Feb. 25, 1941. J. E. WATSON 2,233,066

CLEANING DEVICE

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Fig. 1.

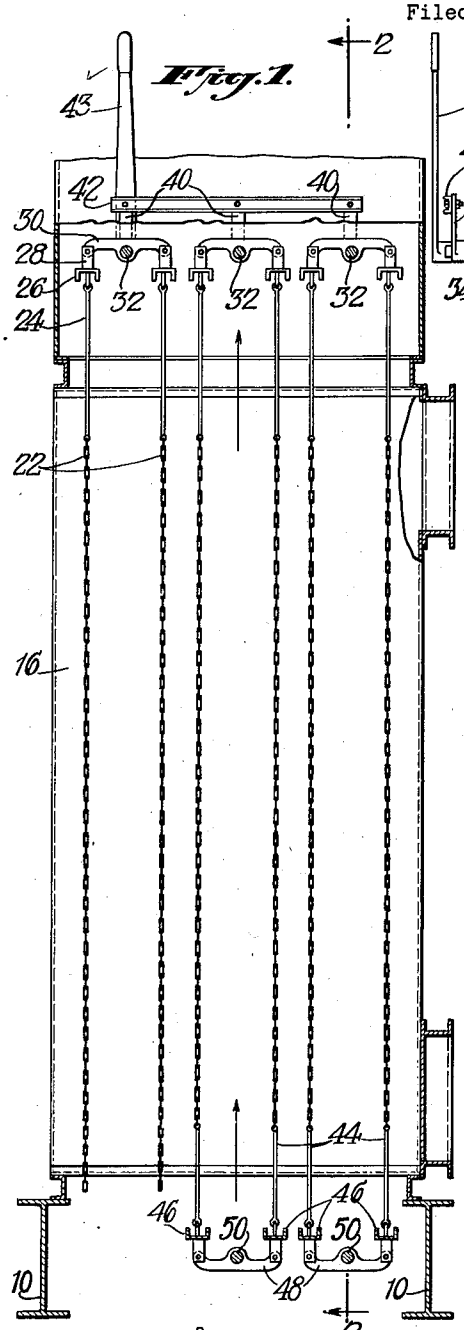


Fig. 2.

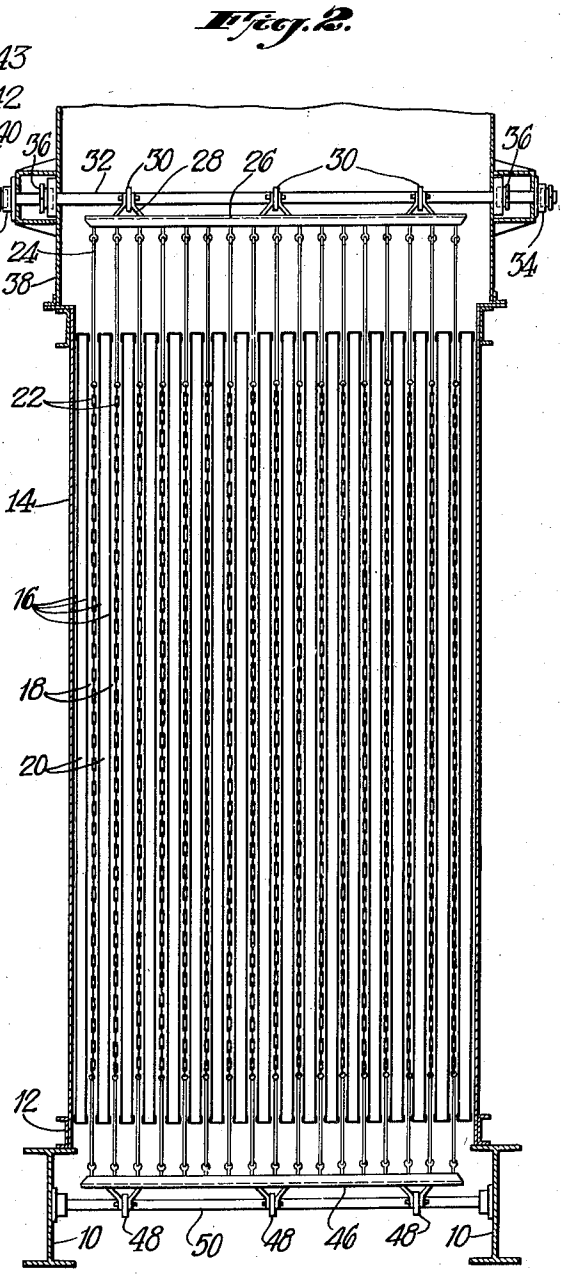
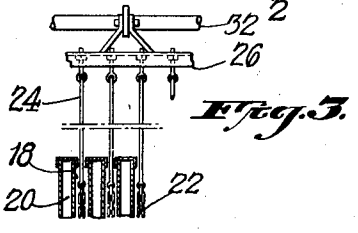


Fig. 3.



