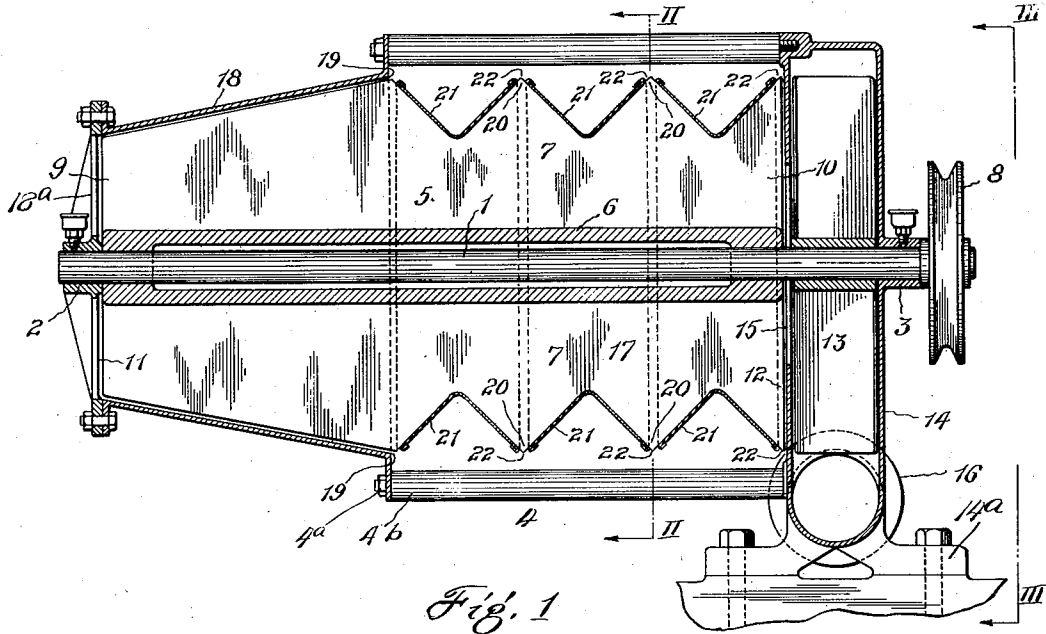
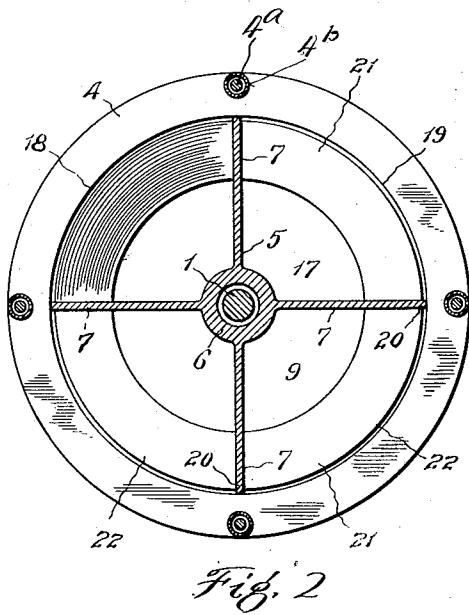
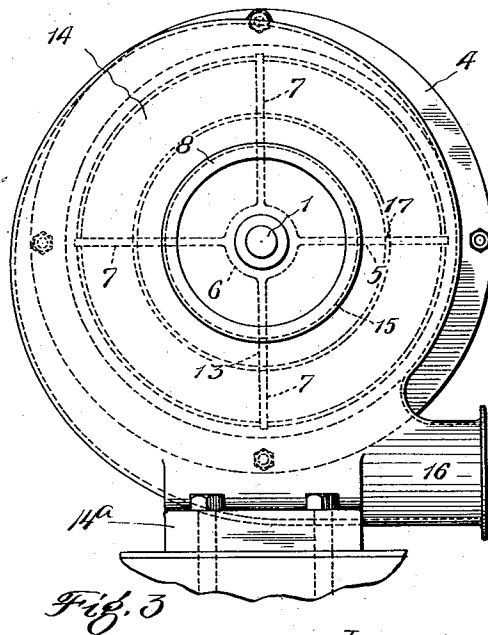


A. G. McKEE.
 APPARATUS FOR CLEANING GASES.
 APPLICATION FILED MAR. 19, 1919.

1,398,598.

