Aug. 16, 1960 A. H. KIRKBY 2,949,282

APPARATUS FOR CLEANING HEAT EXCHANGE MEANS

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FIG. 1

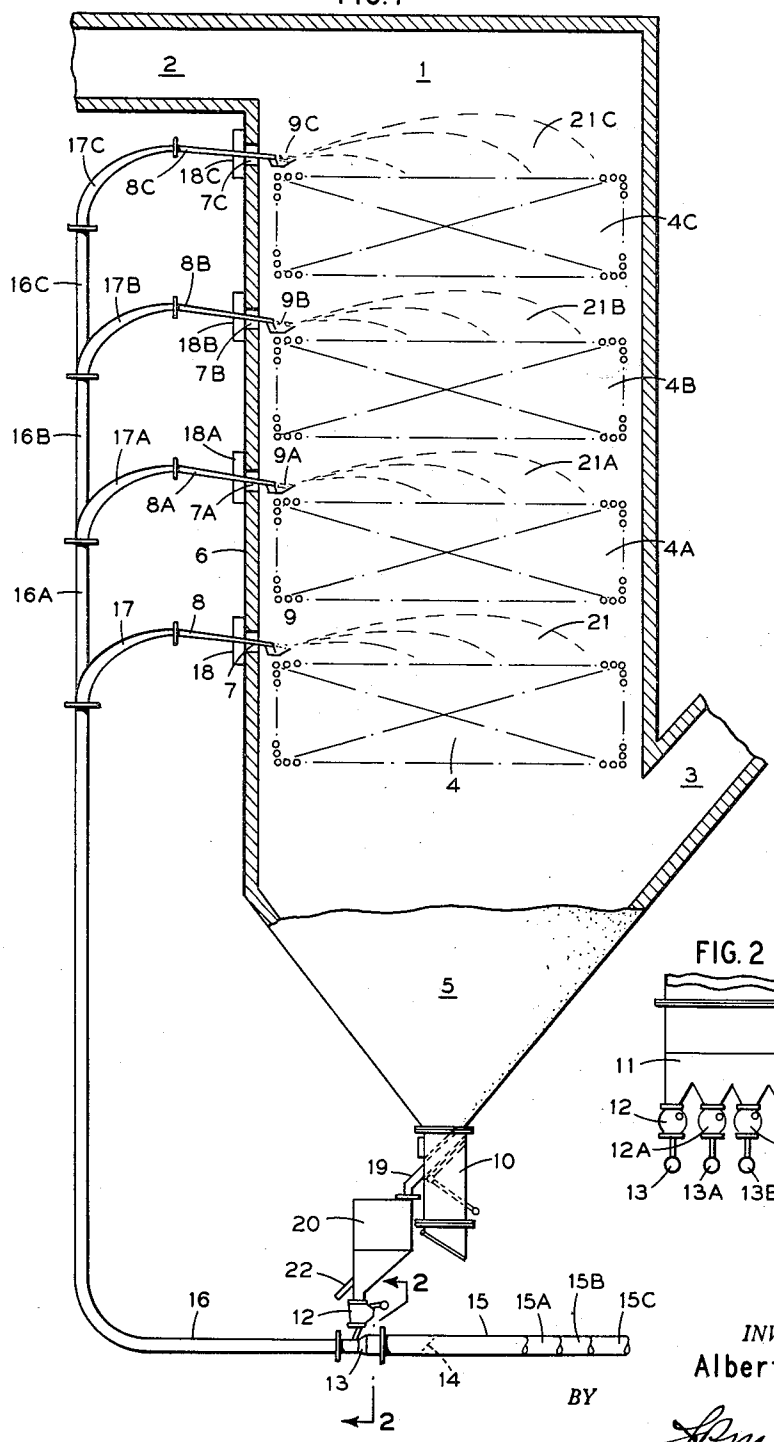


FIG. 2

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FIG. 3

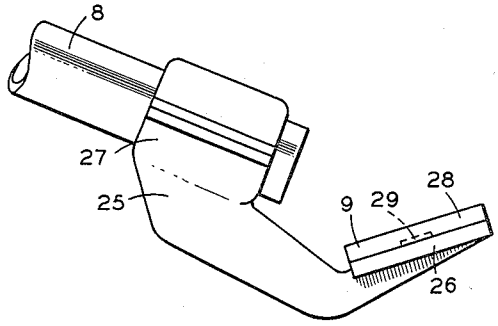


FIG. 4

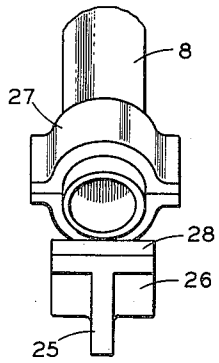