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Fig. 4.

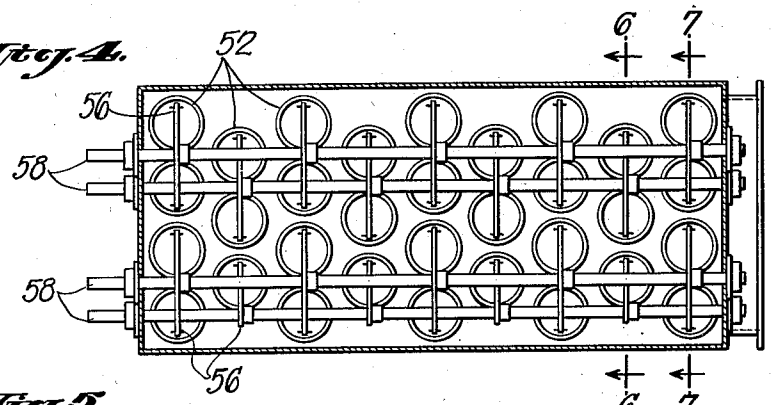


Fig. 5.

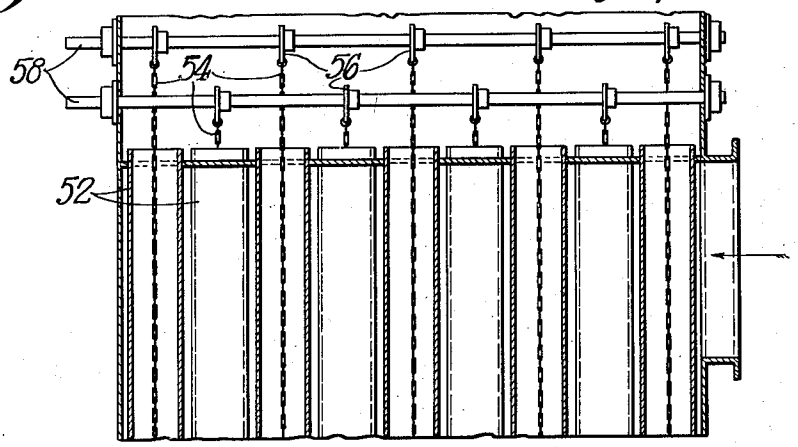


Fig. 6.

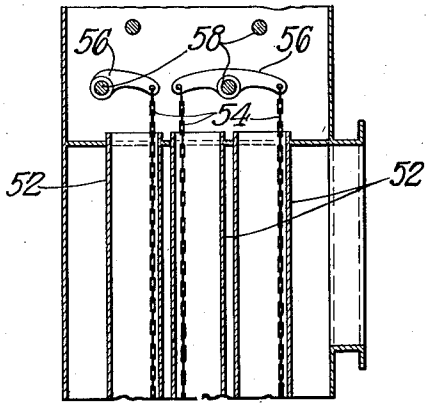
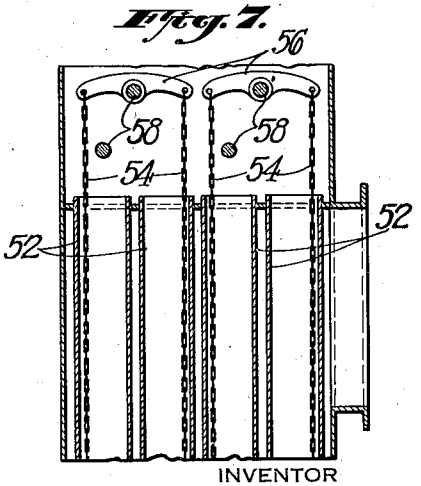


Fig. 7.



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Fig. 8.