Patented Nov. 29, 1921.

2 SHEETS—SHEET 1.



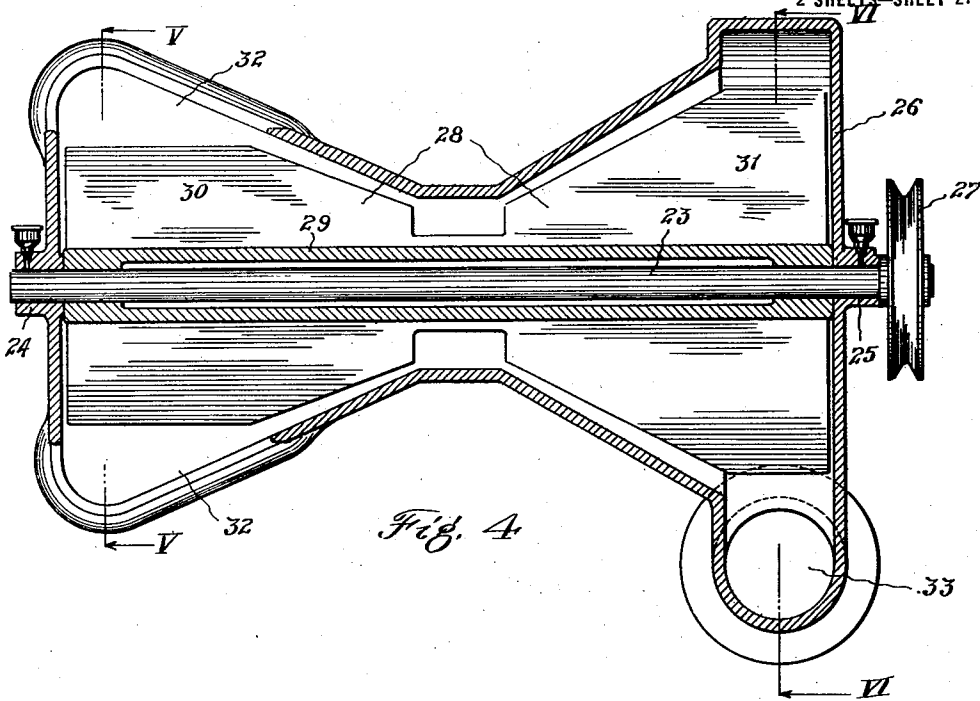
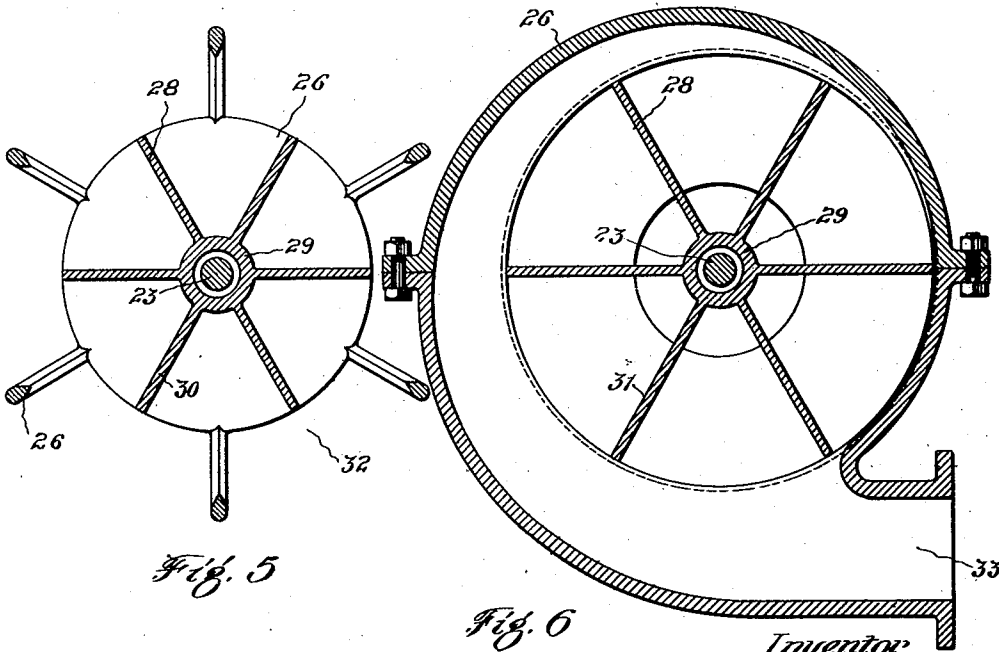
Inventor
 Arthur G. McKee
 by
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2 SHEETS—SHEET 2.



