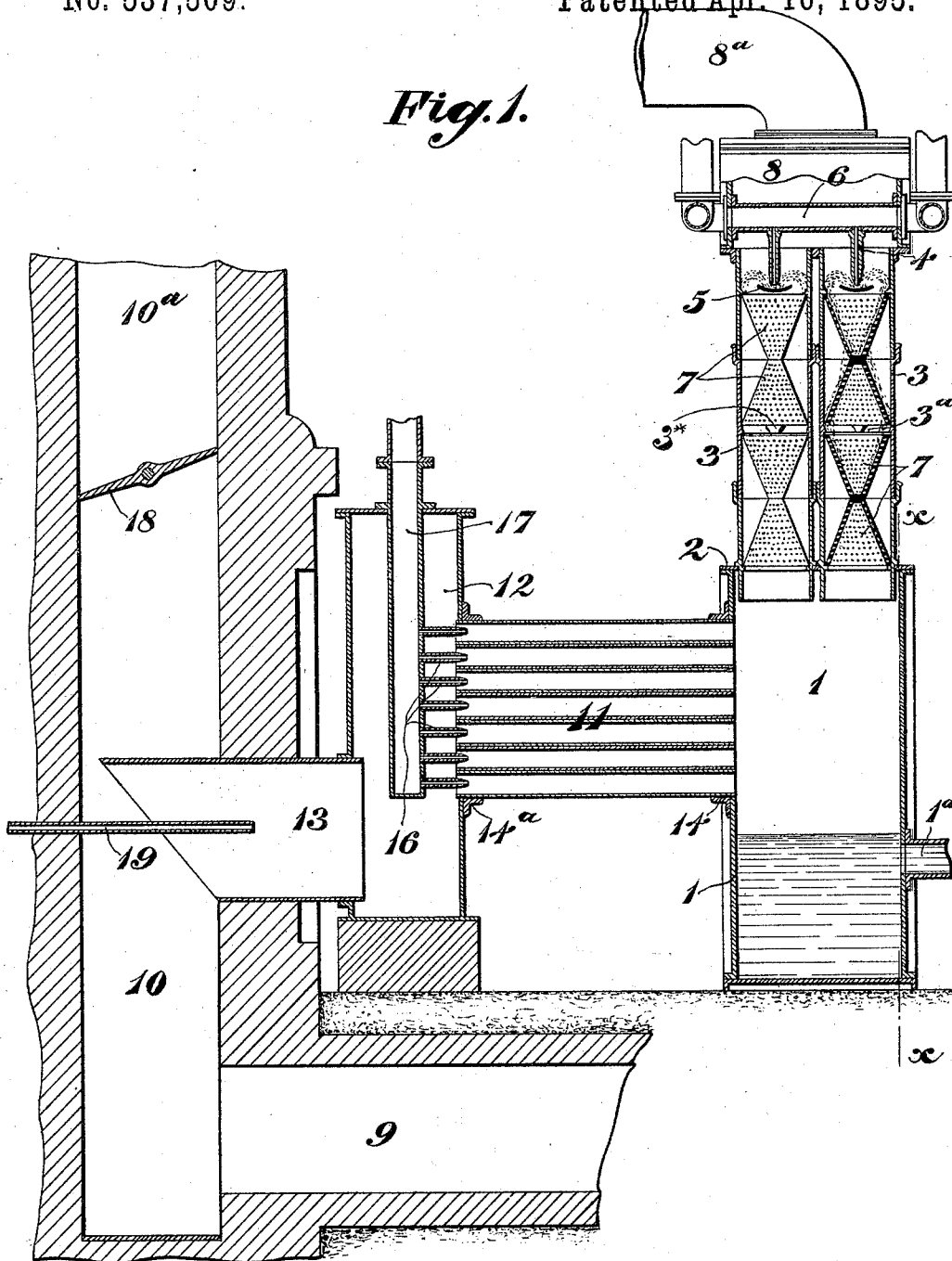


E. WARDLE & J. H. EVERS.
APPARATUS FOR WASHING SMOKE.

No. 537,509.

Patented Apr. 16, 1895.

Fig. 1.



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(No Model.)

5 Sheets—Sheet 2.

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Fig. 2.