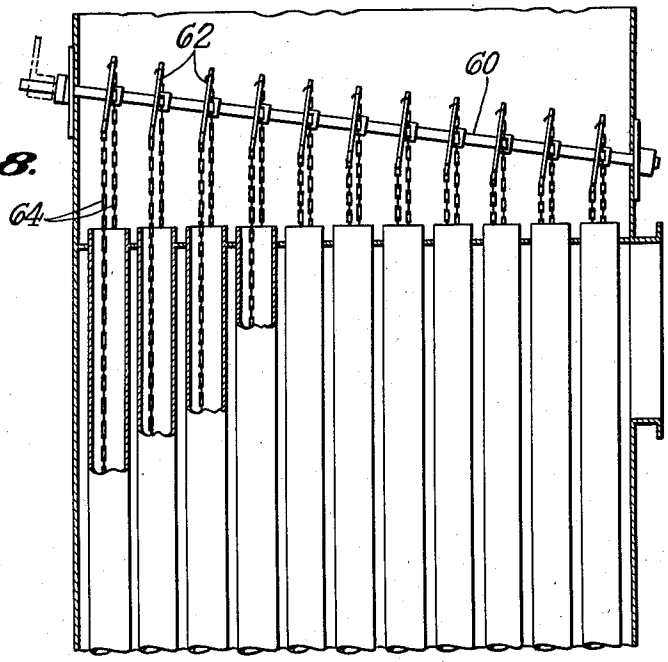


Fig. 9.

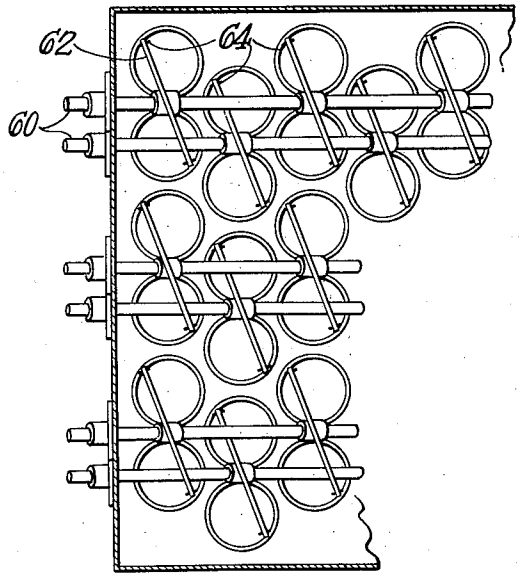
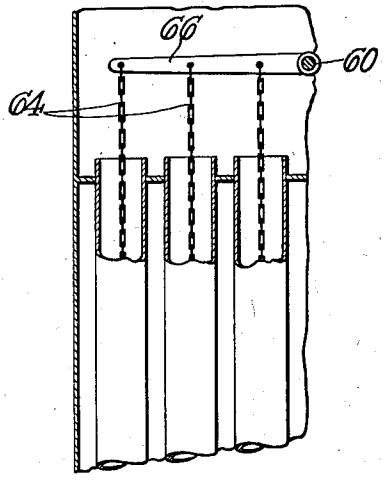


Fig. 10.



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Fig. 11.

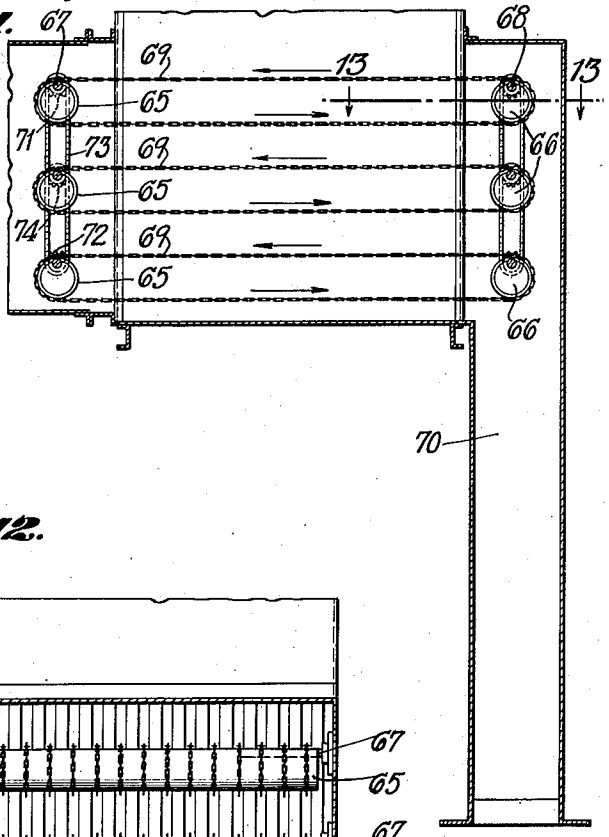


Fig. 13.