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UNITED STATES PATENT OFFICE.

ARTHUR G. McKEE, OF CLEVELAND, OHIO.

APPARATUS FOR CLEANING GASES.

1,398,598.

Specification of Letters Patent.

Patented Nov. 29, 1921.

Application filed March 19, 1919. Serial No. 283,547.

To all whom it may concern:

Be it known that I, ARTHUR G. McKEE, a citizen of the United States, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented certain new and useful Improvements in Apparatus for Cleaning Gases, of which the following is a specification.

My invention relates to apparatus for cleaning gases by the removal therefrom of particles of foreign matter carried by them. While my invention may be utilized in many ways and I do not limit its use to any particular purpose, it is particularly useful in the removal of dust and dirt from the air which is to be used in the cylinders of internal combustion engines.

Among the objects of my invention are the provision of a new and improved self-cleaning apparatus for cleaning gases of the foreign materials carried by them; the provision of a gas cleaning apparatus from which the cleaned gas may be drawn continuously; the provision of a gas cleaning apparatus which continuously expels the particles of foreign materials from the uncleaned gas which enters its zone of action; the provision of a gas cleaning apparatus in which the foreign materials carried by the uncleaned gas are not accumulated in the apparatus and which does not have to be shut down for cleaning; the provision of a gas cleaning apparatus in which the methods of cleaning gas disclosed in my application, Serial No. 265,874, filed December 9, 1918, may be successfully carried out; the provision of a gas cleaning apparatus adapted to effectively clean the air which is to be used in internal combustion engines for tractor and similar services; the provision of a gas cleaning apparatus which may be made to deliver cleaned gas to the apparatus which it is to serve at a pressure equal to or greater than that of the uncleaned gas which is taken into the cleaner; and the provision of an efficient apparatus of low cost and of simple but substantial construction that can be readily mounted upon an automobile engine or the vehicle which it drives.

The method of cleaning gases of the foreign materials carried by them which the apparatus herein described is adapted to carry out, is to subject the gases to centrifugal action by causing them to pass through

the space in which a centrifugal fan is revolving, the direction in which the gases progress through the fan being axial or parallel to the axis about which the fan revolves. The suction of the engine may be used to draw the gases through the cleaner but the means which I prefer to employ for causing the gases to progress in an axial direction along the fan blades is a second fan or blower preferably mounted upon and rotated by the same shaft that carries the first mentioned centrifugal fan. This second fan or blower is preferably made of such portions that its action will balance or overpower the centrifugal action of the first fan upon the gases as well as the frictional resistance to the passage of the gases so that the clean gases which arrive at the service connection to the outlet end of the rotor may have a pressure equal to or above that of the gases as they enter the rotor. While various forms of apparatus may be employed for carrying out my invention, I prefer to employ such apparatus as is shown in the accompanying drawings in which:—

Figure 1 is a longitudinal section through the axis of the fans or rotor; Fig. 2 is a transverse section on line II—II of Fig. 1; Fig. 3 is an end view as seen from line III—III of Fig. 1; Fig. 4 is a longitudinal section through a modified form of apparatus embodying the principles of my invention; Fig. 5 is a transverse section on line V—V of Fig. 4; and Fig. 6 is a transverse section on line VI—VI of Fig. 4.