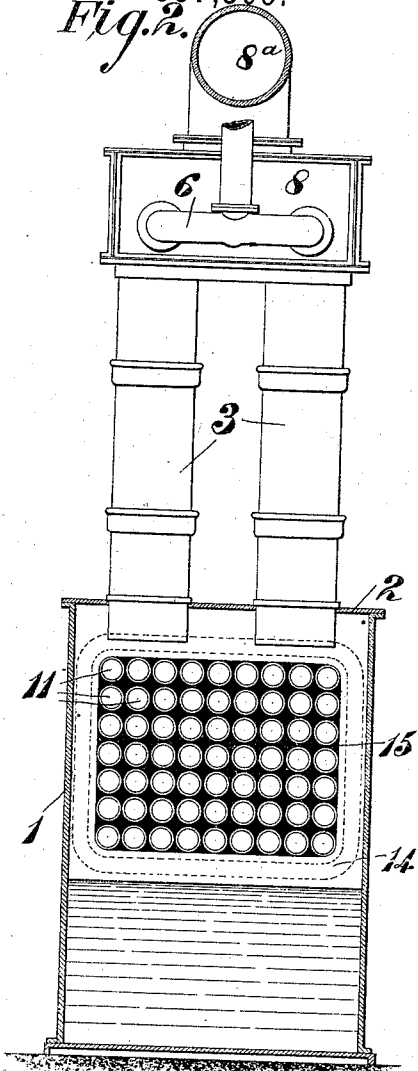


Fig. 3.

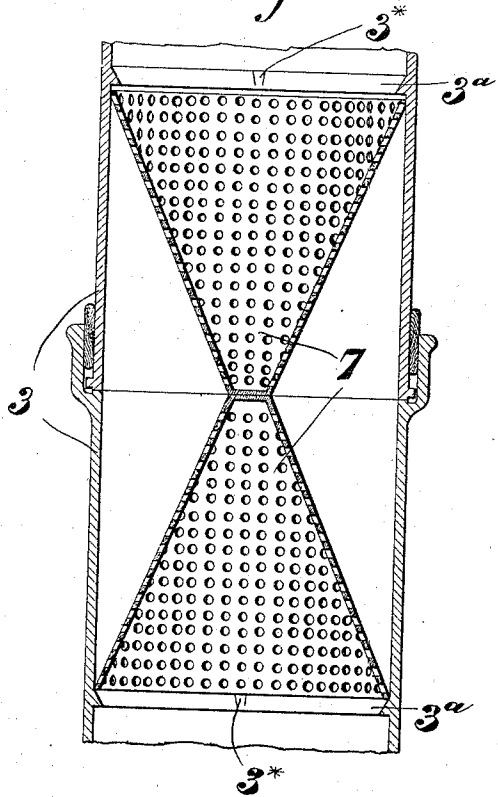
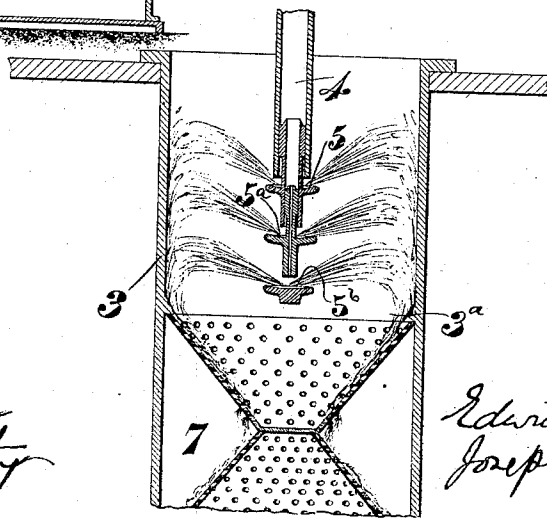


Fig. 7.