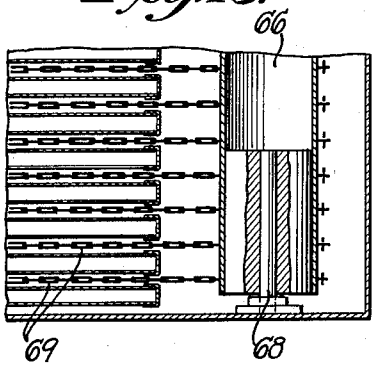
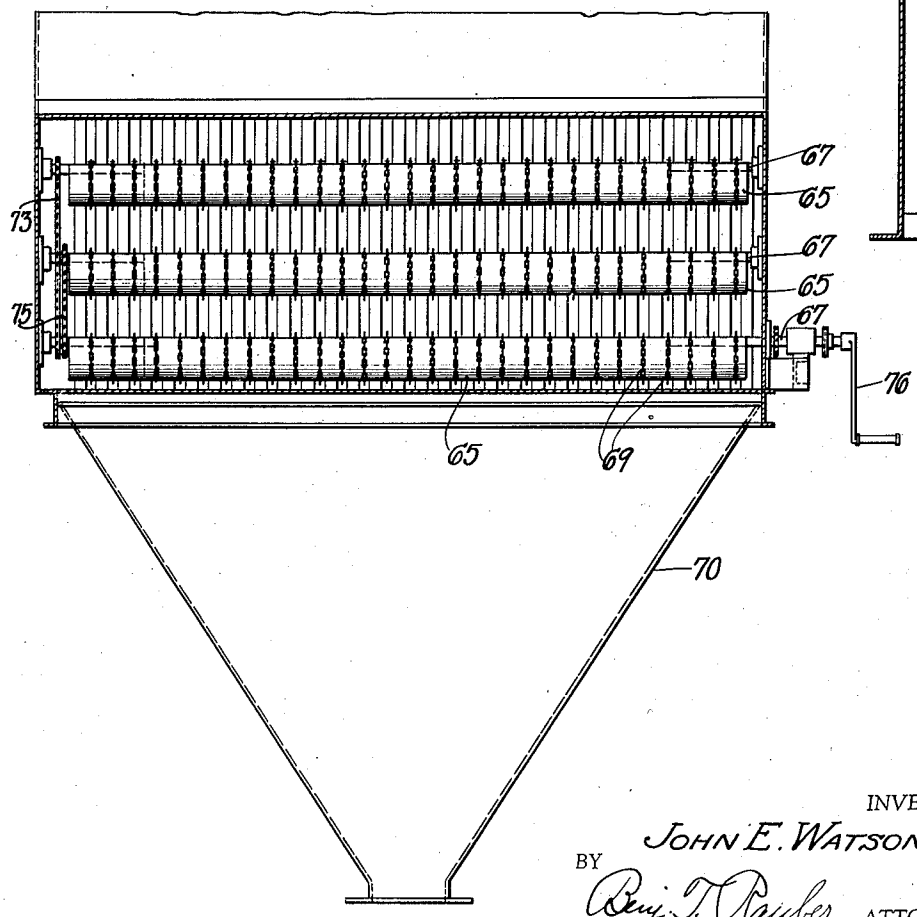


Fig. 12.