FIG. 5

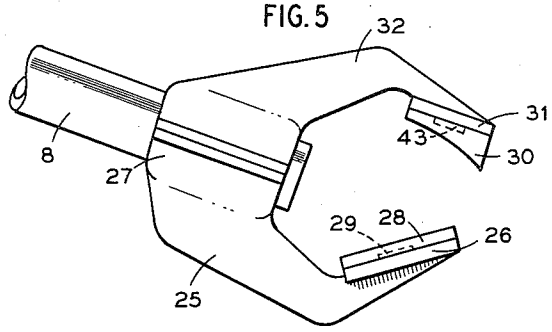


FIG. 6

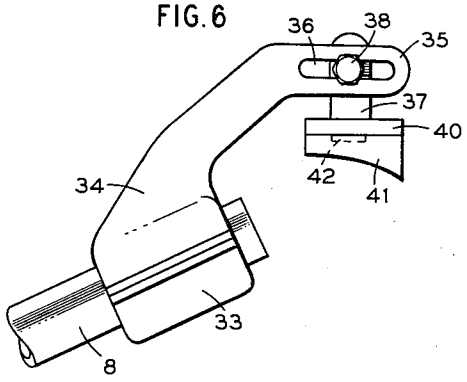
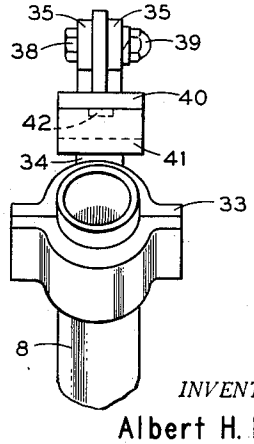


FIG. 7



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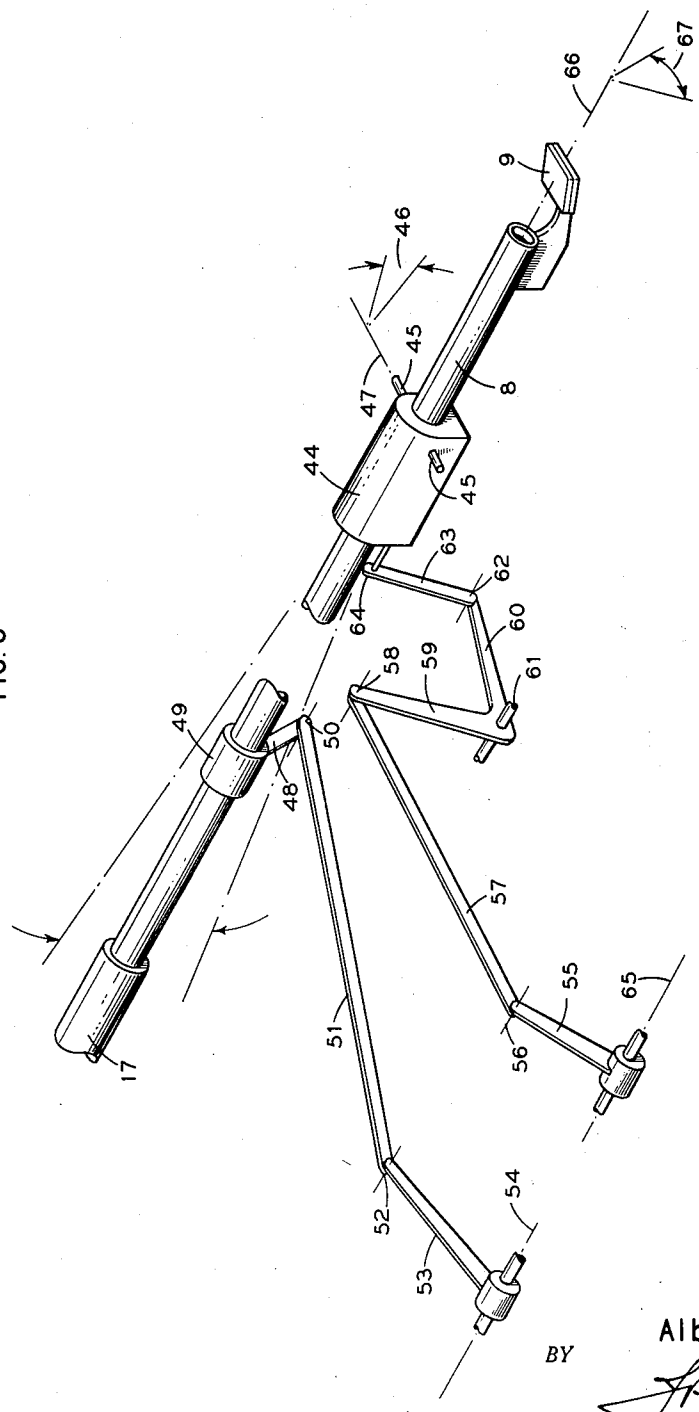
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FIG. 8



