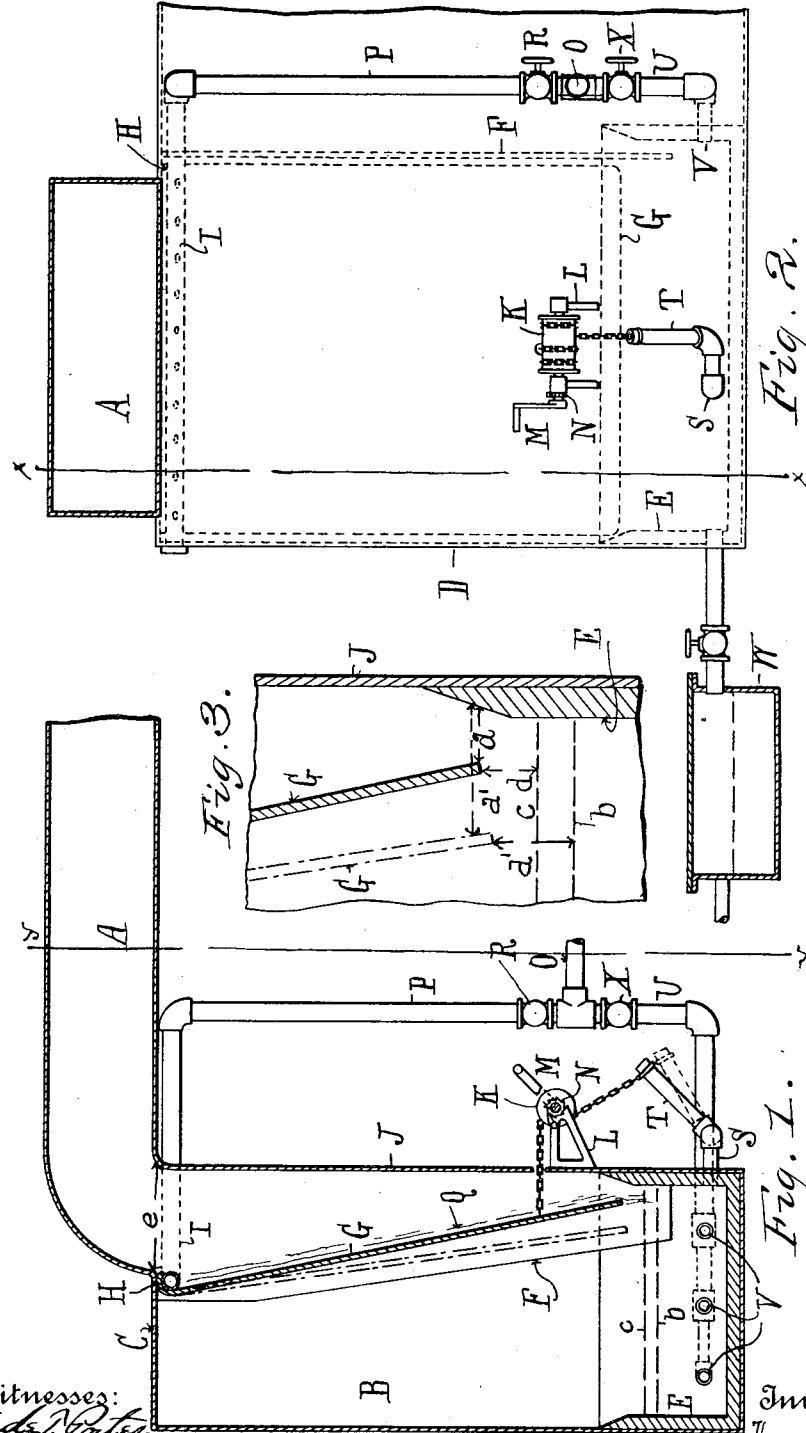


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 APPARATUS FOR TRAPPING PARTICLES IN SUSPENSION IN GAS CURRENTS.
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UNITED STATES PATENT OFFICE.

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APPARATUS FOR TRAPPING PARTICLES IN SUSPENSION IN GAS-CURRENTS.

1,064,984.

Specification of Letters Patent.

Patented June 17, 1913.

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To all whom it may concern:

Be it known that we, THOMAS E. MURRAY and CHARLES B. GRADY, citizens of the United States, residing at New York, in the county of New York and State of New York, have invented a certain new and useful Improvement in Apparatus for Trapping Particles in Suspension in Gas-CURRENTS, of which the following is a specification.