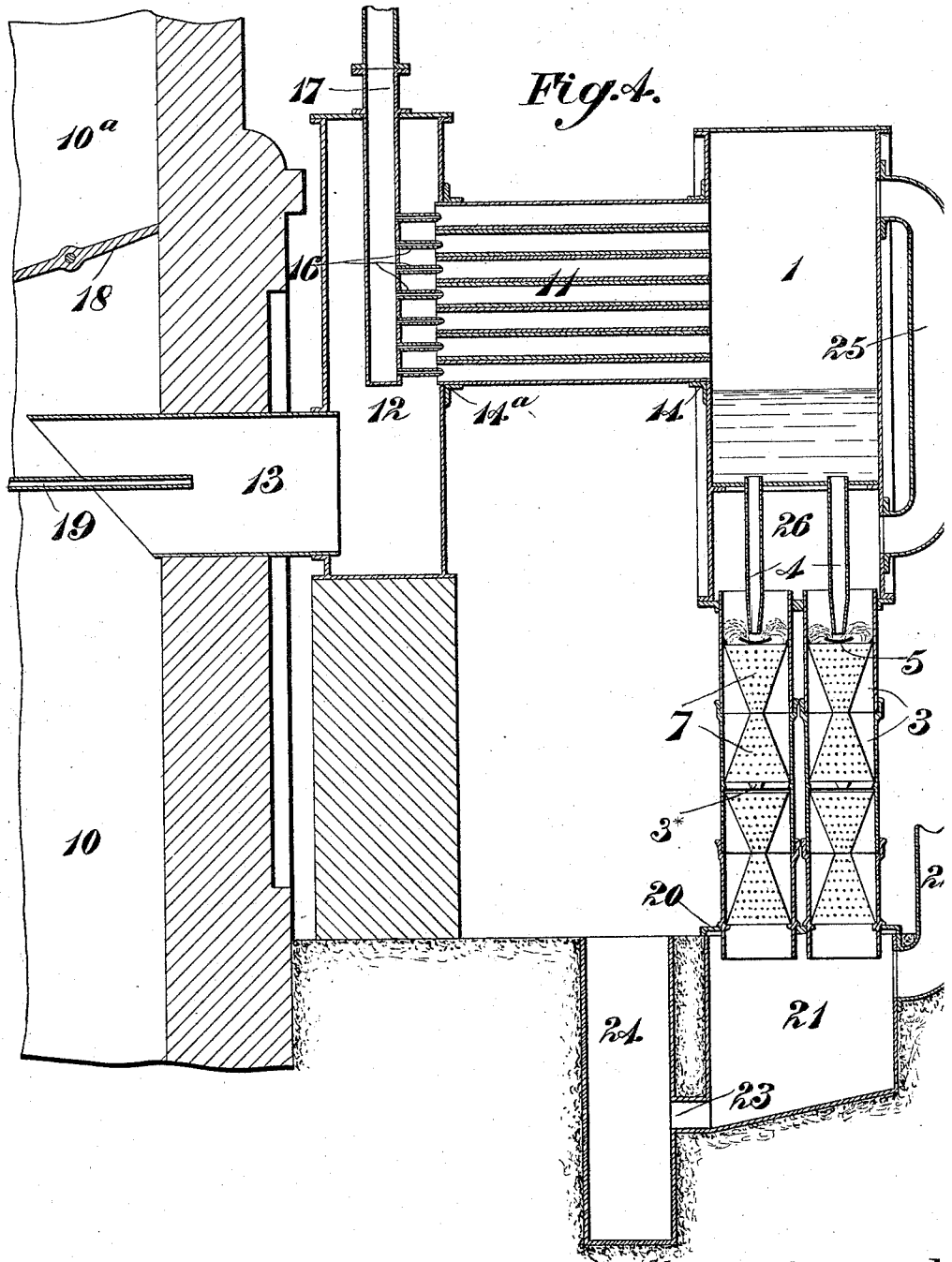
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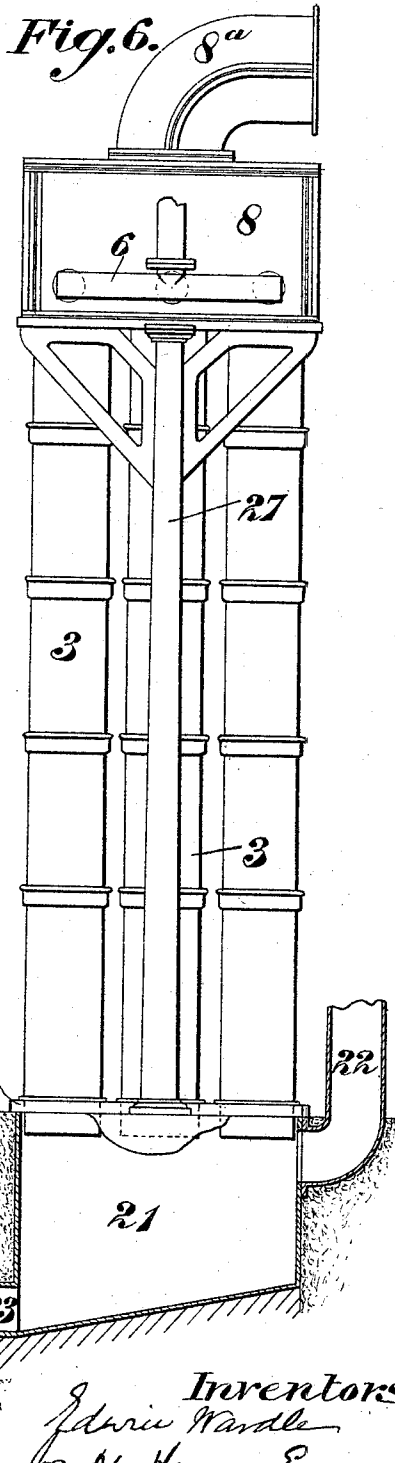
