L. ANDERSON.

DUST SEPARATOR.

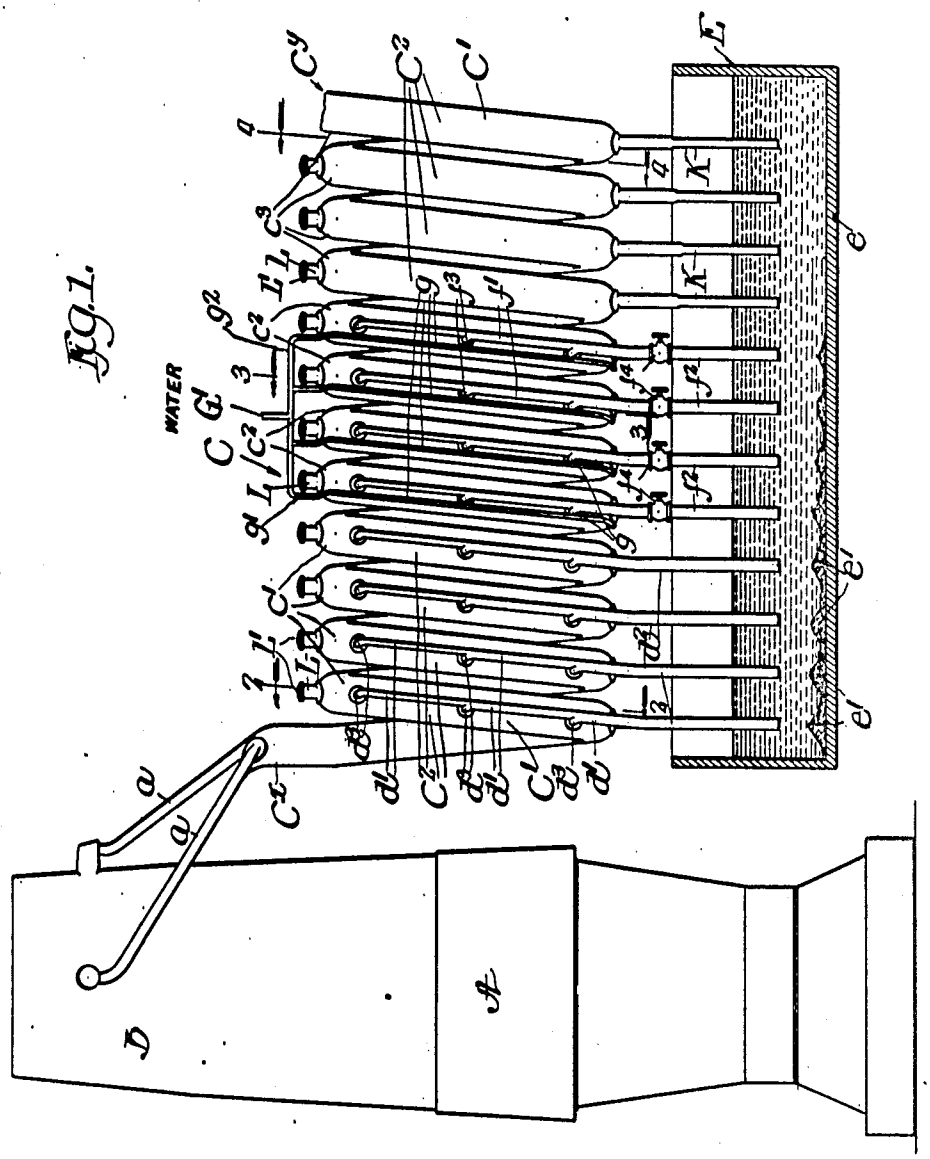
APPLICATION FILED APR. 13, 1911.

1,039,008.

Patented Sept. 17, 1912.

2 SHEETS—SHEET 1.

Fig. 1.