Referring to Figs. 1, 2 and 3, of the drawings, the part marked 1 is a shaft supported for rotation in bearings, 2, 3, carried by the stationary frame or housing, 4. The stationary frame indicated in the drawings by the numeral, 4, preferably comprises the outlet end housing, 14, and the inlet end housing, 18, one or both of which may be provided with supporting lugs or feet such as those shown at 14^a to be formed integrally with the housing, 14. The housings, 14 and 18, are preferably connected and held in alignment by means of a skeletonized or open frame such as the bolts, 4^b, and spacing tubes, 4^c. The end plate or spider, 18^a, which carries bearing, 2, may be formed integrally with the housing, 18, or it may be a separate piece, bolted thereto as shown in the drawings. Upon the shaft, 1, there is mounted

and secured for rotation therewith the centrifugal fan, 5, having a hub, 6, and radial blades, 7. A belt pulley, 8, is shown secured to the shaft, 1, for driving the fan but it will be understood that any other means may be employed for this purpose. The fan blades extend from the inlet end, 9, to the outlet end, 10, of the fan, 5, there being clearance spaces, 11 and 12, between the ends of the fan blades and the housing at the inlet and outlet ends respectively. Adjacent to the outlet end of the fan, 5, mounted upon shaft, 1, and secured to it for rotation with it is the fan or blower, 13, which is inclosed in a housing, 14, forming part of the frame, 4. The housing, 14, is provided with an opening, 15, which is presented to the outlet end, 10, of the fan, 5, and is further provided with a service connection and discharge outlet, 16, which may be connected in any suitable manner to the apparatus which the gas cleaner is to serve. When the rotor, 17, composed of the shaft, 1, and fans, 5 and 13, as above described, is rapidly revolved the air or other gases which may surround the cleaner or which may be piped by suitable conduits to the intake end, 9, of the fan, 5, will be drawn into the space occupied by the fan, 5, and caused to progress toward the outlet end, 10. This is due in part to the fact that the diameter of the fan, 5, increases from the intake end toward the outlet end and due in part to the action of the fan or blower, 13, or of the engine, where the blower is not provided, which, as above stated, may be made powerful enough to balance or overpower the action of the fan, 5. In their passage through the space occupied by the rapidly revolving rotor, 17, the gases together with the particles of foreign matter carried by them are given a rapid rotating motion and the centrifugal action developed by this rotating motion throws the particles of foreign matter radially outward to the periphery of the space described by the fan blades, a portion of the length of which blades I prefer to inclose in a stationary duct or housing, 18, which is supported so that a circumferential opening, 19, is formed between the end of the duct, 18, and the end of the adjacent ring, 21, which ring will be presently described. Out of this opening dirt, dust and particles of other foreign matter carried by the gas together with a scavenging portion of the gas will be expelled.

The portion of the fan inclosed within the tapered duct, 18, and the duct, 18, operate similarly to apparatus disclosed in my application, Serial No. 265,874 filed Dec. 9, 1918.

I prefer that the housing, 18, be tapered to increase in diameter from the inlet end toward the outlet end and that the portions of the fan blades, 7, rotating within the

housing, 18, be correspondingly tapered with only running clearance between them and the housing.

By thus tapering the housing, 18, the axial velocity of the gas which enters the intake end, 9, will be reduced as it passes through the housing and more time will thus be afforded the particles of foreign materials carried by it to arrive at the periphery of the fan, 5, on their passage through the housing. At the same time there will be space for a stream of cleaned gas equal in size to that which entered intake end, 9, to flow axially through housing, 18. The dirt which the gas contained when it entered the space described by the fan will be forced outward against the wall of the housing but will be prevented by the passing fan blades and the motion of the gas from lodging there. There will thus be formed a dirt-laden annular ring of gas adjacent the inner wall of the housing, 18, which will be drawn toward the discharge end of the fan, in part by the action of the fan, 13, and in part by the action of the tapered portion of the blades, 7, within the housing, 18. When the dirt-laden ring of scavenging gas arrives at the opening, 19, it will be expelled by centrifugal action from the space described by the fan.