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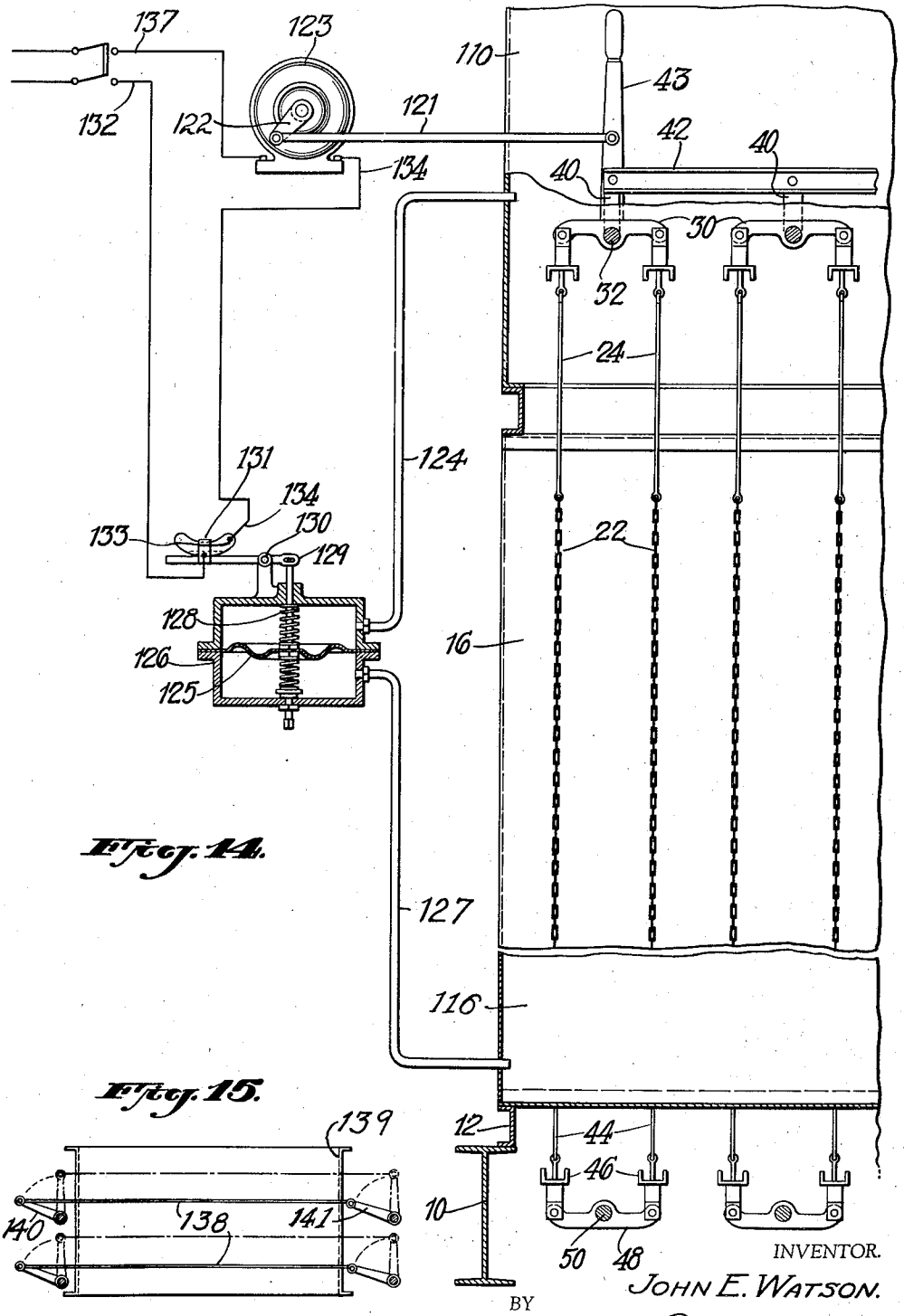


Fig. 14.

Fig. 15.

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Patented Feb. 25, 1941 2,233,066

UNITED STATES PATENT OFFICE

2,233,066

CLEANING DEVICE

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Application April 12, 1938, Serial No. 201,522

8 Claims. (Cl. 15—243)

This invention relates to cleaning devices for freeing the surfaces of heat exchangers and the like from dust or soot accumulated thereon.

In various types of apparatus used for heat transfer, especially between gaseous products, one or both of the products may contain soot or chemicals which have a tendency to deposit upon the side of the plate, tube, or other member defining the passage through which the gas travels. Frequently, there is a deposit of moisture from the gases and if sulphur dioxide is present therein the action of moisture, sulphur dioxide and iron has a tendency to block up the passage.

Heretofore, to clean such passage, soot blowers have been employed using jets of steam or air. Practice has shown, however, that the force of an air or steam jet is frequently insufficient to properly clean the surfaces in question. Moreover, when using such soot blowers, water is condensed in the steam or air lines thereof. This results in moistening the atmosphere and tends with the sulphur dioxide condition above referred to to form a deposit on the plates defining the passages, tending to block such passages.

The present invention aims to provide means for overcoming the defects inherent in the soot blowers of the prior art and does away with the use of jets of steam or air by the provision of a multiplicity of mechanical means arranged to be moved over the surface of the heat exchanger elements with a sweeping motion so as to dislodge from the plates or tubes any soot or dust accumulated thereon.