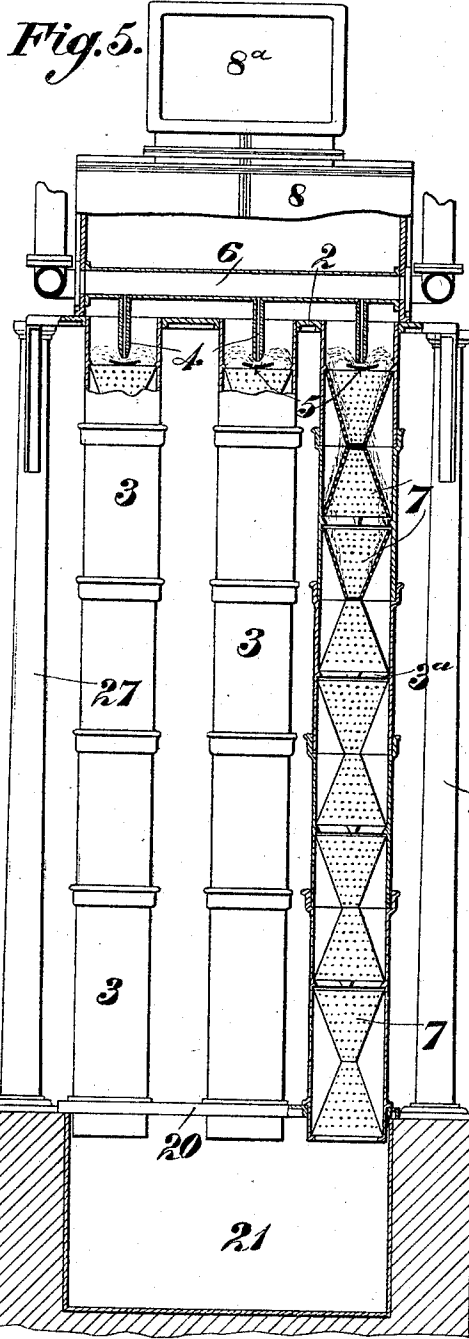
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Fig. 8.