Witnesses:
F. W. Alfeide
A. R. Wilkins

Inventor
Laurence Anderson
by Poole & Brown
Attys

L. ANDERSON.

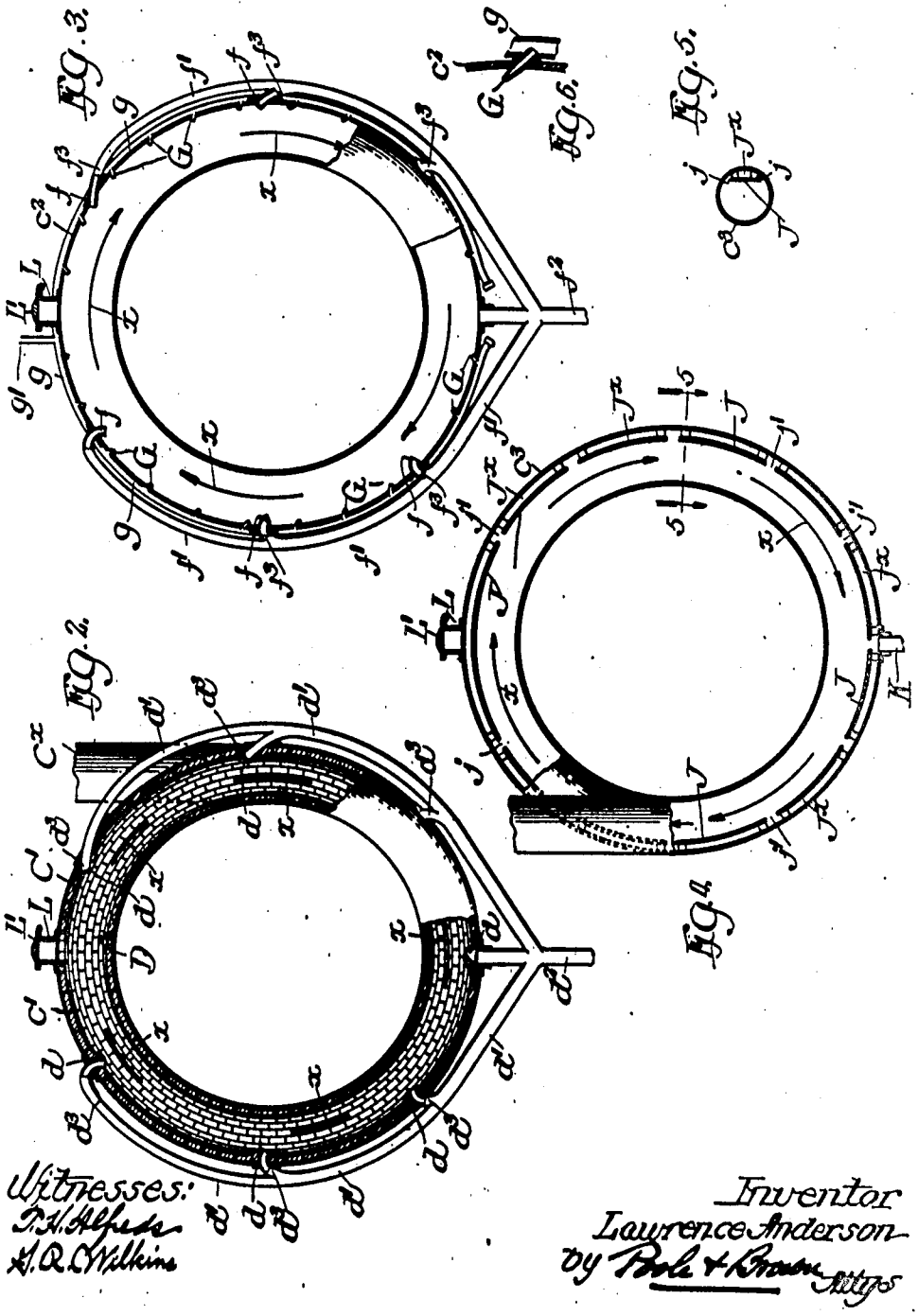
DUST SEPARATOR.

APPLICATION FILED APR. 18, 1911.

1,039,008.