The invention will be more fully apparent from the following specification when read in connection with the accompanying drawings and will be defined with particularity in the appended claims.

In the drawings—

Fig. 1 is a vertical transverse section through a heat exchanger embodying my invention; Fig. 2 is a longitudinal section thereof on line 2—2 of Fig. 1; Fig. 3 is an enlarged detail view more clearly showing the manner of supporting the flexible elements for sweeping the members forming the heat exchanger passageway; Fig. 4 is a plan view of a portion of a form of heat exchanger having tubular passageways equipped with the cleaning device of the present invention; Fig. 5 is a vertical section thereof; Figs. 6 and 7 are sections taken on lines 6—6 and 7—7 of Fig. 4; Fig. 8 is a view of a further modification; Fig. 9 is a partial plan of the apparatus shown in Fig. 8; Fig. 10 illustrates a modification in which a single lever carries a plurality of chains for operating in different rows of tubes; Figs. 11 and 12 illustrate a modification wherein flexible cleaning elements are propelled horizontally by eccentrically mounted rotary members; Fig. 13 is a fragmentary section on line 13—13 of Fig. 11; Fig. 14 is a view illustrating means whereby the flexible sweeping elements are actuated automatically in response to a predetermined variation in the static head required for forcing a given quantity of gas through the gas passages of the heat exchanger. Fig. 15 is a diagrammatic view of another modification of the invention.

Referring in detail first to Figs. 1 to 3 inclusive of the drawings, 10—10 represent structural members which support the lower channel frame members 12 of a heat exchanger, the outer casing of which is indicated at 14. The heat exchanger here illustrated includes a multiplicity of plate-like members 16 defining passageways 18 through which heated gaseous products are adapted to be passed so as to heat air flowing through alternate passages 20. The gas flowing through the passages 18 will frequently carry in suspension dust or soot or chemicals which have a tendency to deposit on the surfaces of the plates 16. To free these plate-like surfaces of such accumulated dust or soot, I provide flexible members and means for providing both a vertical and lateral movement thereto, so as to exert a sweeping effect over the surface of the members defining such passages.

The flexible members shown in Figs. 1 to 3 inclusive are in the form of chains 22 suspended by hanger links 24 from overhead channel bars 26, which have ears 28 pivotally connected to rocker arms 30 carried by rock shafts 32. The several rock shafts are mounted in suitable anti-friction bearings 34 and a dust-type packing gland 36 is provided where the shaft passes through the wall 38 of the duct member secured to the upper end of the heat exchanger.

There may be a plurality of shafts 32, as shown in Fig. 1, and each shaft may carry an arm 40 connected with a cross-link 42, so that movement of any one shaft will be transmitted to the others. The several shafts may be actuated either manually by swinging the hand lever 43, or power driven means may be employed for rocking such shafts. Upon rocking of the shafts, the arms 30 will be turned from the substantially horizontal position of Fig. 1 to a vertical position approximately at right angles thereto. The result of this movement will be to lift the chain on one end of the rocker arm and to lower the chain on the other end. And during such lifting and lowering movements because of the arcuate travel of the bars 26, to which the chains are secured,

the latter will also partake of a lateral or sidewise movement. This movement up and down and sidewise of the chains may be referred to as a sweeping movement, as it is effective to cause each of the chains to sweep over a limited area of the plate to which it is mounted adjacent. The chains may merely hang down loosely from the bars 28, as shown at the left hand side of Fig. 1, or as shown at the right hand side of the figure, the lower end of each chain may be connected to a link 44, which in turn will be secured to a bar 46 coupled to a rocker 48 similar to the rocker 30, this lower rocker being carried by a suitable shaft 50. With this latter arrangement, the arms 48 and 30 will compel the chains 22 to make a substantially parallel motion, as will be understood.

Referring to Figs. 4 to 7 inclusive, I have here shown a heat exchanger in which the passages for the soot carrying air or gas are in the form of round tubes 52, each having therein a loosely hanging chain 54, depending from the end of a rocker 56 carried by a rock shaft 58. In such tubular heat exchangers, the tubes are arranged in rows, as indicated. The rocker arms may be of a length so that the chains hanging from the end thereof strike the opposite walls of adjacent tubes, as shown in Figs. 6 and 7, the shaft 53 being located about midway between the tubes. As the arms 56 are rocked, they will agitate the chains, causing them to strike all sides of the tubes when the rocker arms are given a quick jolt, it being apparent that the loose hanging chains will have a tendency to whip around when quickly moved.

