F. R. McGEE.

METHOD OF AND APPARATUS FOR CLEANING GASES.

APPLICATION FILED MAY 13, 1918.

1,338,143. **Patented Apr. 27, 1920.**

3 SHEETS—SHEET 1.

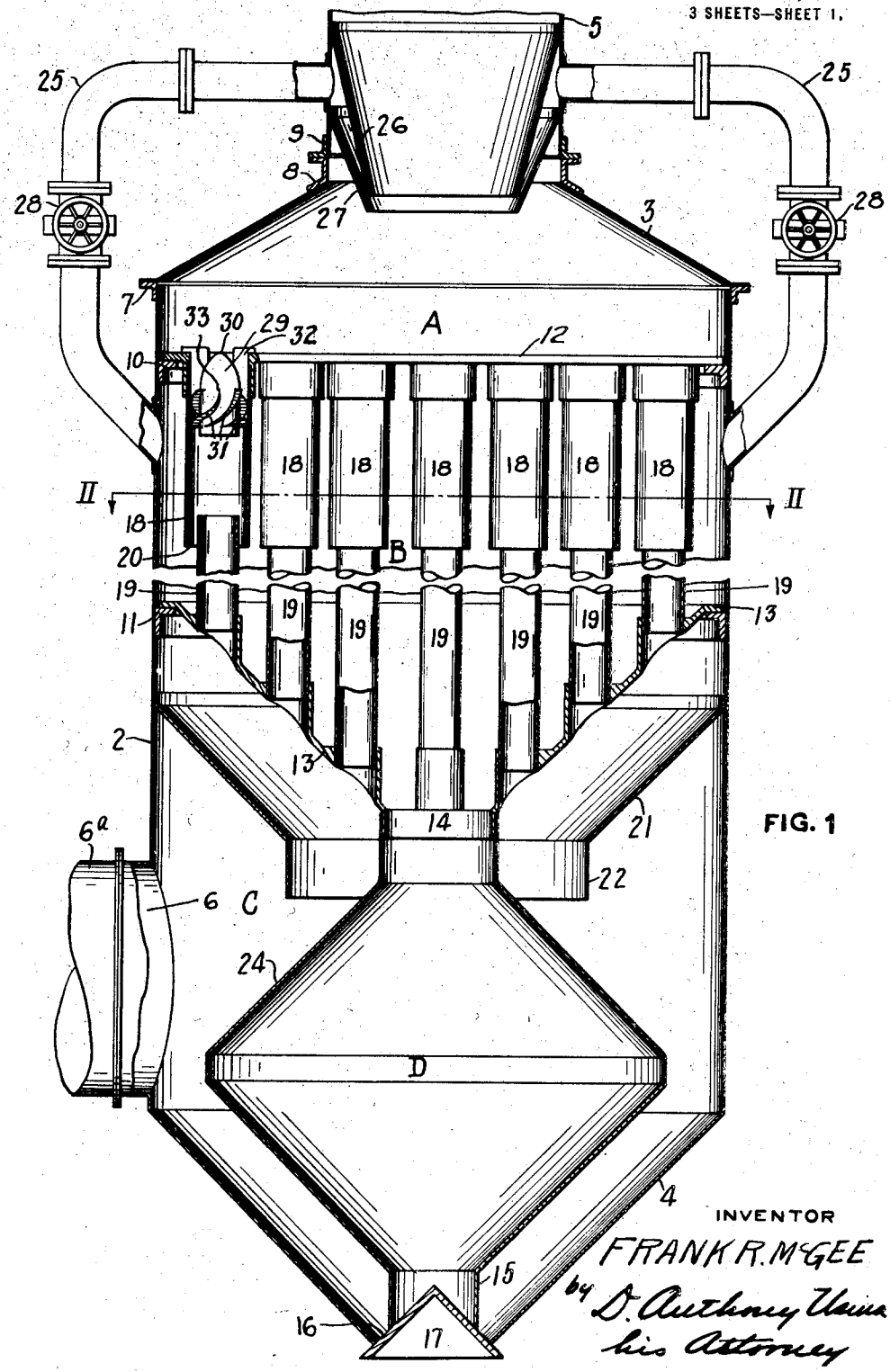


FIG. 1

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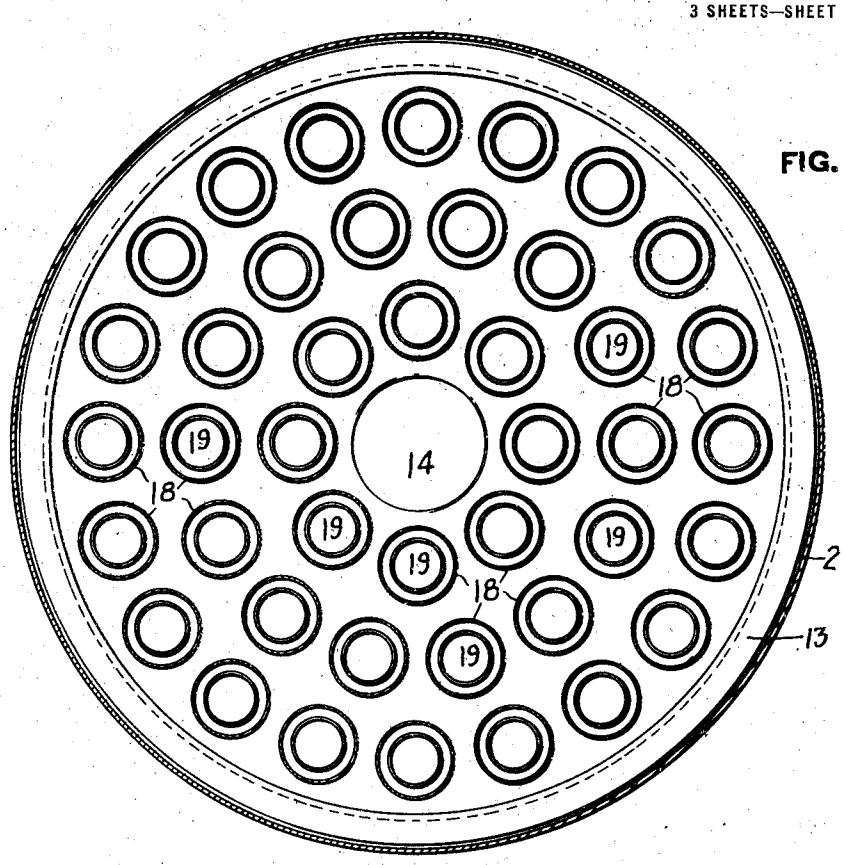