Patented Sept. 17, 1912.

2 SHEETS—SHEET 2.



Witnesses:
P. H. Alfeld
H. Q. Wilkins

Inventor
Laurence Anderson
by Bole & Brown Attys

UNITED STATES PATENT OFFICE.

LAWRENCE ANDERSON, OF CHICAGO, ILLINOIS.

DUST-SEPARATOR.

1,039,008. Specification of Letters Patent. Patented Sept. 17, 1912.

Application filed April 13, 1911. Serial No. 620,747.

To all whom it may concern:

Be it known that I, LAWRENCE ANDERSON, a citizen of the United States, and a resident of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Dust-Separators; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

This invention relates to an improvement in dust separators and consists of the matters hereinafter described and more particularly pointed out in the appended claims.

My improved dust separator is adapted for the separation of dust, dirt, cinders, or other particles heavier than air from a gas or from air which is driven or drawn through the separator in a current flowing at a rapid rate and depends for its operation upon the centrifugal force developed by the rapidly moving current of gas or air while passing through the separator.

My dust separator is shown herein in connection with a system adapted to collect and store for commercial purposes the fuel gas given off as a by-product by a blast furnace and is designed to extract the cinders, dust and dirt from the said fuel gas so as to make it suitable for use for lighting and heating and power purposes.

In the drawings—Figure 1 is a view representing in side elevation my improved dust separator and a blast furnace to which it is connected. Fig. 2 is a view representing a section through one of the spiral coils comprising my improved separator, the section being taken in a plane indicated by the line 2—2 of Fig. 1. Fig. 3 is a view representing a section of another of said spiral coils in a plane indicated by the line 3—3 of Fig. 1. Fig. 4 is a view representing a section through another one of said spiral coils in a plane indicated by the line 4—4 of Fig. 1. Fig. 5 is a view representing a cross section through the spiral coil shown in Fig. 4 in a plane indicated by the line 5—5 thereof. Fig. 6 is a detail sectional view on an enlarged scale, showing one of the spray nozzles connected with the coil illustrated in Fig. 3.

Referring now in detail to that embodiment of my invention illustrated in the drawings, A indicates a blast furnace of familiar construction, which is adapted for the delivery of fuel gas, its by-product, through pipes *a*, *a* connected to the stack B of said furnace.

C indicates my improved dust separator, as a whole, the said separator having one end C^x connected to the pipes *a*, *a* leading from the stack of the furnace and being adapted for the passage of gas therethrough. The other end C^y of said separator may be connected directly to a gas reservoir or storage tank, or in case a more refined product is required for the purpose to which the gas is to be put, it may be connected to other gas washers or purifiers in which the gas is further washed and purified.

The separator consists of a metal pipe C′ of comparatively large cross-sectional area, and having the form of a helical coil with a plurality of convolutions C^2. The pipe C′ may be of any convenient form in cross section and, as shown herein, is circular in cross section. The force of the blast from the furnace drives the gas through the convolutions of the helical coil comprising the separator in a stream which flows at a rapid rate, the gas whirling about the central axis of the said helical coil as it advances through the separator.

The process carried out in the separator in extracting the dirt, dust and the like from the gas is threefold, and in that embodiment of the invention shown herein, is divided into three separate stages which occur in succession. In the first stage, the gas is subjected to a process of dry separation; in the second stage, the gas is washed and may be said to be subjected to a process of wet separation; and in the third stage, the gas is subjected to a dehydrating process, that is to say, a process for the extraction of the water from the gas. The several stages of the threefold process depend for their operation upon the centrifugal force developed in the dust, dirt and water particles carried in suspension by the gas as it travels in a current flowing at high speed through the convolutions of the separator.

