April 1, 1941. J. A. YOUNG ET AL 2,236,635

APPARATUS FOR CLEANING PREHEATERS

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FIG. 1.

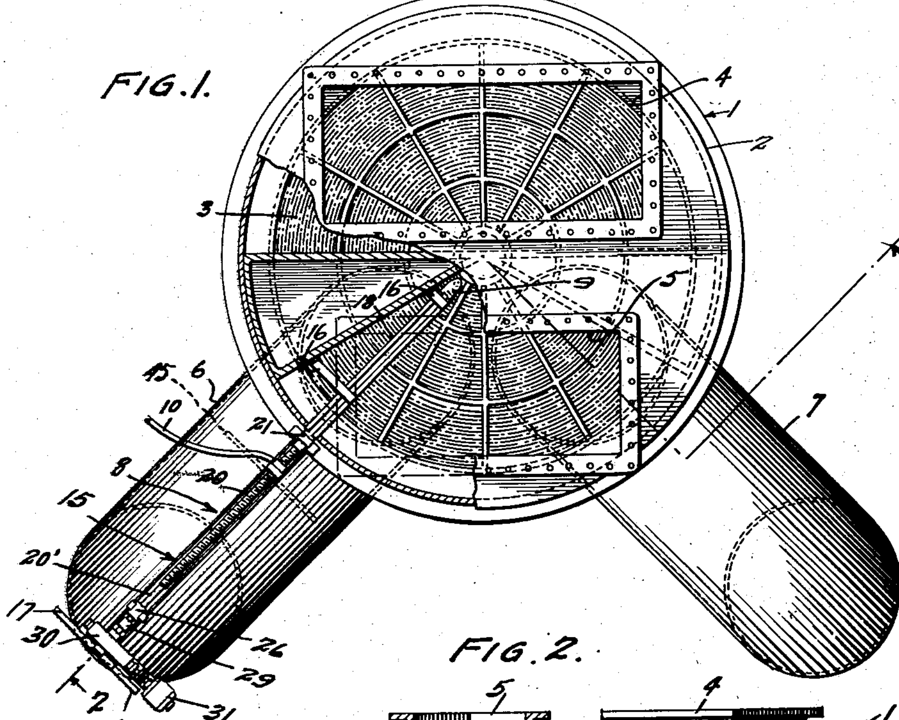
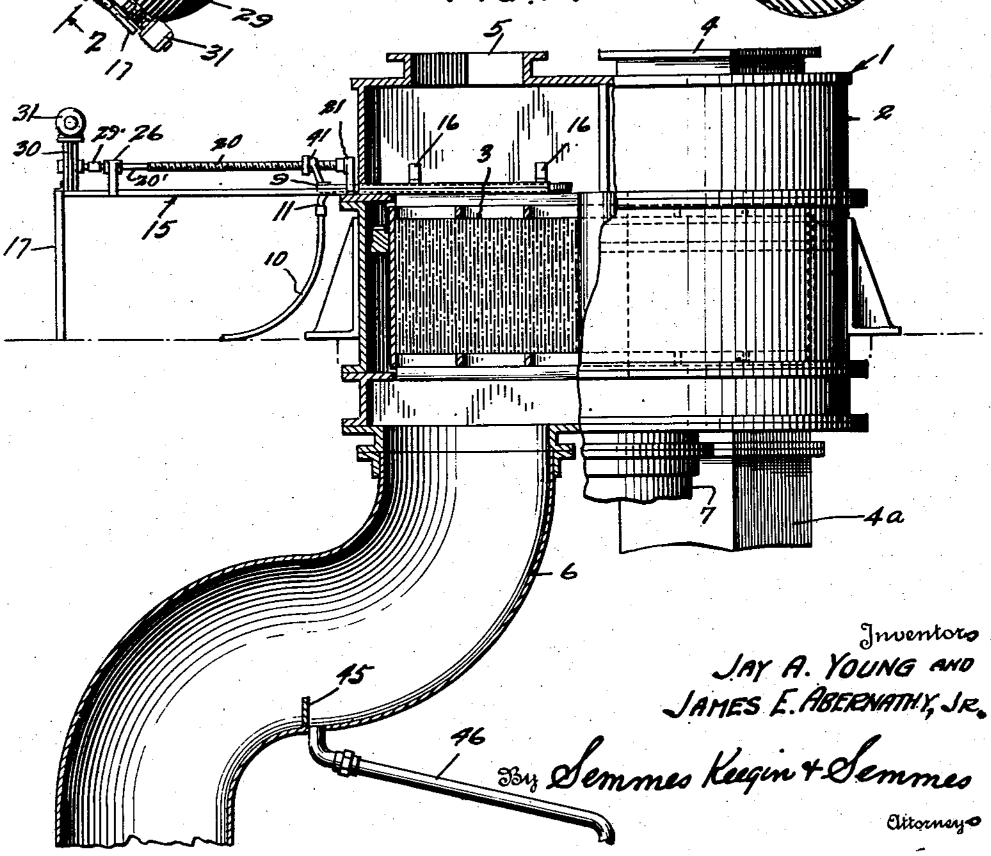