Instead of having the sweeping chains operating in tubes which are immediately adjacent one another, it is evident that a spacing of different levels of shafts 58 may be made so that the rocker arms 56 will be longer than required for immediately adjacent rows of tubes, thus a single rocker arm may serve tubes in rows which are two or more rows apart, with the advantage in such a case of having a clear up and down travel for that part where the chain is carried from one side of the tube to the opposite side.

In the modification of Figs. 8 and 9, the shaft 60 for the rocker arms 62 is inclined at a slight angle to a horizontal line perpendicular to the axis of the tubes. With the shaft so inclined, it is apparent that, as the same is rocked, the chains 64 carried at the respective ends of the double-ended arms 62 will have imparted thereto a lateral motion as well as an up and down motion. This will cause the chains to sweep or brush by the tube surfaces and thus free all portions thereof from any accumulated dust or soot thereon.

In the modification of Fig. 10, the rocker arm 66 illustrated serves more than two rows of tubes, thus simplifying the apparatus by decreasing the number of shafts 60. It is apparent that the sideways and up and down motion of the chains most remote from the shaft will be greater than that of the chains nearest the axis of the shaft, but the tendency of the chains to swing will prevent any objectionable difference occurring in the cleaning effect of the respective chains nearest and farthest from the shaft.

In the above described embodiments of the invention, the flexible sweeping members are disposed for substantially vertical movement. However, in some cases, I contemplate the employment of horizontally disposed members which may be chains or other flexible elements. Such modification is illustrated in Figs. 11 and 12, wherein I provide a plurality of spaced drums 65—66, which are eccentrically mounted on shafts 67 and 68. Chains 69 are trained around the drums.

Thus, as the latter rotate, the chains will travel around the drums. And at the same time, they will have an up and down sweeping movement imparted thereto, thus tending to clean that portion of the plate to which they are mounted adjacent. As the accumulated matter tends to drop toward the bottom, the chains will be effective to have a conveyor-like action tending to sweep any accumulated matter toward the hopper 70 formed at the lower end of the casing. The uppermost shaft 67 will carry a sprocket 71 and the lowermost shaft 67 will carry a sprocket 72. And a chain 73 trained over such sprockets will transmit motion from the uppermost shaft to the lowermost shaft. A middle shaft will carry a sprocket 74, which will be driven by a chain 75 from the sprocket 72 on the lowermost shaft. The lowermost shaft may have an extension, as indicated in Fig. 12, carrying a crank 76, by means of which the shaft may be manually operated, or this crank may be automatically mechanically actuated, by means hereinafter referred to.

In the normal operation of heat exchangers of the kind described herein, the soot, dust, or other foreign matter resulting from the salts formed by the reaction of sulphur dioxide and sulphur trioxide, iron and moisture becomes deposited upon the surface of the plates, or tubes and actually results in an increase in the static head or pressure required for forcing a given quantity of gas through the gas passages. I, therefore, aim in some cases to provide a motor operated device, such as illustrated in Fig. 14, for motivating the lever 43 of Fig. 1 and connected thereto by the link 121 and crank arm 122. Thus, the cleaning action resulting from the sweeping motion of the chains can be automatically set into operation, when the static pressure difference between the inlet and the outlet exceeds a predetermined amount.

This apparatus includes a motor 123 arranged to be rotated when the difference in pressure between the inlet 110 and the outlet 116 of the heat exchanger exceeds a set limit. For this purpose the pressure at the inlet portion 110 is transmitted through a pipe 124 to the upper side of a diaphragm 125 in a diaphragm chamber 126, while the pressure in the outlet chamber 116 of the heat exchanger is transmitted through a pipe 127 to the opposite or underside of the diaphragm 125. The position of the diaphragm will rise or fall, in accordance with the variations in pressure transmitted to the opposite sides thereof. These changes in the height of the diaphragm are transmitted through a connecting rod 128 to one end of a lever 129 pivoted at 130 to an upright on the diaphragm chamber, said lever carrying near its free end a mercury switch 131. Current is supplied from a main 132 to one terminal of the switch 131. A terminal 133 at one end of the switch is connected through a conductor 134 to one terminal of the motor 123. When the diaphragm 125 falls, the switch 131 will be tilted to connect the main 132 with the terminal 133 and thus through the conductor 134 to the motor 123. As this drop in the diaphragm is caused by the increase in the pressure difference from the inlet to the outlet of the heat exchanger, the current supplied through the motor 123 rotates the crank arm 122 to shake the lever 44 and bar 42 so as to actuate the sweeper chains.