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APPARATUS FOR CLEANING HEAT EXCHANGE MEANS

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Claims priority, application Great Britain Nov. 23, 1954

3 Claims. (Cl. 257—1)

This invention relates to an improved apparatus for cleaning heat exchange means and is concerned with apparatus for cleaning heat exchange means disposed in an upright gas pass, the apparatus comprising means for supplying to the pass solid cleaning particles in order that the particles may fall within the pass and in falling may impact with deposits on surfaces of the heat exchange means to be cleaned.

Hitherto the cleaning particles have been fed into the pass through the roof thereof, so that the rain of particles falls through the whole pass. In practice, however, conditions may arise such that heat exchange surfaces near the bottom of a pass suffer more acutely from deposits than heat exchange surfaces near the top of the pass and it may be desirable to act with the cleaning particles more strongly on a lowermost tube bank or lowermost tube banks than on an adjacent tube bank or adjacent tube banks disposed higher up in the pass. Then again, it may be deemed desirable to avoid showering cleaning particles onto a tube bank or tube banks nearest the top of the pass, either because the action of the particles on the said bank or banks is unnecessary or because the action is liable to lead to ill effects.

The present invention includes apparatus for cleaning heat exchange means disposed in an upright gas pass, comprising means for supplying to the pass solid cleaning particles in order that the particles may fall within the pass and in falling may impact with deposits on surfaces of the heat exchange means to be cleaned, wherein provision is made for introducing cleaning particles into the pass at a region between vertically spaced tube banks contained in the pass.

The invention also includes apparatus for cleaning heat exchange means disposed in an upright gas pass, comprising means for supplying to the pass solid cleaning particles in order that the particles may fall within the pass and in falling may impact with deposits on surfaces of the heat exchange means to be cleaned, wherein provision is made for introducing cleaning particles at a plurality of regions above respective tube banks vertically spaced from one another in the gas pass.

The invention further includes apparatus for cleaning heat exchange means disposed in an upright gas pass, comprising means for supplying to the pass solid cleaning particles in order that the particles may fall within the pass and in falling may impact with deposits on surfaces of the heat exchange means to be cleaned, wherein the solid cleaning particle supply means include a tube arranged to receive particles borne by elastic fluid, to extend through a side wall of the pass and to direct the particles against a target member provided with means for imparting to the target member an oscillatory motion adapted to increase the area over which the cleaning particles are scattered.

The invention will now be described, by way of example, with reference to the accompanying partly diagrammatic drawings, in which:

Figure 1 is a side elevation, partly in section of an upright gas pass provided with the cleaning apparatus of the present invention;

Figure 2 is a view of part of the apparatus shown in Figure 1 looking in the direction of the arrows 2 showing the arrangement of entraining nozzles and their associated cleaning particle cut off valves;

Figure 3 is a side elevation of a part of a discharge tube and the associated target member shown in Figure 1, to a larger scale than that figure;

Figure 4 is an end elevation of the discharge tube and target member shown in Figure 3;

Figure 5 is a view similar to that of Figure 3 but showing a deflector member in addition to the target member;

Figure 6 is a side elevation showing part of a discharge tube and an alternative arrangement of target member to that shown in Figure 3;

Figure 7 is an end elevation of the discharge tube and target member shown in Figure 6; and

Figure 8 is a representation of an oscillating discharge tube suitable for use in the apparatus shown in Figure 1. For the sake of clarity the discharge tube is shown broken, the portions of the tube and the respective associated parts being displaced from one another in the direction of the axis of the tube.