FIG. 2

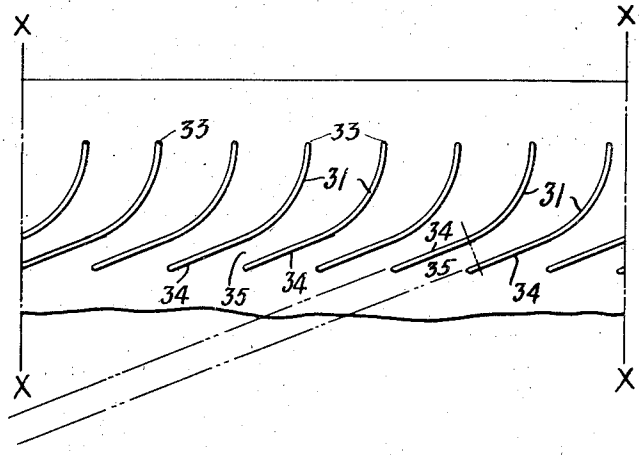


FIG. 8

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3 SHEETS—SHEET 3.

FIG. 7

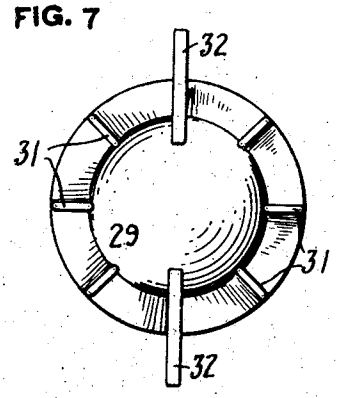
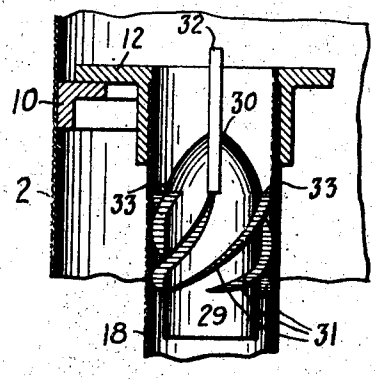