To carry out the threefold process in the three successive stages above referred to, the convolutions of the helical coil C^2 are divided into three sets, each set, as shown

herein, including four convolutions. c' indicates the convolutions of the first set; c^2 the convolutions of the second set; and c^3, those of the third set. As shown in the drawings, the convolutions are formed from a single metal pipe. The body of each convolution is an integral part of said pipe, and in this respect the construction and connection of all the convolutions of one set are alike. The convolutions of the first set are alone lined with a heat resisting means, such as fire-brick or tile, for the purpose, as hereinafter described. As the body of each convolution of all the sets are made of metal, a description of one of each set will suffice for all. Each of the convolutions c' of the helical coil is provided with a fire brick or tile lining D (see Fig. 2) to protect the metal walls of the pipe C', since the gas when it first enters the separator from the blast furnace is very hot. At circumferentially spaced points in the outer peripheral wall of the convolution c', that is to say, that part of the pipe wall which is located at the greatest radial distance from the central axis of the helical coil, are located pockets or chambers d, said pockets or chambers opening into the interior of the pipe in a direction opposed to the direction in which the gas is flowing through the convolution of the helical pipe, as indicated by the arrows ϖ in Fig. 2. The pockets or chambers on either side of the convolution c' are connected with a pipe d', each pipe d' leading to a common discharge pipe d^2. As shown in the drawings, the pipes d' are provided with branches d^3 each of which has an open end projecting into the pipe C', and constituting the pocket or chamber referred to. The ends of said branches are turned so that they are directed opposite to the direcion of flow of the gas through the convolution of the helical coil.

The operation as the gas passes through the convolutions c' is as follows: Under the force of the draft from the furnace, the gas delivered thereby passes through the convolutions of the coil in the direction of the arrows at a very rapid rate, and owing to the centrifugal force developed by this circular flow of the gas, the heavier particles of cinders and dirt are thrown outwardly against the outer peripheral walls of the convolutions c'. The heavier particles are thus carried along in contact with this outer peripheral wall until they reach one of the pockets or chambers d in which they are arrested and from which they pass into the pipes d' and thence into the common delivery pipe d^2. As shown in the drawings, the branches d^3 of the pipes d', constituting the pockets, are so curved that dust and cinder particles will strike against that wall of the pocket farthest in advance in the direction in which the gas is flowing and will then upon deflection have a comparatively free drop downwardly through the pipe under the force of gravity. The pipes d^2 open into a trough E extending below the spiral C' and containing water which seals said pipes. The cinders and dirt falling through said pipes drop upon the bottom e of the trough and collect in piles e', as shown in Fig. 1. Enough convolutions are included in this first section of the helical coil, so that practically all of the larger and heavier particles of cinders and dirt will have been removed from the gas after they have passed through said section of the dust separator.

Each of the convolutions c^2 of the helical coil, comprising the second section of the separator, is provided with circumferentially spaced pockets or chambers f in its outer peripheral wall similar to those provided in the convolutions c' of the first section, said pockets or chambers being in like manner connected with pipes f' leading to a common discharge pipe f^2, which empties into the trough E and is sealed by the water therein. As before, the pockets or chambers are formed by branch pipes f^3 connected with the pipes f'. In addition each of said convolutions c^2 are provided with devices for injecting a plurality of jets or sprays of water into the rapidly whirling stream of gas, the jets or sprays being preferably directed diagonally across and in a direction opposed to the direction in which the stream of gas is traveling so as to thoroughly wash the gas of the finer particles of dust or dirt still remaining therein after it has passed through the first section of the separator.

G (see Fig. 3) indicates a plurality of spray or jet nozzles located at circumferentially spaced points about the outer peripheral wall of the convolution c^2, said nozzles being turned so as to direct a spray of water in a direction opposite to that in which the stream of gas is flowing, as indicated by the arrows ϖ, and preferably diagonally across the direction of flow of said stream, that is to say, at an angle thereto. Said nozzles G are connected to pipes g extending about each side of said convolution and connected by branches g' to a pipe g^2 which is supplied with water from a main supply pipe G' (see Fig. 1).