In Figure 1 of the drawings, an upright gas pass 1 is provided with heat exchange means comprising vertically spaced tube banks 4, 4A, 4B and 4C of horizontal tube lengths arranged with adjacent rows in staggered formation. In a wall 6 of the gas pass is provided an upper gas inlet 2 adjacent the roof of the pass and the lower end of the pass is provided with a hopper bottom 5 adjacent the top of which is a gas outlet 3 from the pass.

The lower end of the hopper bottom is provided with cleaning particle collecting means which may be of the nature disclosed in my co-pending application, Serial No. 437,455, filed June 17, 1954. Thus a particle collecting duct 10 is provided with means for the removal of particles below a predetermined size and pieces of slag from the system, and is connected by a chute 19 for the passage of cleaning particles of normal size to a collecting bin 20 having an overflow spout 22 and a hopper bottom 11.

The lower end of the hopper 11 as is shown more clearly in Figure 2, is provided with outlets respectively connected to entraining nozzles 13, 13A, 13B and 13C, suitably of the nature disclosed in my said co-pending application and arranged side by side, through the associated cut off valves 12, 12A, 12B and 12C. The entraining nozzles are respectively connected at their supply ends to a source (not shown) of gaseous entraining fluid under pressure through the fluid supply ducts 15, 15A, 15B and 15C, and at their outlet ends to the cleaning particle conveying ducts 16, 16A, 16B and 16C. The fluid supply ducts are each provided with a fluid supply control valve, suitably a butterfly valve, as is shown at 14 for the duct 15. The conveying ducts are respectively connected to downwardly inclined, cleaning particle discharge tubes 8, 8A, 8B and 8C by means of associated lengths of suitably armoured flexible hose 17, 17A, 17B and 17C.

The discharge tubes which are respectively provided at their discharge ends with target members 9, 9A, 9B and 9C described below in connection with Figures 2 and 3, pass through the associated openings 7, 7A, 7B and 7C formed in the wall 6 respectively adjacent the regions above the tube banks 4, 4A, 4B and 4C. The tubes are supported on the respective casing members 18, 18A, 18B and 18C which are rigidly attached to the wall 6.

Referring to Figures 3 and 4, the target member 9

comprises a replaceable target plate 28 of wear resistant material spaced in the direction of discharge from the discharge end of the downwardly inclined tube 8 and inclined with respect to the longitudinal axis thereof upwardly and away from the discharge end. The target plate is located on a back plate 26, formed on support arm 25, by a spigot 29 projecting from the back plate and co-operating with a recess formed in the back of the target plate, and is rigidly attached to the back plate by studs (not shown). The support arm is removably attached to the tube 8 close to its discharge end by a split sleeve 27, clamped in position by bolts (not shown).

Elastic entraining fluid, suitably air or gas under pressure, is supplied through the ducts 15, 15A, 15B and 15C to the respective nozzles where the cleaning particles are entrained and carried through the associated ducts 16, 16A, 16B and 16C to the respective discharge tubes 8, 8A, 8B and 8C. The butterfly valves in the ducts 15, 15A, 15B and 15C allow separate regulation of the supply of entraining fluid to the associated nozzles and thereby allow separate regulation of the velocity of discharge of the fluid borne streams of cleaning particles from their associated discharge tubes. When a cut off valve is closed, the supply of entraining fluid to the associated nozzle is stopped by closing the butterfly valve in the corresponding supply duct.

Since the cut off and butterfly valves associated with each discharge tube are separately operable from the cut off and butterfly valves associated with the other discharge tubes, cleaning particles may be selectively introduced to the respective regions above the tube banks. Moreover, the duration of the discharge from any one of the discharge tubes may separately be controlled by operation of the associated cut off valve.

In the apparatus described, the necessity of providing means for separating the cleaning particles from the gaseous carrier fluid before discharging the cleaning particles above a tube bank is avoided.