FIG. 4



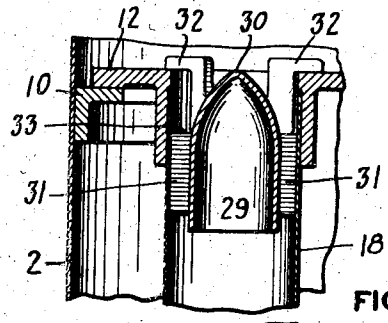
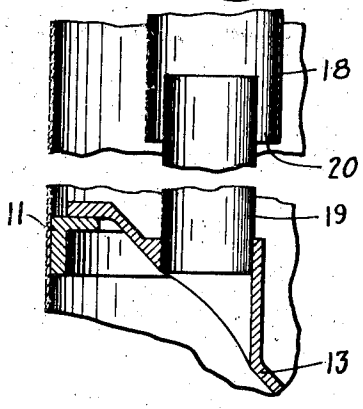


FIG. 3



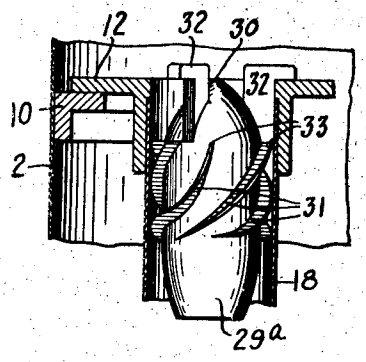


FIG. 5

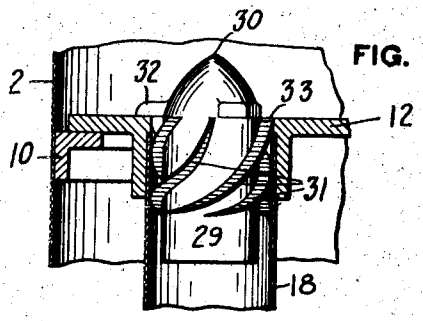


FIG. 6

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UNITED STATES PATENT OFFICE.

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METHOD OF AND APPARATUS FOR CLEANING GASES.

1,338,143. Specification of Letters Patent. Patented Apr. 27, 1920.

Application filed May 13, 1918. Serial No. 234,290.

To all whom it may concern:

Be it known that I, FRANK R. McGEE, a citizen of the United States, and resident of Steubenville, in the county of Jefferson and State of Ohio, have invented certain new and useful Improvements in Methods of and Apparatus for Cleaning Gases, of which the following is a specification.

My invention relates to cleaning gases, and while not limited to such uses, more particularly relates to the removal of finely divided solids and liquids or semi-liquids such as flue dust or tar, or similar impurities, from blast furnace gases, the gases evolved in the operation of by-product coke ovens, gas producers, and similar combustible gases, and from the gases or products of combustion evolved in operating cement kilns, steam boilers, and the like.

One object of my invention is to provide a novel method of cleaning gases embodying a combination of centrifugal and centripetal forces in separating the gases from impurities carried in suspension therein and adapted to form a stream of flowing gases into a core of cleaned gases, and a surrounding annular layer of impurity laden gases to collect the cleaned gases and to separate and collect the segregated impurities.

Another object of this invention is the provision of gas cleaning apparatus having novel means whereby impurities, either solid or liquid or a mixture of both carried in suspension in such gases are mechanically removed therefrom in a rapid, effective and economical manner.

A further object of the invention is to provide a gas cleaner having improved means for automatically separating the gases from the impurities and for trapping or isolating the separated impurities as fast as removed from the gases, and for preventing the removed impurities from reëntering or mixing with the cleaned gases.

A still further object of my invention is the provision of a gas cleaner having the novel constructions, arrangements and combination of parts shown in the drawings, and to be described in detail hereinafter and particularly pointed out in the appended claims.

Referring now to the drawings forming part of this specification, Figure 1 is a sectional elevation showing gas cleaning apparatus embodying the novel features of my invention and adapted for use in carrying out the method forming part of this invention.

Fig. 2 is a sectional plan of the apparatus shown in Fig. 1, the section being taken on the line II—II of Fig. 1.

