class described, a combustion-chamber, means for the escape of products of combustion therefrom, means for centrifugally separating solid products of combustion from the escaping gases, means for giving the said solid particles a spiral motion and means for returning said solid products to the combustion-chamber in a spirally-moving current.

10. In an apparatus of the class described, a combustion-chamber, means for the escape of products of combustion therefrom, means for the return of a portion of the said products of combustion to the combustion-chamber and fluid-pressure means for propelling the said portion of the products of combustion back to the said chamber in a spirally-moving current through said means.

11. In an apparatus of the class described, a combustion-chamber, means for the escape of products of combustion therefrom, means for producing a rotary or spiral movement of said products, fluid-pressure means to increase the rapidity of said movement, means for separating the outer portion of the whirling body from the inner portion and means whereby said separated outer portion may be given a spiral motion and returned to the combustion-chamber in a spirally-moving current by the action of said fluid-pressure means.

12. In an apparatus of the class described, a combustion-chamber, means for the escape of products of combustion therefrom, a separator in communication therewith for separating unconsumed particles from the escaping gases, said separator comprising a casing and means for giving the products of combustion a rotary or spiral movement within said casing and means of communication between the outer portion of said casing and the combustion-chamber, said means extending throughout the vertical height of said casing, whereby unconsumed particles, carried in the outer portion of the whirling products of combustion within the casing may be returned to the combustion-chamber.

13. In an apparatus of the class described, means for separating solid particles from products of combustion, said means comprising a casing, means for giving said products of combustion a rotary or spiral movement therein, the peripheral wall of said casing being provided with a slot extending throughout the height thereof, and one or more offset lips on the periphery of said cas-

ing adjacent said slots for separating the outer portion of said whirling body from the inner portion, substantially as described.

14. In an apparatus of the class described, means for separating solid particles from products of combustion, said means comprising a casing, means for giving said products of combustion a rotary or spiral movement therein, the peripheral wall of said casing being provided with a slot extending throughout the height thereof, means for deflecting solid particles outwardly and one or more offset lips on the periphery of said casing adjacent said slots for separating the outer portion of said whirling body from the inner portion.

15. In an apparatus of the class described, means for separating solid particles from products of combustion, said means comprising a vertically-disposed casing, a fixed turbine-wheel within and spaced away from the walls of the casing to form an annular whirl-chamber between the said wheel and wall, said wheel comprising a hollow cone provided with hollow curved arms outwardly extending therefrom, said wall being provided with one or more slots extending throughout the vertical height of said casing, and one or more offset lips on the inner periphery of said casing adjacent said slot or slots to separate and deflect the outer portion of the products of combustion within the casing from the inner portion.

16. In an apparatus of the class described, a combustion-chamber, a smoke-box connected therewith, a vertically-disposed casing connected with said smoke-box and having a smoke-outlet at its top, a separating-cylinder secured to the said casing and communicating therewith throughout the vertical height thereof, offset lips adjacent said means of communication, a fixed turbine-wheel within and spaced away from the walls of said casing to form an annular whirl-chamber, said wheel comprising a hollow cone provided with hollow curved arms or spokes extending outwardly therefrom to form passage-ways from the smoke-box to the whirl-chamber and means of communication between the said separating-cylinder and the said combustion-chamber.

17. In an apparatus of the class described, a combustion-chamber, a smoke-box in communication therewith, a vertically-disposed casing suitably secured to the said smoke-box and having a smoke-outlet, a separating-cylinder secured exteriorly to the casing and communicating therewith throughout the vertical height of the latter, offset lips adjacent said means of communication, a fixed turbine-wheel within and spaced away from the walls of the casing to form a whirl-chamber, said wheel comprising a hollow cone provided with hollow curved arms or spokes extending outwardly therefrom to form passage-ways from the smoke-box to the whirl-chamber, one or more deflecting elements for throwing solid particles outwardly and means of communication between the separating-cylinder and the combustion-chamber.

18. In an apparatus of the class described, a combustion-chamber, a smoke-outlet therefrom, a vertically-disposed casing in communication with said smoke-outlet, said casing being provided with one or more slots in its peripheral wall extending throughout the vertical height thereof, one edge of said slot being nearer the center of said casing than the other edge, whereby the first-named edge forms an offset lip, a separating-cylinder secured to the said casing and communicating therewith through said slot, a fixed turbine-wheel within and spaced away from the walls of the casing to form an annular whirl-chamber, said wheel comprising a hollow cone provided with radially-disposed hollow arms or spokes forming passage-ways leading from the smoke-outlet to the whirl-chamber and means of communication between said cylinder and the combustion-chamber.

19. In an apparatus of the class described, a combustion-chamber, a smoke-box in communication therewith, a fluid-pressure jet located in said smoke-box, a vertically-disposed casing in communication with said smoke-box and having a smoke-outlet at its top, said casing being provided with a slot in its peripheral wall extending throughout the vertical height thereof, one edge of said slot outstanding from said peripheral wall to form an offset lip, a separating-cylinder secured exteriorly to the said casing and in communication therewith through said slot, said offset lip serving to split off and switch smoke-suspended matter into the said separating-cylinder, a fixed turbine-wheel within and spaced away from the walls of the casing to form an annular whirl-chamber, said wheel comprising a hollow cone provided with hollow tangentially-curved arms or spokes extending outwardly therefrom, communicating with the smoke-box and whirl-chamber and means of communication between the separating-chamber and the combustion-chamber.

In testimony whereof I affix my signature in presence of two witnesses.

SAMUEL BENSON.

Witnesses:

JOHN MAYHEW,

FRANK FOSTER.