Referring to Figures 1 to 4 of the drawings, in operation the fluid borne cleaning particles are discharged from the respective downwardly inclined discharge tubes 8, 8A, 8B and 8C and impinge on the target plates of the associated target members 9, 9A, 9B and 9C so that the particles undergo changes in direction and are dispersed upwardly and sidewardly and follow shallow trajectories through the regions above the vertically spaced tube banks 4, 4A, 4B and 4C, as schematically indicated by the broken lines 21, 21A, 21B and 21C, and fall over wide areas.

The conveying fluid may effect discharge of the cleaning particles from the tube at a high velocity of the order, say, of 100 feet per second. As a result, it is possible to throw particles deflected by the target plate a considerable distance and an area of substantial length may be served by a single tube and target plate. The cleaning particles fall through the tube banks, impacting with the deposits to be removed, and pass through the collecting duct 10 at the lower end of the hopper 5 and accumulate in the collection bin 20. Accumulations of slag and undersize cleaning particles may be removed from the collecting duct 10 at intervals and additional particles added to the system as is described in my copending application, Serial No. 437,455.

The cleaning particles are separately supplied from the collecting means to the nozzles 13, 13A, 13B and 13C through the respective cut off valves 12, 12A, 12B and 12C.

In the embodiment shown in Figure 5 of the drawings, the downwardly inclined tube 8 is provided, in addition to the target member, with a deflector member comprising a deflector plate 30 located on a back plate 31 by a spigot 43. The plate 30 is rigidly supported on the back plate by studs (not shown) and located with respect to the tube 8 by a support arm 32 which extends from one part of the split sleeve 27. The deflector plate 30 is so positioned in the cleaning particle path from the target plate 28 as to interfere with the stream of cleaning particles after their impact with the target plate. In operation some of the particles leaving the target plate 28, impinge on the deflector plate 30 and are deflected downwardly so that they follow paths different from those of particles trajected from the target plate alone. Wider dispersal of the cleaning particle stream may be attained, and heat exchange surfaces closer to the discharge tube 8 may be reached.

In the embodiment shown in Figures 6 and 7, the discharge tube 8 is upwardly inclined and the target member is disposed above the tube and formed with an impact surface inclined with respect to the axis of the tube and spaced in the direction of discharge from the discharge end of the tube. The target member comprises a replaceable target plate 41 having a curved impact face and formed of wear resistant material located on a back plate 40 by spigot 42 and rigidly attached to the back plate by studs (not shown). The back plate is provided with an arm 37 which is mounted between the bifurcations 35, formed at the end of a support arm 34, on a bolt 38. The bolt extends through slots 36 formed in the bifurcations and is provided with locking means 39 whereby the target plate may be clamped in adjusted position with respect to the support arm 34 which is removably attached to the discharge tube close to its discharge end by the split sleeve 33. The location of the target plate with respect to the discharge end of tube 8 may be adjusted by loosing the locking means 39 and rotating the plate about the bolt 38 or/and by sliding the bolt in the slots 36 before again clamping the arm 37 in position. Furthermore, the target member may be rotated about the longitudinal axis of the tube 8 by movement of the support arm 34 before clamping the split sleeve 33. The adjustments enable wear of the plate to be compensated and the dispersion characteristics of the plate with respect to the discharge stream to be varied.

In operation, the stream of fluid borne particles is directed by the upwardly inclined discharge tube against the target plate, and is dispersed downwardly and sidewardly onto the surfaces to be cleaned, ensuring cleaning of heating surfaces subjacent the discharge end of the tube 8. The tube and its target member may be adapted to spread the cleaning particles over a wide area and do not screen any part of the tube bank.

It will be understood that the number of discharge tubes above any one tube bank will depend on the area of surface to be cleaned, and that a plurality of spaced tubes may be positioned above the bank to ensure that cleaning particles reach all portions of the tube bank. For example, when more than one tube is to be provided at a region, the tube may be disposed in spaced relationship along one side of the gas pass, or at least one tube may be provided at each of two opposite walls of the gas pass.

The dispersion characteristics of the target and deflector plates may be varied by using impact surfaces of different contours. The surfaces may be flat, curved, or fluted, for example.

The quantity of cleaning particles discharged over any one tube bank must fall through any bank lower in the pass. The lower banks are therefore subject to the greatest cleaning effect, and the upper banks which may carry little or no deposit are not subjected to unnecessary discharges. In fact the scattering of cleaning particles onto heat exchange surfaces, for example, superheating surfaces in an upper portion of a pass constituting a high temperature zone may be avoided and heat exchange surfaces at the bottom of a pass may be cleaned without eroding clean heat exchange surfaces higher up in the pass.