Fig. 3 is a sectional elevation on a larger scale, showing details in the construction of the gas cleaner.

Fig. 4 is a sectional elevation, showing details in the construction of a modified form of header forming part of apparatus constructed in accordance with this invention.

Fig. 5 is a sectional elevation, similar to that shown in Fig. 4, showing a further modification in the construction of the header forming part of my improved apparatus.

Fig. 6 is a sectional elevation, similar to those shown in Figs. 4 and 5, illustrating another modification in the construction of the headers.

Fig. 7 is a plan, showing details in the construction of the headers forming part of my invention.

Fig. 8 is a plan, showing a development of the curved vanes on the headers of Figs. 1, 3, 4, 5, and 6, the circumference of the headers being equal to the distance between the vertical marginal lines X—X of Fig. 8.

In the accompanying drawings, the numeral 2 designates the cylindrical metal shell of a gas cleaner having frusto-conical ends 3 and 4, with an inlet on its upper end connected to a gas supply conduit 5 and having a gas outlet 6 adjacent to the lower end thereof which is connected to the cleaned gas conduit 6^a. The shell 2 is provided on its upper end with a flange 7 by which the upper end or head 3 of the receiver is detachably fastened to the shell, the small end of this head having a flange 8 by which the flange 9 on the end of the gas conduit 5 is detachably connected to the gas cleaner.

Secured to the inner surface of the shell 2, at separate points in the height thereof, are brackets or annular flanges 10 and 11, and supported on the horizontal legs of these flanges are diaphragms or septums 12 and 13 forming transverse partitions separating the shell 2 into a top gas distributing chamber A, an intermediate dust or impurity receiving chamber B, and a bottom, gas collecting chamber C. The septum 13, which is frusto-conical in cross section, has a neck 14 connecting the lower end of the

chamber B with the upper end of the impurity or dust storage chamber D. Outlet openings 15 and 16 at the lower end of the gas collecting chamber C and the storage chamber D are closed by means of a movable sealing bell 17, this bell and its operating mechanism being old and well known constructions and, in the construction shown, serving to close both of the outlet openings 15 and 16. Obviously, however, separate bells 17, one for each chamber may be used instead of one, when found desirable or necessary.

The upper septum 12 which separates the gas distributing chamber A from the dust or impurity receiving chamber B is provided with a series of flanged openings or holes, which are shown arranged in three concentric rows, (see Fig. 2), and rigidly secured by its upper end in each of these holes, so as to depend therefrom, is a short gas cleaning or conduit pipe 18. The conduits 18, which are peened or otherwise rigidly fastened in the flanged openings of the partition 12 so as to extend vertically, have lower ends which terminate above the upper end of the frusto-conical partition 13 separating the impurity receiving chamber B from the gas collecting chamber C, at about the middle of the height of the chamber B.

The lower frusto-conical septum or partition 13 also is provided with a series of flanged openings, similar to those in the partition 12, which are arranged in three concentric rows and rigidly secured by its lower end in each of the openings or holes is an upwardly extending pipe or conduit pipe 19, the conduits 19 being of somewhat smaller diameter than the conduits 18 and extending upwardly so that the upper end of each pipe or conduit 19 telescopes within the lower end of a depending pipe or conduit 18. (See Figs. 1 and 3). Care is taken in securing the conduits 18 and 19 in the flanged openings of the partitions 12 and 13, and in positioning the partitions in the gas cleaner that the telescoped conduits 18 and 19 are alined axially and that the overlapping ends thereof form an annular gap or outlet 20 at the lower end of each depending conduit 18, the gap forming a trap opening into the impurity receiving chamber B, (as is clearly shown in Figs. 1 and 3).

A frusto-conical deflector 21 having, as shown, a short cylindrical neck 22 which forms an outlet at its lower end, is positioned within the gas collecting chamber C, at the upper end thereof, so as to deflect to the center of the chamber, the gases delivered thereinto through the gas cleaning conduits 19. In this way the gases are caused to flow more equally from conduits 19 and to sweep over the inclined outer surface 24 of the upper part of the chamber D, which aids in removing any impurities in the gases in the passage of the gases to the outlet leading to the clean gas conduit 6, the finely divided solids or liquids or other impurities sliding downwardly over the surface 24 and coming to rest in the lower part of the chamber C below the gas discharge outlet, while the cleaner gases pass through the gas outlet 6 into the clean gas conduit 6a.