FIG. 2.



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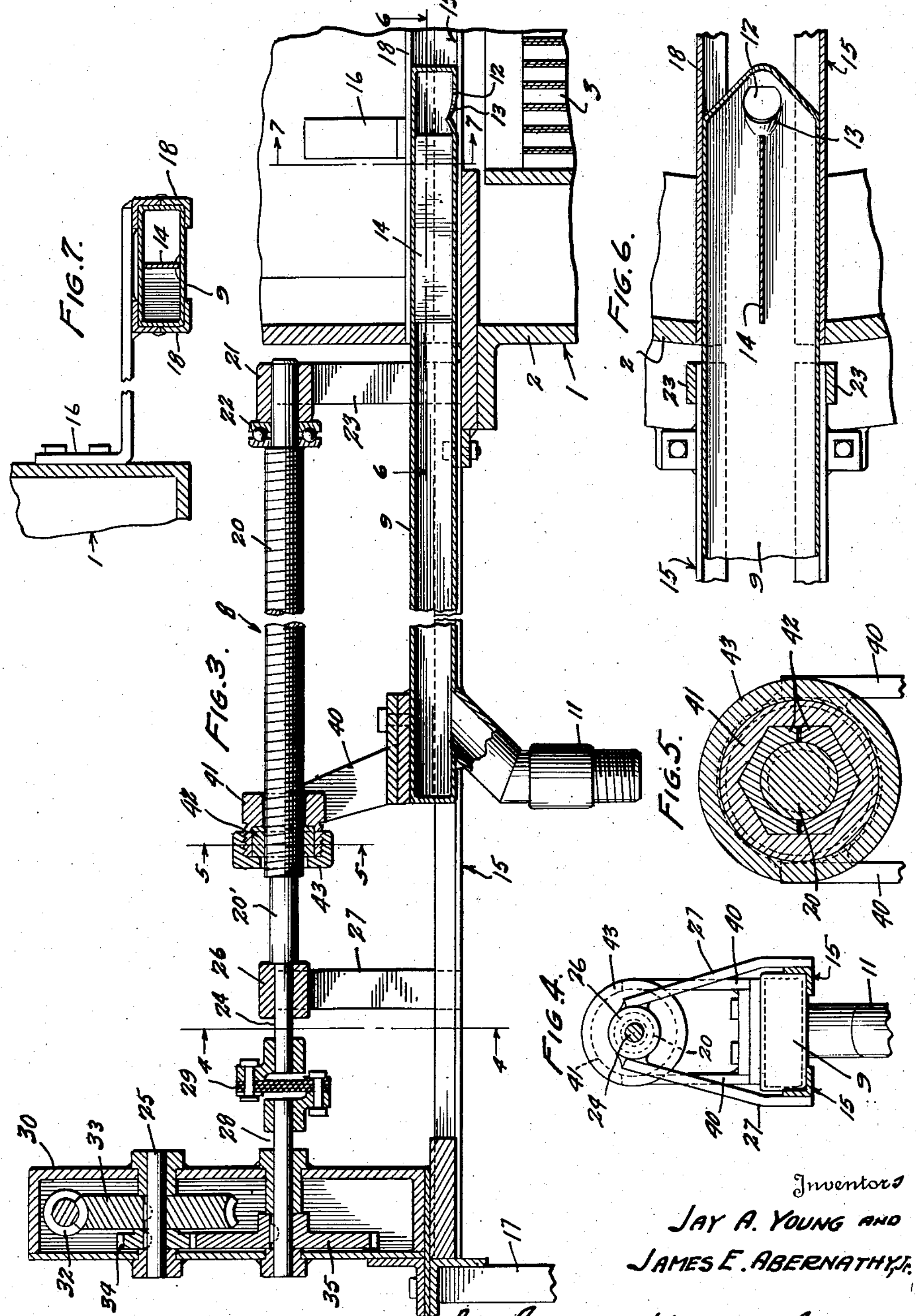