When the gas pass is of large area of cross-section, it may be difficult for discharges from static discharge tubes

and deflector plates to reach all parts of the surfaces to be cleaned whilst retaining a substantially uniform cleaning effect over the whole surface. An increase in the area effectively cleaned by the discharge from one discharge tube 8 may be attained by varying the position of the associated target member. An oscillating mechanism to attain this end is shown in Figure 8 of the drawings in which the discharge tube 8, connected at its discharge end to the target member 9 and at its outer end to flexible hose connection 17, is rotatably mounted in a carrier member 44 which itself is pivotally supported on trunnions 45 on a base member (not shown) secured to a casing member such as 18 in Figure 1, and rotatable about horizontal axis 47 normal to the longitudinal axis 66 of tube 8. The upper end of an operating link 63 is connected by ball joint 64 to an end of the carrier member 44 on a side of the axis 47 remote from the target member 9. The lower end of operating link 63 is connected by ball joint 62 to an arm 60 of a bell crank lever pivoted on pins 61 about a horizontal axis normal to axis 47. The other arm 59 of the bell crank lever is rotatably connected by pin joint 58 to connecting link 57 which is rotatably connected to crank lever 55 by pin joint 56. The crank lever 55 is rotatably mounted about a horizontal axis 65 normal to axis 47.

Rigidly attached to the tube 8 close to the operating link 63 is a boss 49 having a radius arm 48 connected at its outer end by ball joint 50 to one end of the connecting link 51 which is connected as its other end by ball joint 52 to crank 53. The crank 53 is rotatably mounted about horizontal axis 54 which extends normally to axis 47.

In operation, rotation of the crank 55 about axis 65 causes angular oscillation of the tube 8 about axis 47 as indicated by the arrow 46. Rotation of the crank 53 about axis 54 causes angular oscillation of the tube 8 about its longitudinal axis 66 as is shown by arrow 67.

The path through which the beaten zone formed by the cleaning particles falling from the discharge tube 8 moves, may be controlled by adjusting the effective lengths of cranks 53 and 55 and of the arms 59 and 60 of the bell crank lever. In this way the amplitudes of the oscillations may be adjusted and consequently the area of heating surface over which the beaten zone moves may be varied.

The rate at which the beaten zone moves over the area determined by the amplitudes of the oscillations of the tube may be controlled by varying the speeds of rotation of the cranks 53 and 55 with respect to each other and to this end the cranks are mounted on separate driving shafts.

While in accordance with the provision of the statutes I have illustrated and described herein the best form of the invention now known to me, those skilled in the art will understand that changes may be made in the

form of the apparatus disclosed without departing from the spirit of the invention covered by my claims, and that certain features of my invention may sometimes be used to advantage without a corresponding use of other features.

What is claimed is:

1. Apparatus for cleaning heat exchange means including vertically spaced banks of horizontally arranged tubes disposed in an upright gas pass wherein said vertically spaced banks of tubes are sufficiently spaced for transverse distribution of solid cleaning particles completely across said gas pass, comprising means for supplying to the pass said solid cleaning particles in order that the particles may fall within the pass and in falling may impact with deposits on surfaces of the heat exchange means to be cleaned including separate particle discharge means positioned in each of said interbank spaces, and means for introducing controlled amounts of cleaning particles to each of said separate particle discharge means.

2. Apparatus for cleaning heat exchange means including vertically spaced banks of horizontally spaced tubes disposed in an upright gas pass wherein said vertically spaced banks of tubes are sufficiently spaced for transverse distribution of solid cleaning particles completely across said gas pass, comprising means for supplying to the pass said solid cleaning particles in order that the particles may fall within the pass and in falling may impact with deposits on surfaces of the heat exchange means to be cleaned including separate particle discharge tubes positioned in each of said interbank spaces, the said solid cleaning particle supply means including a plurality of tubes arranged to receive particles borne by elastic fluid, and means for regulating the amount of cleaning particles delivered to each of said discharge tubes.

3. Apparatus according to claim 2 including a target member positioned adjacent the discharge end and in the path of flow from each of said tubes, and means for oscillating each said target member about the longitudinal axis of its individual tube and about a horizontal axis transverse to the longitudinal axis thereof.

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