The upper end of the impurity receiving chamber B, or when desired, the impurity storage chamber D is connected by at least one, and preferably by a plurality of pipes 25 to the inlet to the gas cleaner, adjacent to the discharge end of the gas supply conduit 5 (see Fig. 1). The upper end of the pipe or pipes 25 opens into the upper end of the distributing chamber A between the pair of injector cones 26 and 27 so that the stream of gases flowing into the chamber A from the supply conduit 5 will have an aspirating effect within the annular space forming the gas outlet between the cones 26, 27, and in this way create a suction in the pipe or pipes 25 to cause a slight but sustained circulation of gases through the receiving chamber B, the dust collecting or storage chamber D, and circulating pipe or pipes 25. A gate valve 28 is provided on each pipe 25 to shut off either or all the pipes when found necessary, and, by partly closing the valves to regulate and control the circulation through these pipes.

The back pressure within the chamber B may be relieved in other ways. For example the suction cones 26 and 27 may be omitted when a small motor driven exhaust fan or blower is substituted for the valves 28 of Fig. 1.

Positioned within the upper end of each of the depending pipes 18 is a centrifugal header 29, the headers having a hollow center with a pointed upper end 30 and each header having a series of curved vanes 31 on its periphery to impart a rapid whirling motion to the gases passing between adjacent vanes. The outer edges of the series of vanes are of such diameter as will neatly fit within the conduits 18, (see Figs. 1 and 3), and lugs 32 afford means for holding the headers in suspended position within the upper end of the pipes 18.

By making the supporting lugs 32 part of or continuations of two or more of the vanes 31, the header construction may be simplified with less obstruction to the entrance of the gases into the conduits 18.

In the construction shown in Figs. 1 and 3, the upper edges 33 of the vanes 31 are positioned a slight distance below the upper ends of the tubes 18, so that the pointed ends 30 form an inlet of gradually decreasing area for the impurity laden gases entering between the vanes 31 from the gas distributing chamber A.

In the construction shown in detail in Fig. 4, the vanes 31 are located somewhat lower within the tubes 18, so that the pointed ends 30 of the headers are positioned at a point a short distance below the upper ends of the tubes 18.

The header shown in Fig. 5 is similar to those of Figs. 3 and 4, with the added feature of having a frusto-conical lower end 32 on the header extending somewhat below the lower edges of the vanes 31.

In the construction shown in detail in Fig. 6, the upper edges 33 of the vanes are flush with the upper surface of the partition 10 to which the depending pipes 18 are fastened, the pointed ends 30 of the headers projecting upwardly into the gas distributing chamber A in this construction.

By reference to the development shown in Fig. 8, it will be seen that the upper part of the vanes 31 forming part of my improved apparatus are curved downwardly and that the lower ends of the curved portions of the vanes tangent with a straight portion 34 and that the straight portions 34 of adjacent vanes form a parallel sided outlet opening 35 for the gases passed through the cleaning tubes 18.

In the operation of cleaning gases by the method forming part of my invention with the apparatus shown and described, and also forming part of my invention, the impurity laden gases flow into the gas distributing chamber A from the gas inlet 5 which is connected to a source of gas supply, and pass from the chamber A into the open upper ends of the series of depending gas cleaning conduits or pipes 18. In entering the pipes 18 the gases come into contact with the curved vanes 31 of the headers 29 and, in passing through the outlets 35 formed between adjacent vanes, the gases are given a rapid spiral or whirling motion, the velocity of the gases being increased in emerging through the converging outlets formed by adjacent vanes 31. The combined action of the whirling motion and increased velocity of the gases forces the gases to travel through the conduits 18 in a spiral path and causes the finely divided solids or liquids or semi-liquids, or other impurities in the gases to be thrown outwardly by centrifugal force so as to form a thin, annular ring of impurity laden gases, this annular ring of gases and outwardly thrown impurities hugging the walls of the pipes 18 and forming annular streams of impurities which pass downwardly with the gases in the pipes 18, and which scour the surfaces of the pipes in passing therethrough.