The rotating tapered fan within the housing, 18, impels the gas which enters the inlet end to flow toward the outlet end while centrifugal action impels the particles of foreign matter carried by the gas toward the periphery of the rotating, axially moving column of gas.

Beyond the scavenger opening, 19, of the fan the stationary housing is omitted and there are provided upon the outer edges of the blades of the fan serrations or saw-tooth projections, 20, forming notches between them in which notches are secured for rotation with the fan, V shaped, closed rings, 21, preferably of sheet metal. This serrated fan construction is disclosed in my application Serial No. 278,253, filed February 20, 1919.

Between the rings, 21, at the outer ends of the saw-tooth projections, 20, scavenger openings or circumferential slots, 22, are provided out of which any dirt, dust or other particles of foreign matter which were not expelled through the opening, 19, may be expelled from the gas as it progresses axially through the serrated portion of the rotor. This portion of the fan may, therefore, be said to be provided with a shroud or shell having openings through it. The openings are unrestricted and are located between the axial ends of the fan blades. With the particles of foreign matter that are expelled from scavenger openings, 19 and 22, there will also be expelled a scavenging portion of the air or other gases which carry

them. It is evident that by suitably proportioning the length of the fan, 5, and the number of scavenger openings, 19 and 22, the air or gas arriving at the outlet end, 10, of the fan, 5, may be completely rid of all the particles of foreign matter which entered the intake end, 9. There will consequently be a supply of cleaned gas or air adjacent to the opening, 15, which may be drawn into the fan or blower, 13, and discharged from or drawn out of the service connection, 16, into the apparatus which the cleaner serves.

It will be observed that the fans, 5 and 13, are connected in opposition to each other. That is to say, the fans being placed end to end, the centrifugal action of each tends to oppose that of the other. It will be obvious that the opening, 15, between the fans may be axially elongated to form a duct or that other suitable gas conducting means may be provided to connect the end openings of the fans for the purposes required. They may, in fact, be mounted in separate housings on separate shafts and have different driving means and the suction of the second fan may be replaced or augmented by the suction of the engine as noted above.

The fan or blower, 13, may be made sufficiently powerful to build up a pressure at the service connection equal to or greater than that of the entering gases at the intake end, 9, of the fan, 5. In this way when the apparatus is employed for cleaning the air used in an internal combustion engine, atmospheric pressure or a pressure greater than that of the atmosphere may be developed at the service connection so that there will be no loss of power developed in the engine due to what might be termed throttling of the intake air in its passage through the cleaner.

In fact, the fan or blower, 13, may be made so powerful that instead of gas or air being discharged through the scavenger openings, 19 and 22, it may flow inwardly, radially of the fan, 5, through these openings while the particles of foreign matter heavier than the gas will be thrown out of these same openings due to the centrifugal action being greater upon the heavier particles than it is upon the gas which carries them.

In Figs. 4 and 5, I have shown a form of apparatus for cleaning gas and embodying the principles of my invention, in which the inlet serves also as the scavenger opening. In this form the radially entering gas together with the particles of foreign matter which it carries are immediately subjected to the centrifugal action of a fan, the particles of foreign matter being expelled by this action and the cleaned gas alone progressing through the rotor to the discharge end through which it may be conducted to the apparatus which the cleaner serves.