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APPARATUS FOR CLEANING PREHEATERS

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10 Claims. (Cl. 257—6)

This invention relates to cleaning, and more especially to a device for automatically and progressively removing soot and other foreign matter from the heat exchange surfaces of preheaters.

Hitherto, soot has been removed from the heat transfer structure of preheaters by blowing steam or heated air over the surfaces to be cleaned. One of the principal objections to such prior devices has been the failure to provide adequate means to dispose of the soot removed from the surfaces. For instance, in the case of preheaters of the regenerative type, these cleaners are designed to inject heated gas into the draft (or combustion air) side of the preheater, which causes the soot to be blown directly into the combustion chamber of the furnace. This obviously interferes with combustion, thereby reducing the efficiency of the furnace. In another type of cleaner the heated gas is injected into the induced draft (or flue gas) side of tne preheater which results in the soot being blown upward through the stack where it builds up on the induction fan, thus increasing the load on the fan and reducing the draft.

In either of these types of cleaners a gaseous substance, such as steam or heated air, must be used because no provision has heretofore been made for the removal from the system of a liquid cleaning agent and the soot dissolved or suspended therein. These gaseous cleansers will not remove soot or other caked deposits as efficiently as a cleaning liquid, such as water. Moreover, the temperatures of the cleaning substances used in the devices disclosed in the prior art must be raised in order to avoid chilling the preheater.

One of the objects of this invention is to overcome the above-mentioned disadvantages of the prior art.

Another object of this invention is to provide a cleaning device for a preheater which utilizes a liquid as the cleaning medium.

Still another object of this invention is to provide a cleaning device which is designed to progressively clean sections of a preheater so as to make unnecessary the use of a preheated liquid.

A further object of this invention is to provide a cleaning device for a preheater of the regenerative type which is so constructed that it will inject a liquid in the air or direct draft side of the preheater above the rotor and remove the liquid from the heater at a point between the rotor and the combustion chamber of the furnace.

With these and other objects in view, this invention embraces broadly the concept of providing a cleaning device for a preheater which is provided with means for discharging a liquid, such as water, into a heat exchange surface which has become coated with soot, etc. Our invention finds particular application in the case of a regenerative preheater, in which event the water is directed into the air or draft side of the preheater at a point above the rotor and the mixture of water and soot is removed at a point in the air or draft conduit between the bottom of the rotor and the combustion chamber of the furnace. The device is provided with means whereby the nozzle which ejects the water may be radially drawn across the top of the rotor so that the water will be directed onto only a small portion of the rotor at a time. Inasmuch as only a small portion of the rotor is subjected to the water at a given time, it is not necessary that the water be heated.

In passing through the rotor the water removes the accumulated soot and other caked material and then flows downwardly through the combustion air (or draft) conduit to a point intermediate the preheater and the combustion chamber of the furnace where it is trapped and withdrawn to a sump. This prevents the water from interfering with the combustion in the furnace.

In the drawings:

Figure 1 is a top plan view of a preheater of the regenerative type showing the invention in operative position.

Figure 2 is a view taken along line 2—2 of Figure 1, looking in the direction of the arrows.

Figure 3 is a detail elevational view, partly in section, of the nozzle and feed mechanism of the cleaner.

Figure 4 is a view taken along line 4—4 of Figure 3, looking in the direction of the arrows.

Figure 5 is a view taken along line 5—5 of Figure 3, looking in the direction of the arrows.

Figure 6 is a view taken along line 6—6 of Figure 3, looking in the direction of the arrows.

Figure 7 is a view taken along line 7—7 of Figure 3, looking in the direction of the arrows.

It will be noted that in the drawings the cleaner has been shown attached to a regenerative preheater which is provided with a rotary drum, and it will be so described herein. However, it is to be distinctly understood that this cleaner is adapted for use with preheaters of other types.