The problem which we have solved is to entrap the maximum percentage of solid particles entrained with and suspended in a gas current. This problem presents itself in the arts under many and different conditions. Those under which we have encountered it and which are therefore dealt with herein as typical, arise from the need which exists especially in cities and densely populated areas, of preventing the discharge of cinders and other solid matter in comminuted form from chimneys connected to boiler flues—especially when forced draft is used and when changes in the load demand the driving of the boilers to varying limits often much beyond their ratings. This is especially the case when the boilers furnish the power for electric lighting installations, the demands upon them then varying at different periods of the day, and sometimes suddenly increasing. The gas currents in the flues then vary greatly in velocity, with corresponding variations in the quantity of solid matter entrained.

We provide a body of liquid, preferably water, which receives and retains the particles projected upon it. We project the stream of particles vertically downward upon the surface of said liquid.

When the gas current varies in velocity, we vary the cross sectional area of the delivery outlet proportionately to said velocity, so that as this velocity decreases, the area will decrease, and as the velocity increases, the area will increase, thus maintaining a constant—or substantially constant—velocity of the projected jet of particles, and thus neutralizing the effect of the velocity changes in the current in the flue. If, therefore, at the outset, and for some selected velocity of flue current, the interval between the delivery outlet and the liquid level be chosen which will be, on the one hand, sufficiently large not to impose a constriction in the path of the escaping

gases, and, on the other, not too great materially to diminish the inertia of the projected particles before they strike the liquid, then it is obvious that no matter what conditions arise in the boilers capable of changing that velocity, by keeping the velocity of the projected jet constant, we can maintain the advantageous status previously decided upon, or, in other words, eliminate the effects of the varying conditions.

In addition to varying the escape outlet to maintain constant velocity, we may also vary the interval between the level of the liquid and said outlet or point of projection of the particles proportionately to the change in area of said outlet. For, obviously, if the area diminish to keep the discharge velocity constant, then the quantity of discharge per given time will be reduced. Because of this, we can reduce the interval between outlet and liquid level to an extent sufficient to accommodate this diminished quantity of outflow. Then because the liquid level has been brought nearer the discharge outlet, the jet of projected particles will strike the liquid with greater energy than before, will, therefore, more deeply penetrate it, and so will become more efficiently trapped.

We have invented a method and an apparatus which is the best we now know for carrying said method into practical effect.

Our present invention is the apparatus, more particularly set forth in the claims. In another application for Letters Patent, Serial No. 740,946 simultaneously filed herewith, we have set forth said method.

In the accompanying drawings—Figure 1 is a section of our apparatus on the line x, x of Fig. 2. Fig. 2 is a section on the line y, y of Fig. 1. Fig. 3 shows the relations of the discharge orifice and the water level as in Fig. 1, but on a larger scale.

Similar letters of reference indicate like parts.

A is a flue, leading from any source of gas current, which entrains in suspension the solid particles which are to be trapped. Such particles, for example, may be cinders, flue dust, ash, unconsumed carbon, or any other comminuted material present in the gas current in the flue of a steam boiler. The flue A communicates with an enlarged flue B, through the top wall C thereof. One end of flue B is closed by wall D. The

other end, shown broken off, in practice communicates with a chimney or other escape conduit. At the bottom of the flue B is a tank E for holding water. Said tank
 5 is preferably made of cement, or other material, which will resist the attack of such acids as may be formed by the gas combining with said water. Within the flue B and terminating at its lower edge,
 10 below the horizontal plane coinciding with the water level in the tank E, is a narrow vertical partition F.

G is a swinging plate extending between the partition F and end wall D. Said plate is hinged to the upper wall of flue B in any
 15 suitable way. As here shown, it has a hooked upper edge H which is received upon the water supply pipe I, which pipe is supported on the under side of the top wall C. The swinging plate G, the longitudinal
 20 wall J of flue B, the end wall D, and the fixed partition F, form a substantially funnel-shaped continuation of the flue A, which terminates above the liquid level in tank E, so that the solid particles escaping at the
 25 outlet *a*, Fig. 3, of said continuation are projected upon the liquid in a direction normal to the liquid surface. It will be obvious that by swinging the plate G nearer
 30 to the wall J, the area of said outlet *a* will be diminished, and by swinging the plate G farther from the wall J, the area of said outlet *a* will be increased. In order to swing the plate G for the purpose of ad-
 35 justing said outlet area, we here show a drum K mounted in brackets L on the exterior of wall J, and connected to plate G by a chain passing through said wall. Said drum is turned by the crank handle M, and
 40 is provided with a pawl and ratchet N, whereby the plate G is held in adjusted position.