The operation of this part of the apparatus is as follows: The drops or particles of water sprayed from the nozzles G move in paths which cross the rapidly flowing current of gas in a direction opposed to the direction of flow of said current, and catch or hold and thereby separate from the gas the finer particles of solid matter carried thereby. The force of the jet or spray carries the drops or particles of water toward the inner peripheral wall of the convolution, that is to say, toward that part of the pipe wall

which is located at the least radial distance from the central axis of the helical coil, and as the direction of travel of said water drops or particles is opposed to that of the current of gas the advance of the water drops or particles in that direction will be retarded and their movement arrested at or before the time the same reaches said inner peripheral wall of the convolution and the drops or particles of water will then be caught by and subjected to the influence of the rapidly flowing current of gas, and will be carried by or caused to move with said current and soon acquire the same speed as that of the gas. The action of centrifugal force thereafter has the effect of impelling the drops or particles of water in paths across the current of the gas, toward the outer circumferential wall of the convolutions c', so that the said drops or particles pass twice through or across the current of gas and the same is subjected to a double washing operation. The water with the solid particles suspended therein collects in the pockets or chambers f in the same way as did the solid particles in the first section of the separator, and, passing, into the pipes f' and f^2 flow into the tank E. Such larger particles of solid material as were not removed in the first section of the coil and are too heavy to be caught and held by the particles of water will be driven out of the second section of the separator by centrifugal force and the action of the current in the same manner as in the first section. The last section of the separator provides means for dehydrating the gas, that is to say, for separating from the gas the moisture remaining in the same after its passage through the section comprising the convolutions c^3. Primarily this result is produced by the centrifugal action on the particles of water suspended in the gas, due to the rapid rotary motion of the current of gas about the axis of the coil, whereby the said particles, which are heavier than the gas, are thrown by such centrifugal action outwardly against the peripheral walls of said convolutions c^3, the accumulated water being drained from said convolutions through suitable openings or drainage pipes. To facilitate the separation of the water from the gas in this way, each of the convolutions c^3 is shown in the drawings as provided with a plurality of separator plates J (see Figs. 4 and 5), said plates each comprising a section of a cylinder having a radius slightly less than that of the outer peripheral wall of the convolutions c^3, with its axis coincident with the axis of the helical coil. The lateral edges j of said plates extend preferably closely adjacent to but are separated by lateral spaces from the transversely circular wall of the pipe. Said plates are also preferably separated from each other at their ends by spaces j'. The pleats J provide a space J^x next to the outer peripheral wall of each convolution c^3 containing a body of gas that is practically unaffected by the rapidly moving current of gas in the interior of said convolutions. A discharge pipe K connected with the lowest part of the convolution, leads down to the trough E and is sealed by the water therein, as in the case of the other discharge pipes. As the gas passes through this section of the separator, the finely divided particles of moisture carried in suspension therein, being heavier than the gas, are thrown by centrifugal force against the plates J and to some extent through the apertures between the sides of the plates and between the ends of the plates and the wall of the convolution c^3. The water accumulating on the plates J, and on the walls of the coils, enters the space J^x and being there unaffected by the main current of the gas, flows by gravity through said space and along the outer peripheral walls of the convolutions into the discharge pipes K whence they flow into the tank E. The gas when it passes through the outlet end C' of the separator is comparatively clean and free of moisture. From the separator it may be led directly to a place for consumption, may be conducted to storage tanks or may be directed through other apparatus adapted to further free it from impurities, as may be done when the gas is to be used in explosive engines for power purposes. At the top of each turn of the spiral I provide a manhole L closed by a gravity controlled hinged cap L' which is weighted and serves as a safety valve in case, through the entrance of air with the gas, an explosion occurs, or for any other reason a pressure higher than that designed to be borne by the pipe comprising the helical coil is developed therein. In each of the pipes f^2, draining the sections c^2 of the spiral, I preferably provide a hand-valve f^4, by means of which said pipes may be closed so that if desired one or more of the sections c' may be allowed to become partially filled with water to provide a water seal to prevent a back-flow of the gas from the storage tanks, or other parts of the system supplied by the device, in case it is desired to open up the blast furnace or for any other reason.