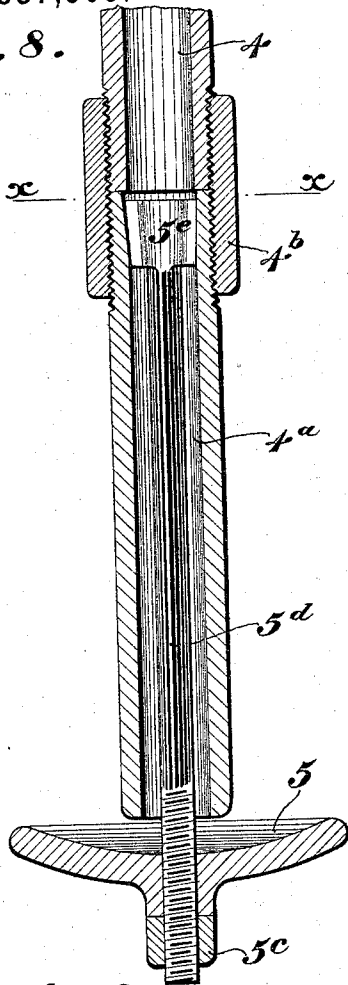


Fig. 10.

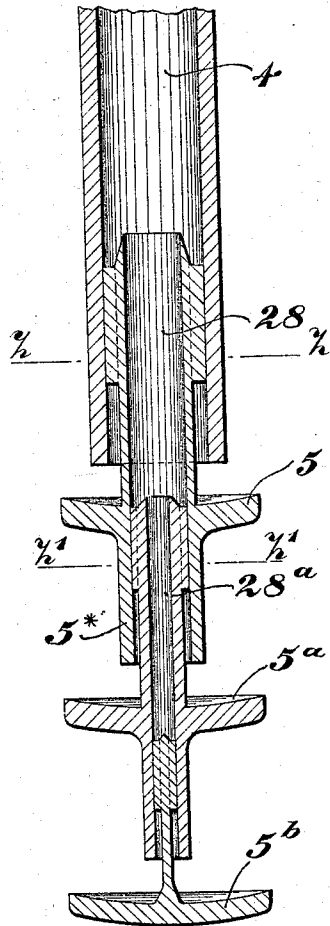


Fig. 9.

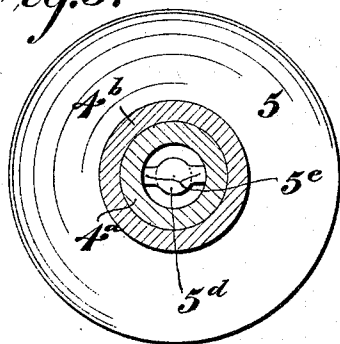


Fig. 11.

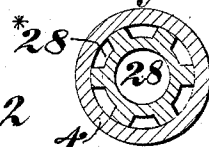
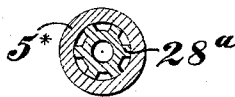


Fig. 12



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UNITED STATES PATENT OFFICE.

EDWIN WARDLE AND JOSEPH HENRY EVERS, OF LEEDS, ENGLAND.

APPARATUS FOR WASHING SMOKE.

SPECIFICATION forming part of Letters Patent No. 537,509, dated April 16, 1895.

Application filed May 8, 1894. Serial No. 510,520. (No model.) Patented in England December 20, 1892, No. 23,497; in France March 19, 1894, No. 237,140; in Belgium March 30, 1894, No. 109,263; in Canada June 1, 1894, No. 46,208, and in Italy June 30, 1894, LXXI, 294.

To all whom it may concern:

Be it known that we, EDWIN WARDLE, residing at Boyne Engine Works, and JOSEPH HENRY EVERS, residing at Middleton Crescent, Leeds, in the county of York, England, subjects of the Queen of Great Britain and Ireland, have invented improvements in apparatus for washing the smoke and gaseous products escaping from boiler and other furnaces and for increasing the draft in such furnaces, (patented in Great Britain December 20, 1892, No. 23,497; in France March 19, 1894, No. 237,140; in Belgium March 30, 1894, No. 109,263; in Italy June 30, 1894, Reg. Att. Vol. LXXI, No. 294, and in Canada June 1, 1894, No. 46,208,) of which the following is a specification.

This invention has reference to improved constructions and arrangements of apparatus whereby smoke, hot gases and products of combustion (hereinafter referred to as gaseous products) can, while on their way from a boiler or other furnace to the atmosphere, be effectually washed for the purpose of removing therefrom, smoke and deleterious or noxious vapors or gases, so that the remaining gases shall be rendered innocuous before escaping into the atmosphere; and in order that the invention may be fully understood we will no describe with reference to the illustrative drawings, the best ways known to us of carrying it into practical effect.

Figure 1 is a vertical section of apparatus constructed according to this invention, shown applied to the flue of a furnace. Fig. 2 is an end view partly in vertical section on the line $x x$, Fig. 1. Fig. 3 is a vertical section, to a larger scale, showing a portion of a washing tube with a pair of hollow truncated perforated cones therein. Fig. 4 is a similar view to Fig. 1, showing a modified arrangement. Figs. 5 and 6 are sectional views at right angles to each other showing a further modified arrangement of smoke washing apparatus according to this invention. Fig. 7 is a vertical section showing part of a washing tube with compound nozzle and baffles. Figs. 8 and 9 are respectively a central vertical section partly in elevation and a horizon-

tal section on the line $x x$ of Fig. 8, showing a construction of simple nozzle and baffle according to this invention. Fig. 10 shows in central vertical section, and to a larger scale, the construction of compound nozzle and baffles shown in Fig. 7. Figs. 11 and 12 are cross sections on the line $z z$ and $z' z'$ respectively of Fig. 10.