The major portion of the gases entering each of the conduits 18 after passing the headers 29 is expanded centripetally and forms a central core of cleaned gases surrounded by a thin annular layer of gases which contains the centrifugally thrown impurities.

Upon reaching the lower end of the depending pipes 18 the annular rings of impurities or impurity laden gases pass through the gaps or annular openings 20 formed between the telescoped ends of the conduits or pipes 18 and 19, and are thereby trapped within the dust receiving chamber B. The circulation of gases maintained through the chamber B and circulating pipes 25 relieves the back pressure within the chamber B and being slight, the finely divided solids or other impurities fall upon the conical partition 13 and slide downwardly, passing by gravity through the neck 14 into the impurity storage chamber D. The central core of cleaned gases in the pipes 18, from which the impurities have been removed by centrifugal force due to the whirling motion of the gases, pass through the pipes 19 into the clean gas collecting chamber C and pass out of this chamber through the gas outlet 6 to a place of use. The relatively small amounts of gases mixed with the thin annular rings of impurities formed in the depending pipes 18 also pass through the pipes 18, gravity causing the rapidly moving particles of dust or other impurities to travel into and through the annular space 20 formed between the telescoped ends of the pipes 18 and 19 into the dust receiving chamber B, and the gases flowing through the pipes 25 being practically clean and preventing retardation of the flow of impurities into the chambers B and D.

The peculiar construction and arrangement of the vanes 31 on the headers 29 in the upper ends of the tubes 18 very materially increases the velocity of the gases passing through the pipes 18, and impart a rapid spiral or whirling motion to the gases so that the impurities in the gases are thrown outwardly and are held by centrifugal force against the wall of these pipes, while the gases after passing the headers 29 are permitted to expand centripetally and move toward the axial center of the pipe, in this way forming a core of cleaned gases and surrounding layer of impurity laden gases in each of the pipes 18.

The scouring action of the dust laden gases in passing helically downward through the pipes 18 and 19 will keep the surfaces of these pipes clean and will prevent the impurities from clinging or building up on the inner surfaces of the pipes. By maintaining a slight circulation of gases through the chambers B and D the deposition of the impurities is facilitated, while picking up of deposited impurities by the gases passing through the chamber B is substantially eliminated.

The advantages of my invention will be

apparent to those skilled in the art. The apparatus is simple, has no moving parts, and is easily and cheaply constructed and will not require frequent repairs. The gases are effectively cleaned by the combined centrifugal and centripetal forces employed. By employing a large number of comparatively small cleaning pipes, instead of a single large pipe the stream of gases is broken up into a multiplicity of small streams which enables a much larger proportion of the impurities being removed due to the greater centrifugal force developed in the small pipes, and permits of the length or vertical height of the cleaning pipes being materially reduced.

Modifications in the construction and arrangement of the parts forming my improved gas cleaning apparatus may be made without departing from my invention as defined in the appended claims.

I claim:—

1. A gas cleaner comprising a gas distributing chamber, a gas collecting chamber and an impurity receiving chamber, a gas inlet on the distributing chamber, a gas impurity outlet on the collecting chamber, an outlet on the impurity receiving chamber, a series of conduits connecting the distributing chamber with the collecting chamber, said conduits having annular outlets opening into the impurity receiving chamber, and means in each conduit for imparting a whirling motion to the gases passed through said conduits.

2. A gas cleaner comprising a gas distributing chamber, a gas collecting chamber and an impurity receiving chamber, a gas inlet on the distributing chamber, a gas outlet on the collecting chamber, an outlet on the impurity receiving chamber, and means connecting the impurity receiving chamber and gas collecting chamber for establishing a circulation of gases through said impurity receiving chamber, a series of conduits connecting the distributing chamber with the collecting chamber, and means in each conduit for imparting a whirling motion to the gases passed through said conduits.

3. A gas cleaner comprising a gas distributing chamber, a gas collecting chamber and an impurity receiving chamber, a gas inlet on the distributing chamber, a gas outlet on the collecting chamber and an outlet on the impurity receiving chamber, a series of conduits connecting the distributing chamber with the collecting chamber, said conduits having annular outlets opening into the impurity receiving chamber, and a header for each conduit, said headers having spiral vanes thereon arranged to impart a spiral whirling movement to the gases passed through said conduits.