It will be noted that the essential feature of my improved separator is the conduit in the form of a coil provided, in the example illustrated, by the coiled metal tube or pipe, through which the gas is caused to travel and by means of which the continuously advancing rotary current of gas is produced whereby the centrifugal force upon which the separator depends for its operation, is developed.

While in describing one embodiment of my invention, I have referred to certain details of mechanical construction and ar-

rangement, it is to be understood that my invention is not limited thereby except as pointed out in the appended claims.

I claim as my invention—

1. An apparatus for separating matter in suspension from a rapidly moving current of gaseous fluid, comprising a single pipe bent in the form of a coil, means providing a plurality of equally spaced discharge passages opening through the outer peripheral wall of said coil at circumferentially arranged points, a common outlet passage communicating with said discharge passages, and means normally closing the discharge end of said common outlet passage.

2. An apparatus for separating matter in suspension from a rapidly moving current of gaseous fluid, comprising a single pipe bent in the form of a helical coil having a horizontal axis and provided with a plurality of convolutions, said convolutions being provided with a plurality of equally spaced discharge passages opening through the outer peripheral walls thereof at circumferentially arranged points, a common outlet passage for the several discharge passages of each convolution, and means normally closing the discharge end of each of said common outlet passages.

3. An apparatus for separating matter in suspension from a rapidly moving current of gaseous fluid, comprising a single pipe bent in the form of a helical coil having a horizontal axis and provided with a plurality of convolutions, means providing a plurality of equally spaced, circumferentially arranged discharge passages opening through the outer peripheral wall of each of said convolutions, a common outlet passage for the several discharge passages of said convolutions, and a water seal closing the discharge end of each of said common outlet passages.

4. An apparatus for separating matter in suspension from a rapidly moving current of gaseous fluid, comprising a single pipe bent in the form of a coil, said coil being provided in its outer peripheral wall with a plurality of equally spaced, circumferentially arranged pockets, means substantially encircling said coil and providing a common discharge passage connected with each of said pockets, and means normally closing the outlet end of said common discharge passage.

5. An apparatus for separating matter in suspension from a rapidly moving current of gaseous fluid, comprising a single pipe bent in the form of a helical coil, having a horizontal axis and provided with a plurality of convolutions, some of said convolutions being provided in their outer peripheral walls with a plurality of equally spaced, circumferentially arranged pockets, having orifices constituting discharge passages opening into said convolutions in a direction opposed to the direction of movement of said current, and a common discharge pipe for each convolution connected with the several discharge passages thereof, said several common discharge pipes being provided with a water seal at their outlet ends.

6. An apparatus for separating matter in suspension from a rapidly moving current of gaseous fluid, comprising a single pipe bent in the form of a coil, means providing a plurality of discharge passages opening through the outer peripheral wall of said coil at circumferentially arranged, equally spaced points, a common outlet passage communicating with said discharge passages, means normally closing the outlet end of said common outlet passage, and means for injecting a spray of water into said coil at a plurality of circumferentially spaced points.

7. An apparatus for separating matter in suspension from a rapidly moving current of gaseous fluid, comprising a conduit in the form of a coil, means providing a plurality of discharge passages opening through the outer peripheral wall of said coil at circumferentially spaced points, means normally closing the outlet ends of said discharge passages, and a plurality of discharge jets opening into said coil at circumferentially spaced points, and adapted to direct a jet of water across and in a direction opposing the direction of said current.

8. An apparatus for separating matter in suspension from a rapidly moving current of gaseous fluid, comprising a single pipe bent in the form of a coil having a plurality of convolutions, said convolutions being divided into three sets, each of the convolutions of the first two sets being provided with a plurality of circumferentially spaced outlet openings in their outer peripheral walls, a plurality of discharge jets adapted to spray water into the convolutions of the second set at circumferentially spaced points thereof, each of the third set of said convolutions being provided with an outlet opening located at its lowest point, means providing discharge passages connected with each of said outlet openings, and means providing water seals for said discharge passages.