In the apparatus shown in Figs. 4 and 5,

23 is a shaft mounted for rotation in bearings, 24, 25, carried by the frame or housing, 26. A belt pulley, 27, is shown mounted upon and secured to the shaft, 23, for driving it but it will be understood that any other suitable driving means may be employed. Mounted upon shaft, 23, and secured to it for rotation with it is the rotor, 28, which, as shown, is provided with a hub, 29, and the centrifugal fans 30 and 31. The rotor, 28, is composed of two portions one of which, fan, 30, is at the inlet end and the other of which, fan 31, is at the outlet end. As will be seen in the drawings, the fan, 30, is wider than the fan, 31, while the fan, 31, is of greater diameter than the fan, 30. The fan, 31, will therefore, develop a greater pressure than is developed by fan, 30, and if the discharge outlet of fan, 31, be open and the fans be driven, there will be a flow of air or gas into inlet, 32, of fan, 30, through the connection between fans, 30 and 31, and out of the discharge outlet or service connection, 33. The housing, 26, surrounds and supports the fan or rotor, 28, and is provided with an inlet opening, 32, adjacent to the intake portion of the fan, 30. The housing, 26, is also provided with a service connection, 33, which is the discharge outlet of the discharge portion, 31, of the fan or rotor. It will be evident that the fan portions, 30 and 31, may be separate structures and that if desired they may be mounted upon separate shafts and be driven by separate driving means, and further, it will be evident that they may be of different relative proportions and be inclosed in separate housings connected by suitable conduits, providing only that they be driven at such speeds that there will be created the desired difference in pressure between that developed by the separating fan, 30, and that developed by the suction or discharge fan, 31.

The operation of this form of my invention is as follows: The service connection, 33, being properly connected to the apparatus which the cleaner is to serve, the rotor, 28, is rapidly revolved by power supplied to the shaft, 23, through the belt pulley, 27, or other driving means. The uncleaned gas or air which surrounds the intake opening, 32, will be drawn radially into the intake fan, 30, of the rotor, 28, due to the fact that the centrifugal action of the discharge fan, 31, of the rotor, 28, is greater than that of the intake or separating fan, 30. As soon as the uncleaned gas or air enters into the space traversed by the blades of fan, 30, it will be given a rapid rotary motion and the particles of foreign matter carried by it will be thrown outward due to the centrifugal action being greater upon them than it is upon the lighter gas or air in which they are suspended. By making

the area of the inlet opening, 32, large as compared to the area of the connection between fans, 30 and 31, or, by making the pressure developed by fan, 31, only slightly greater than that developed by fan, 30, the velocity of the air or gas entering the opening, 32, may be made very slow so that there will be little tendency for the particles of foreign matter to be carried through the fan, 30, by the inflowing air or gas when compared to the centrifugal action which tends to expel such particles from the space traversed by the rotating blades of that fan. Only clean gas or air will be drawn through fan, 30, and discharged by fan, 31.

It will be apparent that my invention may be embodied in still other forms of apparatus without departing from its scope.

Having thus described my invention, I claim and desire to secure by Letters Patent:

1. In apparatus for cleaning gas a centrifugal fan having a portion of the length of its blades surrounded by a stationary housing and another portion of the length of its blades provided with a serrated shell secured to the fan for rotation therewith and having openings through its serrations.

2. In apparatus for cleaning gas, a centrifugal fan, a support therefor, said fan being adapted to permit the passage of gas in an axial direction through the space described by said fan, a stationary duct surrounding a portion of the length of the fan, and a serrated shroud secured to another portion of the length of the fan having openings through its serrations.

3. In apparatus for cleaning gas, a centrifugal fan, a support therefor, said fan being adapted to permit the passage of gas in an axial direction through the space described by said fan, a stationary duct surrounding a portion of the length of the fan, a serrated shroud secured to another portion of the length of the fan said shroud having openings through its serrations, and means for causing a flow of gas axially through the space described by said fan.

4. In apparatus for cleaning gas, a centrifugal fan, a support therefor, said fan being adapted to permit the passage of gas in an axial direction through the space described by said fan, a stationary duct surrounding the periphery of a portion of the fan adjacent to its inlet end, a perforated shroud secured to the periphery of a portion of the fan adjacent to its outlet end, a second centrifugal fan, and a housing surrounding said second fan having an inlet opening adjacent the outlet end of said first named fan.