4. A gas cleaner comprising a gas distributing chamber, a gas collecting chamber and a dust receiving chamber, a gas inlet on the distributing chamber, a gas outlet on the collecting chamber and a dust outlet on the dust receiving chamber, a series of conduits connecting the distributing chamber with the gas collecting chamber, said conduits having annular dust outlets opening into the dust receiving chamber, and a header for the conduits having spiral vanes thereon arranged to impart a spiral whirling movement to the gases passed through said conduits, said headers having a conoidal upper end.

5. A gas cleaner comprising a gas distributing chamber, a gas collecting chamber and a dust receiving chamber, a gas inlet on the distributing chamber, a gas outlet on the collecting chamber and a dust outlet on the dust receiving chamber, a series of conduits connecting the distributing chamber with the collecting chamber, said conduits having annular dust outlets opening into the dust receiving chamber, and a header for each conduit having spiral vanes thereon arranged to impart a spiral whirling movement to the gases passed through said conduits, said headers having a conoidal upper end located within and coacting with the wall of the conduits to form a converging inlet to said vanes.

6. A gas cleaner comprising a receiver having partitions forming a gas distributing chamber, a gas collecting chamber and an intermediate dust receiving chamber, a dust storage chamber below the dust receiving chamber having a neck connecting the dust receiving and storage chambers, a gas inlet on the gas distributing chamber, a gas outlet on the gas collecting chamber and a dust outlet on the dust storage chamber, a plurality of pipes depending from the partition separating the gas distributing and dust receiving chambers, a plurality of pipes extending upwardly into the dust receiving chamber from the partition separating the dust receiving chamber and gas collecting chambers, the upper ends of said upwardly extending pipes telescoping within the lower ends of said depending pipes and the overlapped pipe ends coacting to form annular outlets at the lower ends of the depending pipes opening into said dust receiving chamber.

7. A gas cleaner comprising a receiver having partitions forming a gas distributing chamber, a gas collecting chamber and an intermediate dust receiving chamber, a dust storage chamber below the dust receiving chamber having a neck connecting the dust receiving and storage chambers, a gas inlet on the gas distributing chamber, a gas outlet on the gas collecting chamber and a dust outlet on the dust storage chamber, a plurality of pipes depending from the par-

tition separating the gas distributing and dust receiving chambers, a plurality of pipes extending upwardly into the dust receiving chamber from the partition separating the dust receiving and gas collecting chambers, the upper ends of said upwardly extending pipes telescoping within the lower ends of said depending pipes and the overlapped pipe ends coacting to form annular outlets at the lower ends of the depending pipes opening into said dust collecting chamber, and means connecting the dust receiving chamber with the gas distributing chamber and arranged to create a circulation of gases through said dust receiving chamber.

8. A gas cleaner comprising a receiver having partitions forming a gas distributing chamber, a gas collecting chamber and an intermediate impurity receiving chamber, an impurity storage chamber below the impurity receiving chamber having a neck connecting said chambers, a gas inlet on the gas distributing chamber, a gas outlet on the gas collecting chamber and an impurity outlet on the impurity storage chamber, a plurality of pipes depending from the partition separating the gas distributing and impurity receiving chambers, a plurality of pipes extending upwardly within the impurity receiving chamber from the partition separating the gas collecting and impurity receiving chambers, the upper ends of said upwardly extending pipes telescoping within the lower ends of said depending pipes and the overlapped pipe ends coacting to form annular outlets at the lower ends of the depending pipes opening into said impurity receiving chamber, and means for imparting a whirling motion to the gases passed through said pipes.

9. A gas cleaner comprising a receiver having partitions forming a gas distributing chamber, a gas collecting chamber and an intermediate impurity receiving chamber, an impurity storage chamber below the impurity receiving chamber having a neck connecting said chambers, a gas inlet on the gas distributing chamber, a gas outlet on the gas collecting chamber, and an impurity outlet on the storage chamber, a plurality of pipes depending from the partition separating the gas distributing and impurity receiving chambers, a plurality of pipes extending upwardly within the impurity receiving chamber from the partition separating the impurity receiving and gas collecting chambers, the upper ends of said pipes telescoping within the lower ends of the depending pipes and the overlapped pipe ends coacting to form annular outlets at the lower ends of the depending pipes opening into said impurity receiving chamber, and a header in said pipes, said headers having vanes adapted to impart a helical whirling movement to gases passing through the pipes.