9. An apparatus for separating matter in suspension from a rapidly moving current of gaseous fluid, comprising a conduit in the form of a coil having a plurality of convolutions, the convolutions of said coil being divided into three sets, each of the convolutions of the first two sets being provided in its outer peripheral wall with a plurality of circumferentially spaced pockets opening into said convolution in a direction opposed to the direction of flow of said current, a

plurality of nozzles adapted for directing sprays of water into the convolutions of said second set at circumferentially spaced points thereof, each of the third set of said convolutions having an outlet opening located at its lowest point, means providing discharge passages for each of said pockets in the first and second sets of convolutions and for said outlet openings in said third set of convolutions, and means for normally closing the outlet ends of said discharge passages.

10. An apparatus for separating matter in suspension from a rapidly moving current of gaseous fluid, comprising a conduit in the form of a coil having a plurality of convolutions, the convolutions of said coil being divided into three sets, each of the convolutions of the first two sets being provided in its outer peripheral wall with a plurality of circumferentially spaced pockets opening into said convolution in a direction opposed to the direction of flow of said current, a plurality of nozzles adapted for directing sprays of water into the convolutions of said second set at circumferentially spaced points in the outer peripheral wall thereof, said nozzles being directed at angle to and in a direction opposed to the direction of flow of said current, each of the third set of said convolutions having an outlet opening located at its lowest point, means providing discharge passages for each of said pockets in the first and second sets of convolutions and for said outlet openings in said third set of convolutions, and means for normally closing the outlet ends of said discharge passages.

11. An apparatus for separating matter in suspension from a rapidly moving current of gaseous fluid, comprising a conduit in the form of a coil of metal pipe having a plurality of convolutions, said convolutions being divided into three sets, the first set of said convolutions being provided with a fire proof lining and each convolution of the first two sets being provided with a plurality of circumferentially spaced pockets in its outer peripheral wall, said pockets opening into said convolutions in a direction opposed to the direction of flow of said current, means for injecting a plurality of sprays of water into the convolutions of said second set at points circumferentially spaced in the outer peripheral wall of said convolutions, each of the convolutions of said third set being provided with outlet openings at its lowest point, means providing discharge passages for each of said pockets in the first two sets of said convolutions and for the outlet openings in the third set of said convolutions and means normally closing the outlet ends of said discharge passages.

12. An apparatus for separating matter in suspension from a rapidly moving current of gaseous fluid, comprising a conduit in the form of a metal pipe having a plurality of convolutions, said convolutions being divided into three sets, the first set of said convolutions being provided with a fire proof lining and each convolution of the first two sets being provided with a plurality of circumferentially spaced pockets in its outer peripheral wall, said pockets opening into said convolutions in a direction opposed to the direction of flow of said current, a plurality of said nozzles opening into the convolutions of said second set at circumferentially spaced points in the outer peripheral walls thereof, said nozzles being arranged to direct a jet of water across and in a direction opposed to the direction of said flow of current, a plurality of annularly arranged plates located in the convolutions of said third set near the outer peripheral walls thereof, means providing discharge passages for each of said pockets in the first and second sets of said convolutions and for the outlet openings in the third set of said convolutions and means normally closing the outlet ends of said discharge passages.

13. An apparatus for separating matter in suspension from a rapidly moving current of gaseous fluid, comprising a conduit in the form of a helical coil having a horizontal axis and provided with a plurality of convolutions, said convolutions being divided into three sets, means providing a plurality of discharge passages opening through the outer peripheral walls of the convolutions of the first two sets at circumferentially spaced points, each of the convolutions of the third set being provided with discharge opening at its lowest point, means for injecting water into the convolutions of said second set at circumferentially spaced points, and means for absolutely closing one of the discharge passages of said second set thereby allowing the water to partially fill the convolution of said set to form a water seal therein and prevent the back flow of gas therethrough.

In testimony, that I, claim the foregoing as my invention I affix my signature in the presence of two witnesses, this 10th day of April A. D. 1911.

LAWRENCE ANDERSON.

Witnesses:

CLARENCE E. MEHLHOPE,

GEORGE R. WILKINS.