The water supply to tank E is preferably admitted in a constant and regulated flow
 45 from the pipe O, communicating with any suitable source, which pipe connects by pipe P with the pipe I. The pipe I is perforated and is located at the top of plate G, so that a sheet of water Q flows down the inner side
 50 of plate G and into the tank E. This stream may be regulated by the valve R, in pipe P.

Water flows from the tank E by the pipe S located near the bottom thereof and provided outside the tank with a hinged section
 55 T. Said section is connected by a chain to the drum K. The function of the pipe section T is to adjust the water level in tank E, said level being raised when the pipe section is raised and lowered when said section is
 60 lowered. The chains from the swinging plate G and the pipe section T are connected to the drum K, so that when the drum is rotated, the plate and the pipe section will
 65 be moved or be permitted to move simul-

taneously. Hence, for example, when the area of the outlet *a* is reduced, the water level in tank E is correspondingly raised from the line *b* to the line *c*, Fig. 3.

The operation is as follows: The gas current holding the solid particles in suspen-
 70 sion enters the top of flue B between the swinging plate G and wall J, and passes downwardly, meeting the descending water stream Q. The current then escaping
 75 through the outlet *a*, the solid particles are projected downward upon the surface (indicated by line *c*, Fig. 3) of the water in tank E. The gas passes through the interval
 80 *d* between the lower end of the swinging plate G and the liquid surface *c*, and then travels through the flue B to the chimney or other outlet. The downward pro-
 85 jection of the particles is assisted by the water stream Q, delivered into them. The particles after striking the water in tank E, enter the same and so become trapped.

Attention is now called to the fact that the passage of which plate G forms a swing-
 90 ing wall has an inlet *e*, Fig. 1, of substantially the area of the flue A; while, when the plate G is in the position shown in dotted lines, Figs. 1 and 3, the area of the then
 95 existing escape outlet *a* is less than that of inlet *e*. As the cross sectional area of the passage from inlet *e* to the escape outlet *a*
 100 decreases, the velocity of the gas current is increased. Hence the inertia of the projected solid particles is increased. As this increase varies as the square of the velocity,
 105 and as the resistance of the projected particles to any force tending to change their direction of travel varies as the inertia, the result is a very effective trapping of the
 110 particles by the water.

Tests made by us upon an actual apparatus constructed substantially in accordance with our present disclosure show that it
 115 is possible to make the velocity of the gases at the escape outlet *a* or point of projection of the particles from two to eight times
 120 greater than the ordinary velocity of travel of gases in boiler flues, and still not seriously affect the draft.

It will be observed that the cross sectional
 115 area of the funnel-shaped passage bounded by plate G is gradually reduced so that the velocity of the particles before projection
 120 will be gradually increased. In actual practice, we find that the length of said passage may be from two to ten feet, but it is
 125 better to make it as long as possible so that the particles may be carried gradually to a velocity at the outlet *a*, relatively much
 130 higher than that which they have in flue A.

In many steam power plants, the quantity of steam required from the boilers varies considerably and quite rapidly
 130 throughout the day. For instance, a boiler may be running at a certain rating and the

demand may be such that double this rating may be required in a comparatively short space of time. When the boiler is running at double rating, approximately twice as much gas will be delivered from flue A. In using our apparatus in such circumstances, the swinging plate G is normally set in a selected position which gives an outlet area *a* to produce a certain escape velocity of the particles suitable to a certain rating—say the position shown in full lines in Fig. 1. If the rating is augmented—say doubled—then the pawl and ratchet mechanism N is released and the plate G is permitted to swing to another position whereby the escape area *a* is increased to *a'* sufficiently to reduce the velocity to that previously chosen—say the position shown in dotted lines in Figs. 1 and 3; or, in other words, by suitably adjusting the escape area at *a*, as the rating of the boiler is exceeded, we may keep the velocity of the particles constant at their point of projection or escape orifice.