When the pressure difference falls, the dia-

phragm 135 will rise, tilting the switch 131 in the opposite direction and break the circuit to stop the motor. Current supplied to the motor 123 returns to the main 137. With this arrangement it is apparent that the sweeping chains are automatically set in operation, when the static pressure difference at the inlet above that at the outlet exceeds a predetermined amount.

When the invention is to be applied in other than a vertical position, as, for example, with the dust dislodging means horizontal or inclined, rods are preferably used as shown in Fig. 15. In this embodiment, the ends of rods 138, extending through a passage 139 to be cleaned, are supported at their opposite ends on rocking levers 140 and 141 which rock in phase to swing the rods 138 upwardly and downwardly as indicated in the dot and dash lines. It will be understood that the rods may swing over areas that contact or overlap so as to clean all portions of the passages.

While I have described quite precisely certain structural details of the embodiments of the invention herein illustrated, it is to be understood that the drawings and description are to be interpreted in an illustrative rather than a limiting sense since various modifications and substitutions of equivalents may be made by those skilled in the art without departure from the invention as defined in the appended claims.

What I claim is:

1. In a heat exchanger, a multiplicity of members defining passages for impurity laden gas, means for dislodging accumulated deposits from said members comprising flexible chains disposed in said passages, bars from each of which a multiplicity of said chains are suspended and a shaft having rocker arms supporting said bars, the arrangement being such that as the arms are rocked, the chains will be moved upward and downward and from side to side so as to contact said members with a sweeping motion and thus dislodge any accumulated deposits.

2. In an apparatus of the character described having a member whose surface is exposed to a stream of gas carrying foreign matter such as dust, soot, or chemical products resulting from the formation of deposits thereon, a flexible element adapted to sweep the surface of said member, means for imparting a sweeping movement to said element, and means responsive to variations in the gas pressure for automatically actuating said last-named means.

3. In a heat exchanger having inlet and outlet portions, a multiplicity of members defining passages for impurity laden gases, means for dislodging accumulated deposits from said members comprising flexible elements disposed in said passages, motion imparting means effective to actuate said flexible elements, and means responsive to variations in the gas pressure between the inlet and outlet portions of the heat exchanger for automatically actuating said motion imparting means.

4. In a heat exchanger having gas inlet and outlet portions, a multiplicity of members defining passages for impurity laden gas, flexible elements disposed in said passages for dislodging accumulated deposits from said members, mechanism for imparting movement to said flexible elements, a motor for driving said mechanism and means responsive to variations in the gas pressure between the inlet and outlet portions of the heat exchanger for automatically controlling the operation of said motor.

5. Apparatus for cleaning accumulated solid matter from the walls of gas passages which comprises a pair of arms pivoted on spaced parallel axes, and a chain suspended between and secured to said arms at distances from their pivotal axes to move over an area to be cleaned as said arms rock in unison said arms each swinging in an arc to one side of a line through their pivotal points to cary said element in movement substantially of translation only.

6. Apparatus for cleaning accumulated solid matter from the walls of gas passages which comprises rocker arms, one at each end of an area to be cleaned, and pivoted on axes intermediate their ends, and chains suspended between said arms on opposite sides of their axes to sweep over the areas to be cleaned as said arms are rocked in unison.

7. Apparatus for cleaning accumulated solid matter from the walls of gas passages which comprises a pair of elements pivoted on spaced parallel axes at opposite ends of the area to be cleaned and swinging in unison and in the same angular direction and in approximate parallelism, and a chain supported between said pivoted elements at a distance from the pivotal axes thereof to be moved with a movement of translation over the area to be cleaned as said pivoted elements are swung on their pivotal axes.

8. Apparatus for cleaning accumulated solid matter from the walls of gas passages which comprises a pair of elements pivoted on spaced parallel axes at opposite ends of the area to be cleaned and swinging in unison and in the same angular direction and in approximate parallelism, and a flexible sweeping member supported between said pivoted elements at a distance from the pivotal axes thereof to be moved with a movement of translation over the area to be cleaned as said pivoted elements are swung on their pivotal axes.

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