Referring to Figs. 1 to 3 inclusive, 1 is a metal casing or chamber to the top of which is secured a tube plate 2 carrying vertical tubes 3 in the upper part of each of which is arranged a depending water nozzle 4 below the lower open end of which is a fixed baffle plate 5, the arrangement being such that water escaping from the nozzles will issue in the form of broad sheets that will extend to the inner sides of the tubes and through or between and in contact with which the gaseous products are compelled to pass on their way to the atmosphere. 6, 6 are water supply pipes connected to the said nozzles and to an external water pipe or pipes, tank or other suitable source of supply. Each tube 3 is provided below the water nozzle 4 and baffle plate 5 with a series of independent pairs of superimposed perforated truncated cones 7 each closed at its smaller end, the upper cone of each pair being inverted as shown, and the lowest of each pair being carried by a rib or shoulder 3^a on the inner side of the tube 3, the arrangement of the cones in each tube being such as to form a zig-zag or circuitous passage through which the gaseous products flow or are forced in an upward direction while the water flows downward in a zig-zag direction first through one cone and then over the next and so on, so as to more or less close the holes in the cones with the result that the gaseous products in passing through the holes, will be brought into intimate contact with the water so as to be effectually washed thereby, the passage of the gaseous products through the annular sheet (or sheets) of water escaping from the nozzles finally completing the washing operation. To insure that the water flowing over the outer surface of the lowest of each pair of cones shall not flow down the inner surface of the tube 3 and so cease to

act in the manner described to wash the gaseous products flowing through the tube each annular rib or shoulder 3^a (which is preferably cast in one piece with the length of tube 3 carrying it) is made to incline inwardly as shown in Fig. 3 so as to overlap the top edge of the perforated cone 7 below it and thus direct the washing water into such cone.

In the example now being described, there are four washing tubes each provided with a series of perforated truncated cones 7. To the upper ends of the tubes 3, each of which may conveniently consist of several lengths of pipe connected together by spigot and socket joints as shown, or by bolts and nuts through flanges, is secured a casing 8 from which the washed gaseous products are led by a pipe 8^a. The metal casing 1 is or may be provided with a hinged or removable door, not shown, by opening which access can be gained, when necessary, to the interior of the casing. The bottom of the casing serves, as shown, as a receptacle for water that has been used for washing the gaseous products, and which therefore, contains carbonaceous and other impurities removed therefrom. 1^a is an outlet through which this water can either escape, or be pumped back into the pipes 6 and be used over again. The intermediate portion of the casing 1 is, in this arrangement, connected with the furnace flue 9 and the lower part 10 of the chimney by a series of horizontal tubes 11, a casing 12, and a connecting flue 13. The tubes 11, in the example shown, are arranged close together, and are held at their ends within suitable frames 14 and 14^a that are fixed to the casings 1 and 12 respectively, the interstices between the tubes being filled with a suitable filling material 15 such as cement. Into each tube 11 projects a nozzle 16 connected to a pipe 17 to which water under pressure is supplied, the arrangement being such that the water issuing from the nozzles, will induce the gaseous products to flow through the flues and tubes 11 into the casing 1, and thence through the tubes 3, wherein they will be washed as hereinbefore described the purified gaseous products then flowing away through the pipe 8^a, it may be into the upper part 10^a, of the chimney and thence to the external atmosphere; or they may be sent into the atmosphere direct without passing into the said chimney. The water issuing through the nozzles 16 will also aid in washing the gaseous products while passing through the tubes 11.

18 is a valve arranged within the chimney. When closed, this valve serves to separate the upper and lower parts 10, 10^a of the chimney from each other, so that the gaseous products are compelled to pass through the washing apparatus. By opening it, the gaseous products can, when desired, be passed direct into the external atmosphere. 19 is a nozzle through which a jet of exhaust or live steam can be caused to issue for the purpose of aiding or increasing the draft of the furnace and

the passage of the gaseous products through the washing apparatus.

