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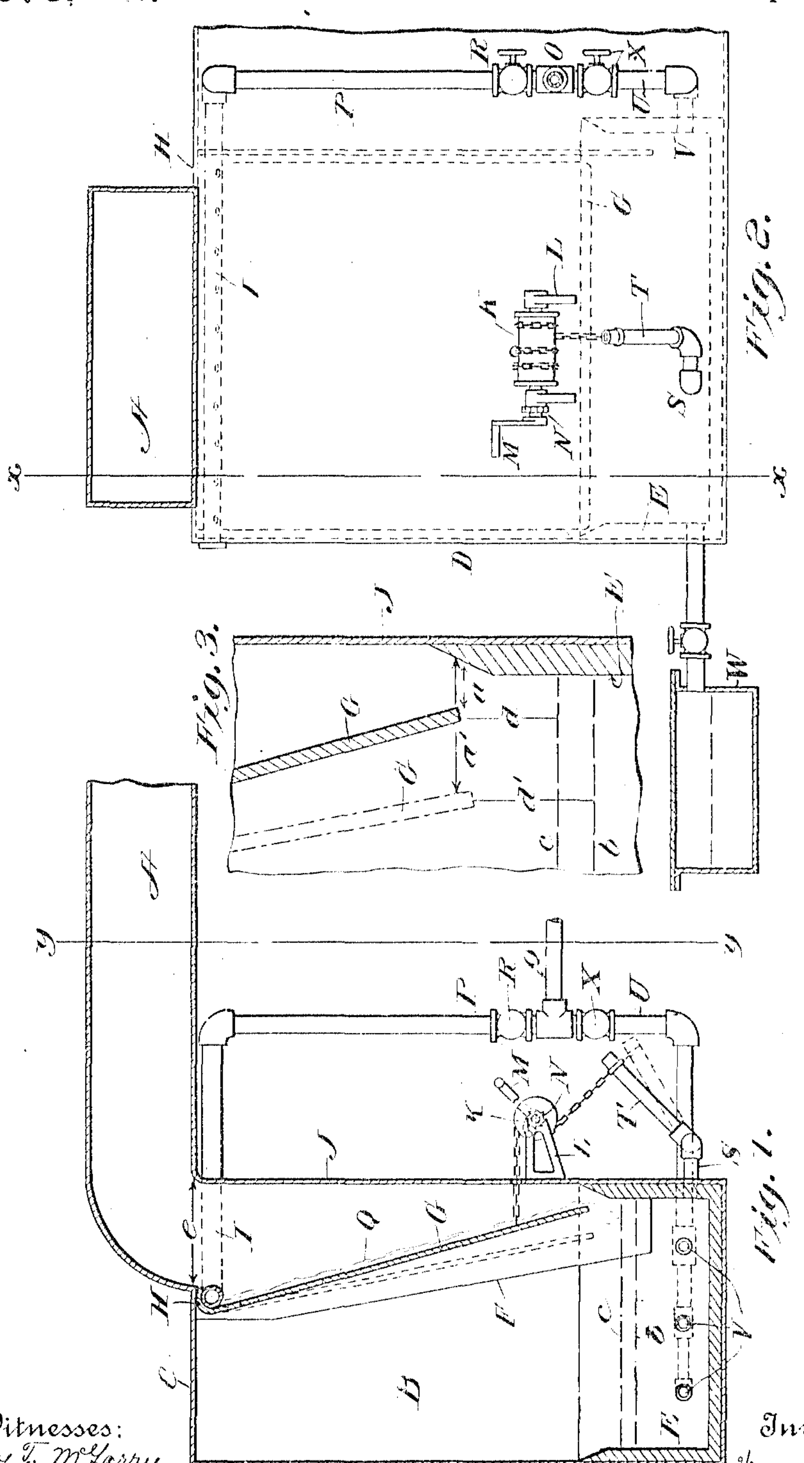
METHOD OF TRAPPING SOLID PARTICLES IN SUSPENSION IN GAS CURRENTS.

APPLICATION FILED MAY 28, 1913.

**1,073,622.** Patented Sept. 23, 1913.



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# UNITED STATES PATENT OFFICE.

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## METHOD OF TRAPPING SOLID PARTICLES IN SUSPENSION IN GAS-CURRENTS.

1,073,622. Specification of Letters Patent. Patented Sept. 23, 1913.

Original application filed January 9, 1913, Serial No. 740,946. Divided and this application filed May 28, 1913. Serial No. 770,305.

*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 Methods of Trapping Solid 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.

Our present invention is the method of trapping solid particles by projecting said particles in a direction normal to and upon the surface of the body of liquid, and maintaining the velocity of said particles at their point of projection substantially constant. In another application for Letters Patent, Serial No. 740,946, filed January 9, 1913, we have set forth another method, wherein the velocity of the particles at their point of projection is varied, and in application for Letters Patent Serial No. 740,947, filed January 9, 1913, we have set forth an apparatus in which either of said methods may be carried into practical effect. Our present application is a division of the aforesaid application Serial No. 740,946.

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 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, 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 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 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 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 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 adjusting 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 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 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 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 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 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 be moved or be permitted to move simultaneously. 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 suspension 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 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 *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 projection 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 swinging 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 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* 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, 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 particles by the water.

Tests made by us upon an actual apparatus constructed substantially in accordance with our present disclosure show that it 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 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 area of the funnel-shaped passage bounded by plate G is gradually reduced so that the velocity of the particles before projection 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 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 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 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 position 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. The method of trapping solid particles in suspension in a gas current of varying velocity which consists in projecting said particles in a direction normal to and upon the surface of a body of liquid, and maintaining the velocity of said particles at their point of projection substantially constant.

2. The method of trapping solid particles in suspension in a gas current of varying velocity which consists in projecting said particles in a direction normal to and upon the surface of a body of liquid, maintaining the velocity of said particles at their point of projection substantially constant, varying the cross-sectional area of discharge at said point and simultaneously varying the interval between the surface of said liquid body and said point of projection proportionately to said area variation.

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

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CHARLES B. GRADY.

Witnesses:
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