5. In a gas cleaner, a pair of centrifugal fans connected in opposition to each other; means for driving said fans; one of said fans being inclosed by a housing provided with a discharge outlet adapted to be con-

nected to the apparatus which the cleaner serves; and the other of said fans having one end connected to the intake end of said first named fan and its periphery open to the surrounding atmosphere from which the uncleaned gas is drawn and means including said first named fan for causing a flow of gas radially into said open periphery of said second fan and thence through said first named fan to said discharge outlet.

6. In a gas cleaner, a pair of centrifugal fans mounted end to end upon a common shaft, a housing surrounding one of said fans, and the other of said fans having its periphery open to the surrounding atmosphere from which the uncleaned gas is drawn, said housing forming a fan chamber for said first named fan having an inlet opening between the adjacent ends of said fans and an outlet opening near the periphery of said first named fan.

7. In apparatus for cleaning gas, a centrifugal fan having a portion of its length surrounded by a stationary housing and another portion of its length provided with a shell secured to the fan for rotation therewith and having openings or slots at intervals therethrough.

8. In apparatus for cleaning gas, a pair of centrifugal fans mounted end to end upon a shaft, a housing surrounding one of said fans forming a fan chamber therefor provided with a central inlet opening presented to the end of the other of said fans and a peripheral discharge outlet opening, said last named fan having its periphery open to the surrounding atmosphere from which the uncleaned gas is drawn and being of larger diameter than said inlet opening, said first named fan being adapted to develop greater pressure than said last named fan.

9. In apparatus for cleaning gas two centrifugal fans mounted end to end with a space between them, a partition wall between said fans in said space, said space providing only running clearances between said wall and said fans, said wall having an opening through it concentric with said fans, one of said fans having its periphery open to the atmosphere from which the uncleaned gas is drawn and the other of said fans being adapted to develop greater pressure than said fan the periphery of which is open to the atmosphere whereby when said fans are operated gas will be caused to flow through said opening into the space described by said fan which develops the greater pressure.

10. In apparatus of the class described, two centrifugal fans, mounted end to end upon a shaft one of said fans being surrounded by a stationary housing, the other of said fans having a perforated shell secured to it for rotation with it, said housing having a central inlet opening, and means

for conducting gas away from the end of said last named fan.

11. In apparatus of the class described, two centrifugal fans, one of said fans being 5 surrounded by a stationary housing and the other of said fans having a perforated shell secured to it for rotation with it, said fans being adapted and connected for the passage of gas first longitudinally through the space 10 described by one of said fans and then longitudinally through the space described by the other of said fans.

12. In apparatus of the class described, a pair of centrifugal fans, each connected 15 for the passage of gas longitudinally through the space described by it, one of said fans being surrounded by a stationary housing provided with an inlet opening at one end, a peripheral scavenger opening and an out- 20 let opening at its other end, and the other of said fans having a shell secured to it for rotation with it, an inlet opening at one end, a peripheral scavenger opening, and an outlet opening at its other end, said 25 fans being adapted and connected for the passage of gas first longitudinally through the space described by one of said fans and then longitudinally through the space described by the other of said fans.

30 13. In apparatus for cleaning gas, a centrifugal fan adapted and connected for the

passage of gas longitudinally through the space described by said fan, a portion of the length of said fan being tapered in diameter increasing in the normal direction 35 of the flow of gas through said space, a correspondingly tapered stationary housing surrounding said tapered portion of said fan, the portion of said fan outside said housing being provided with a serrated shell 40 secured to the fan for rotation therewith and having openings through its serrations.

14. In apparatus for cleaning gas, a centrifugal fan, a housing surrounding said fan provided with a central inlet opening and a 45 peripheral outlet opening, and a second centrifugal fan outside of said housing having its periphery open to the atmosphere from which the uncleaned gas is drawn said last named fan being concentric with said inlet 50 opening and having one end in close proximity to said housing and of larger diameter than said inlet opening, the periphery of said last named fan being open to the surrounding atmosphere. 55

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

ARTHUR G. McKEE.

Witnesses:

M. M. MEADOWS,
R. RAHE.