Washing tubes 3 with perforated cones 7, over which the washing water flows and through which the gaseous products pass as described, can be constructed and arranged in various ways. Thus Fig. 4 shows an arrangement in which the washing tubes 3 with hollow perforated truncated cones 7 are arranged below the casing or chamber 1, and are carried by a tube plate 20 that forms the top of a chamber 21 provided with an outlet pipe 22 for the washed gaseous products and with an outlet 23 through which the water and impurities removed from the gaseous products pass into a receptacle 24. In the bottom of this receptacle the said impurities can be collected, while the supernatant water can be drawn off for re-use. In this arrangement the gaseous products are led from the casing 1 through a pipe 25 to a casing 26 arranged between the bottom of the casing 1 and the tube plate 2 in which the upper end of the tubes 3 are fitted, and the water entering the casing 1 from the tubes 11 is discharged through nozzles 4, traversing the casing 26, against the baffles 5 in the upper ends of the tubes 3. The gaseous products in this arrangement pass downward through the tubes 3 in the same direction as the washing water instead of upward as in the previously described arrangement.

In the modified arrangement shown in Figs. 5 and 6, the washing tubes 3, of which nine are shown, are secured at the top to a tube plate 2, forming the bottom of a casing 8 that carries the water supply pipes 6 and nozzles 4 as in Fig. 1, the lower ends of the said tubes 3 being carried by a tube plate 20 that forms the top of a chamber 21 provided with an outlet pipe 22 for the washed gaseous products, and with an outlet 23 through which the water and impurities pass into a receptacle 24 as in the arrangement shown in Fig. 4, the said casing 8 being carried by pillars 27 and provided with an inlet pipe 8^a for gaseous products.

As will be obvious the number of washing tubes 3 employed can be varied to suit requirement. In some cases only one of such tubes with perforated cones 7 may be used. The said tubes may be of any desired size say from six inches to three feet in diameter. The perforated cones may also be varied in number and size to suit requirement. Instead of passing the gaseous products downward through the tubes 3, they may obviously be passed upward therethrough if desired.

Instead of providing each water nozzle 4 with a single baffle 5 as in the arrangements hereinbefore described, it may be provided with a series of baffles 5, 5^a, 5^b as in the example shown in vertical section in Fig. 7, so that a number of annular sheets of water will be obtained from each nozzle.

The water nozzles 4 and baffle plates 5 shown in Figs. 1 to 6 inclusive may be con-

constructed and arranged as shown to a larger scale in Figs. 8 and 9. Each nozzle is made in two parts of which the upper part 4 is in one with or secured to the corresponding water supply pipe 6, and is connected to the lower part 4^a by a screw-threaded sleeve 4^b. The baffle plate 5 is supported centrally below the nozzle by a nut 5^c screwed on the lower end of a rod 5^d which passes through the lower part 4^a of the nozzle, and has its upper end formed with a T-shaped head 5^e the sides of which are tapered, and simply rest in the correspondingly tapered upper end of the lower part 4^a of the nozzle.

In the modified construction shown in Figs. 10, 11 and 12 the upper baffle plate 5 is carried by a tube 28 the upper end of which is enlarged and fixed in the lower end of the nozzle 4, vertical passages 28* being formed in the said enlarged end of the tube for the passage of water to the corresponding baffle plate. The next lowermost baffle 5^a is supported by a similar tube 28^a fixed in the lower tubular extension 5* of the baffle plate 5, while the lowermost baffle plate 5^b may be carried by the lower tubular extension of the baffle plate 5^a as shown, or by an attachment to the inner side of the corresponding tube 3.

Although it is advantageous to supply the washing water to the tubes 3 and cones 7 through nozzles 4 provided with a baffle 5 (or baffles) as described and shown, it is to be clearly understood that the water may be introduced into the tubes in any other suitable way, as for example from a rose, or a perforated pipe, or through a perforated plate, arranged either in each tube 3 or outside and above the same as may be desired.

Although in the drawings the casing or chamber 1 is shown as made of plate metal, it will be obvious that it may when desired, as where intensely heated gases have to be dealt with, be built of suitable refractory material such as fire-brick. In cases where there is not much heat, the upper portion of the casing may be of wood. The tubes 3 and the perforated cones therein may also be made of refractory material, such as fire clay where intensely heated gases have to be dealt with, while in other cases they may be of other material such as metal or wood.

What we claim is—

1. In apparatus for washing smoke and gaseous products, a washing tube provided with inclined perforated surfaces arranged to form a zig-zag passage over which water can be caused to flow, in combination with a furnace flue 9, leading to one end, and a passage 8^a communicating with a chimney 10 from the other end, and means for supplying water, and means for conveying away the water after its traverse over the several surfaces, to be re-used or otherwise disposed of, all substantially as herein described and for the purpose specified.