In cases where the velocity of the current in the flue varies, especially when forced draft is used, it is desirable not only to vary the area of the outlet *a* so as to maintain the velocity there constant, but also to vary the interval *d* or length of the projected jet of particles between said outlet and the liquid level. Said interval should not be less in area than the area of outlet *a*. On the other hand, it is desirable to make it as small as possible. Let it now be assumed, for purposes of present explanation, that the plate G and the pipe section T are in the positions shown in dotted lines. The corresponding water level is then at *b*. When the velocity of the flue current falls off, the handle M is operated to bring the plate G into the position shown in full lines, thus reducing the area of outlet from *a'* to *a*, and increasing the velocity to normal rate. The velocity being kept constant, it follows that the amount of particles projected will be less as the area of discharge is constricted. Hence the interval at *d'* from partition G to level *b* may be diminished by raising the water to level *c*. This is effected as already explained, with an increase in the trapping efficiency.

Tests made by us with this apparatus applied to four 650 H. P. boilers have shown that ninety-two per cent. of the cinders or flue dust delivered to the apparatus was trapped in the water, and prevented from passing to the chimney.

In order to remove the accumulated cinders or like material from the tank E, we provide a branch pipe U from the water supply pipe O which has several inlets V into said tank. Similar outlets are provided on the opposite side of the tank which communicate with a settling vessel W. When

it is desired to clean out the tank, the gas current from the flue A is shut off, the valve R in pipe P is closed to cut off the water supply, and the valve X in pipe U is opened. The water entering the several inlets V sweeps the solid material to the outlets, and said material is collected and drained in the settling vessel W.

We claim:

1. A device for trapping particles in suspension in a gas current, comprising a duct receiving said current and tapering downwardly to an outlet, means for varying the cross sectional area of said outlet, and a tank containing liquid disposed below said outlet and receiving the particles projected therefrom.

2. A device for trapping particles in suspension in a gas current, comprising a tank, and a duct delivering said particles vertically downward upon the liquid in said tank; a portion of the wall of said duct being movable to vary the cross sectional area of the outlet of said duct.

3. A device for trapping particles in suspension in a gas current, comprising a tank, and a duct delivering said particles vertically downward upon the liquid in said tank; a portion of the wall of said duct being suspended to swing and movable to vary the cross sectional area of the outlet of said duct.

4. A device for trapping particles in suspension in a gas current, comprising a horizontal flue, closed at one end, a partition extending partly across said flue, a swinging plate suspended from the top of said flue at a distance from a longitudinal wall thereof and interposed between said partition and the closed end of said flue, a tank disposed in said flue below the space between said plate and said longitudinal wall, means for delivering the gas current into said space at the upper part thereof, and means for moving said plate to vary the distance of the lower edge thereof from said longitudinal wall.

5. A device for trapping particles in suspension in a gas current, comprising a tank, a duct delivering said particles downward upon the liquid in said tank and having one wall inclined toward the outlet, and means for delivering a liquid stream upon the surface of said inclined side.

6. A device for trapping particles in suspension in a gas current, comprising a tank, a duct delivering said particles downward upon the liquid in said tank, means for varying the cross sectional area of the outlet of said duct, and means for varying the distance between said outlet and the liquid level in said tank.

7. A device for trapping particles in suspension in a gas current, comprising a tank, a duct delivering said particles downward

upon the liquid in said tank, means for varying the cross sectional area of the outlet of said duct, means for varying the distance between said outlet and the liquid level in said tank, and mechanism for simultaneously controlling both of said means.

8. A device for trapping particles in suspension in a gas current, comprising a horizontal flue, closed at one end, a partition extending partly across said flue, a liquid supply pipe, having perforations, at the top of said flue, a swinging plate suspended from said pipe and receiving the liquid stream therefrom, the said plate being placed at a distance from a longitudinal wall of said flue and interposed between said partition and the closed end of said flue, a tank disposed in said flue below the space included between said plate and said longitudinal wall, and means for delivering a gas current into the upper part of said space.

9. A device for trapping particles in suspension in a gas current, comprising a duct receiving said current and tapering to an outlet, and means for delivering a stream of liquid upon the inner inclined surface of said duct.

10. A device for trapping particles in suspension in a gas current, comprising a vertical duct receiving said current at its upper end and having one wall suspended and movable to vary the area of the outlet, and means for delivering a stream of liquid within said duct and upon said suspended wall.

11. A device for trapping particles in suspension in a gas current, comprising a duct conveying said current, an inclined plate transversely placed therein, and means for delivering a liquid stream upon the side of said plate receiving the impact of said particles.

12. A device for trapping particles in suspension in a gas current, comprising a vertical duct conveying said current, an inclined plate suspended therein, and means for delivering a liquid stream upon the upper side of said plate.

In testimony whereof we have affixed our signatures in presence of two witnesses.

THOMAS E. MURRAY.
CHARLES B. GRADY.

Witnesses:

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Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."