10. A gas cleaner comprising a receiver having partitions forming a gas distributing chamber, a gas collecting chamber and an intermediate impurity receiving chamber, an impurity storage chamber below the impurity receiving chamber having a neck connecting the impurity receiving and storage chambers, a gas inlet on the gas distributing chamber, a gas outlet on the gas collecting chamber and an impurity outlet on the impurity storage chamber, a plurality of pipes depending from the partition separating the gas distributing and impurity receiving chambers, a plurality of pipes extending upwardly within the impurity receiving chamber from the partition between the impurity receiving and gas collecting chambers, the upper ends of said pipes telescoping within the lower ends of said depending pipes, and the overlapped pipe ends coacting to form annular outlets opening into said impurity receiving chamber, and a header in each pipe, said headers having a series of radial vanes adapted to impart a helical whirling movement to the gases in the travel thereof through said pipes.

11. A gas cleaner comprising a receiver having partitions forming a gas distributing chamber, a gas collecting chamber and an intermediate impurity receiving chamber, an impurity storage chamber below the impurity receiving chamber having a neck connecting said chambers, a gas inlet on the gas distributing chamber, a gas outlet on the gas collecting chamber and an impurity outlet on the impurity storage chamber, a plurality of pipes depending from the partition between the gas distributing and impurity receiving chambers, a plurality of pipes extending upwardly within the impurity receiving chamber from the partition between the impurity receiving and gas collecting chambers, and telescoping within the lower ends of said depending pipes, and the overlapped pipe ends coacting to form annular outlets opening into said impurity receiving chamber, and a header in each pipe, said headers having a series of radial downwardly converging vanes adapted to impart a helical whirling motion to the gases in the travel thereof through said pipes.

12. A gas cleaner comprising a receiver having partitions forming a gas distributing chamber, a gas collecting chamber and an intermediate impurity receiving chamber, an impurity storage chamber below the impurity receiving chamber having a neck connecting said chambers, a gas inlet on the gas distributing chamber, a gas outlet on the gas collecting chamber and an impurity discharge outlet on said storage chamber, a plurality of pipes depending

from the partition between the gas distributing and impurity receiving chambers, a plurality of pipes extending upwardly within the impurity receiving chamber from the partition separating the impurity receiving and gas collecting chambers into the upper ends of said depending pipes and the overlapped pipe ends coacting to form annular outlets at the lower ends of the depending pipes opening into said impurity receiving chamber, and a header in said pipes, said headers having a series of radial downwardly converging curved vanes adapted to impart spiral whirling movement to the gases in the travel thereof through said pipes.

13. The method of cleaning gases which consists in dividing a flowing stream of impurity laden gases into a plurality of smaller annular streams, imparting a whirling motion to said annular streams to thereby centrifugally maintain the impurities in an annular layer while expanding the gases centripetally to form a central core of cleaned gases, delivering the core of expanded gases into a gas collecting chamber, diverting the annular layer of impurities into an impurity collecting chamber, and inducing a flow of gases through the impurity collecting chamber to thereby prevent back pressure in said impurity collecting chamber.

14. The method of cleaning gases which consists in dividing a flowing stream of impurity laden gases into a plurality of smaller annular streams, imparting a whirling motion to said annular stream to thereby centrifugally maintain the impurities in an annular layer while expanding the gases centripetally to form a central core of cleaned gases, delivering the core of expanded gases into a gas collecting chamber and diverting the annular layer of impurities into an impurity collecting chamber, and inducing a flow of gases through the impurity receiving chamber to thereby prevent back pressure therein.

15. The method of cleaning gases which consists in dividing a flowing stream of impurity laden gases into a plurality of smaller annular streams, imparting a whirling motion to said annular stream to thereby centrifugally maintain the impurities in an annular layer while expanding the gases centripetally to form a central core of cleaned gases, delivering the core of expanded gases into a gas collecting chamber and diverting the annular layer of impurities into an impurity collecting chamber, inducing a flow of gases through the impurity receiving chamber to thereby prevent back pressure therein, and regulating the flow of gases therethrough.

In testimony whereof I have hereunto set my hand.

FRANK R. McGEE.