2. In apparatus for washing smoke and gase-

ous products, a washing tube provided with perforated hollow bodies of double taper form, said bodies being arranged one above another so that washing water will flow over the inner surface of one and over the outer surface of the next and so on in a zig-zag manner, in combination with means for aiding the motion of the gases, and with a damper 13 located in the flue above the branch pipe 13 for allowing the gases to flow directly to the chimney when desired, all substantially as herein described and for the purpose specified.

3. In apparatus for washing smoke and gaseous products, a washing tube provided with internal guide ribs and fitted with perforated hollow bodies having inclined surfaces and arranged in reversed positions one above another with the upper open end of each alternate one located beneath one of said ribs and the lower end of the intermediate one resting on such rib so as to enable the said ribs to perform the double functions of deflecting the water inward as it trickles down the interior of the tube, and of supporting the said hollow bodies, all arranged for joint operation, substantially as herein described for the purpose specified.

4. In apparatus for washing smoke and gaseous products, a washing tube through which the smoke and gaseous products are to flow, one or more water nozzles arranged within said tube, and a baffle or baffles arranged opposite said nozzle or nozzles so that water will issue therefrom in a form of a sheet or sheets that will extend to the inner surface of said tube substantially as herein described for the purpose specified.

5. Apparatus for washing smoke and gaseous products, comprising one or more tubes each adapted to be placed in communication at one end with a furnace flue and at the other end with a chimney or with the external atmosphere, perforated bodies of hollow conical form in axial section arranged one above another within said tube or tubes so as to form a zig-zag passage therein, and water supply apparatus for discharging water into the upper end or ends of said tube or tubes substantially as herein described.

6. Apparatus for washing smoke and gaseous products, comprising a plurality of vertical washing tubes each fitted with perforated bodies of hollow conical form in axial section arranged one above another so as to form a zig-zag passage, an inlet chamber adapted to be placed in communication with a furnace flue and common to the inlet ends of said tubes, an outlet chamber common to the outlet ends of said tubes and provided with an outlet branch, and means for supplying water to the upper ends of said tubes, substantially as herein described.

7. In apparatus for washing smoke and gaseous products, the combination with one or more vertical washing tubes and an inlet chamber with which said tube or tubes com-

municate, of a second chamber adapted to be placed in communication with a furnace flue, a plurality of horizontal tubes connecting said chambers, and a plurality of water nozzles carried by a water supply vessel and arranged to project water into said horizontal tubes substantially as herein described for the purpose specified.

8. Apparatus for washing smoke and gaseous products from furnaces, comprising a plurality of vertical washing tubes each fitted with perforated bodies of hollow conical form in axial section arranged one above another so as to form a zig-zag passage, inlet and outlet chambers common to said tubes, means for supplying water to the upper ends of said washing tubes, a third chamber adapted to be placed in communication with a furnace flue, a plurality of horizontal tubes connecting said inlet and third chambers, and a plurality of nozzles carried by a water supply vessel and arranged to project water into said horizontal tubes substantially as herein described for the purpose specified.

9. Apparatus for washing smoke and gaseous products from furnaces, comprising one or more washing tubes provided or each provided with inner horizontal guide ribs a water nozzle and baffle, and perforated hollow truncated cones arranged one above the other in pairs with the upper open end of one of the cones of each pair below one of said guide ribs, and inlet and outlet chambers in communication with the respective

ends of said tube or tubes, substantially as herein described for the purpose specified.

10. Apparatus for washing smoke and gaseous products comprising washing tubes 3 provided with internal ribs 3^a and fitted with superimposed pairs of hollow truncated cones 7 having closed smaller ends, upper and lower chambers 8 and 21 common to said tubes and provided with branches 8^a and 22 respectively, water supply pipes 6 located in said chamber 8 and provided with nozzles 4 and baffles 5 arranged in the upper ends of said tubes, and a receptacle 24 connected with said chamber 21 substantially as herein described for the purpose specified.

11. In apparatus for washing smoke and gaseous products, a washing tube provided with a compound water nozzle, comprising several tubes fixed one within the other with water passages between them and each projecting beyond the tube that carries it, and annular baffle plates fixed opposite the water passages between said tubes substantially as herein described for the purpose specified.

In testimony whereof we have signed our names to this specification in the presence of two subscribing witnesses.

EDWIN WARDLE.

JOSEPH HENRY EVERS.

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H. S. LANTY,

36 Trinity Street, Leeds.