In order to illustrate the invention, we have shown in the drawings a regenerative preheater, generally designated by the numeral 1, which consists of a casing 2 and a rotor 3.

The top of the preheater is provided with the flue outlet 4 and the cold air (or combustion air) inlet 5. The preheater shown in the drawings is of the conventional regenerative type, and in accordance with common practice the flue outlet 4 is in communication with the necessary stack or chimney, in which an induction fan is usually mounted. Likewise the flue gases are conveyed from the furnace to the preheater by a suitable conduit and enter the preheater through duct 4ª in the base directly below the flue let 4 in the conventional manner.

In practice, the cold air inlet 5 is connected to a conduit which is open to the atmosphere and there is usually a direct draft fan located in such conduit to force fresh air into the preheater through inlet 5. The fresh air, after passage through the preheater, is split into two streams by means of a pair of ducts 6 and 7 which connect the preheater to the combustion chamber of the furnace.

By means of this construction heated flue gases constantly pass around the honeycombed surfaces of the rotor 3 of the preheater and are drawn through the outlet 4 into the stack by the action of the induction fan. At the same time fresh air is forced by the direct draft fan through the inlet 5 into the preheater and, after absorbing heat by coming into contact with the heated honeycombed surfaces of the rotor 3, it is forced through the conduits 6 and 7 into the combustion chamber of the furnace.

Obviously the flue gases carry a certain amount of suspended soot, and such soot is deposited upon the surfaces of the rotor as the gases pass therethrough. These deposits gradually accumulate and interfere with the heat exchange efficiency of the honeycombed surfaces.

The cleaning device which is the subject of this invention is designated generally by the numeral 8 and operates in the preheater above the rotor and directly in line with conduit 6. As best shown in Figure 3 the cleaning device is provided with a rectangular-shaped nozzle 9, near one end of which is a hose connector 11. The opposite end is provided with a discharge port 12. What might be termed the near edge of the discharge port 12 is upturned as at 13 which serves to direct the cleansing fluid as it leaves the nozzle so that it is discharged onto the heat exchange surfaces of the rotor at the proper angle. As best shown in Figure 6 a longitudinal baffle 14 is also provided in the conduit 9 at a point directly behind the discharge port 12.

A flexible hose 10 is fitted onto the connector 11, through which liquid may be supplied to the nozzle while the latter is moving, as will be pointed out. The discharge nozzle 9 is movably mounted on a track, designated generally 15, one portion of which is attached to the conventional partition wall of the casing 2 by suitable brackets 16. The track extends into the preheater to a point adjacent the axis of the rotor and is positioned directly above the upper surface of the rotor. The other extremity of the track is supported by legs 17.

As shown in Figure 7 the track 15 consists of two channel-shaped members 18 which fit over each side of the nozzle 9. This construction prevents a rotary movement of the nozzle but permits a lineal movement. By means of this track the discharge port 12 can be positioned directly above the heat exchange surfaces at any point on the radius of the rotor described by the track 15.

The mechanism for moving the nozzle 9 radially across the rotor consists of a feed screw 20 provided with a reduced plain section 20'. One end of the feed screw is journaled in a suitable bearing 21 provided with a radial thrust bearing 22. The bearing 21 is carried by a bracket 23 mounted on the preheater casing 2. The other end of the feed screw, adjacent the plain section 20', is provided with a reduced portion 24 which is supported by a bearing 26. The bearing 26 is supported by brackets 27 mounted on the track 15. The reduced extremity of the feed screw 20 is connected to a shaft 28 by means of a flexible coupling 29. The shaft 28 is journaled in a reduction gear box 30 which may be of any suitable construction.

The feed screw may be driven by an independent motor, as shown at 31 in Fig. 1, in which event the motor operates a worm 32 which meshes with a worm gear 33. The worm gear is keyed to a shaft 25, on which is also keyed a pinion 34. The pinion 34 drives the gear 35 keyed to shaft 28.

The nozzle 9 carries an arm 40 which is provided with a socket 41 which encircles the feed screw 20, and which contains a recessed portion designed to hold a split nut 42. The split nut 42 is threaded to engage the threads of the feed screw 20 and is held within the socket 41 by means of a cap 43 which is threaded upon the socket.

It will therefore be seen that rotation of the feed screw effects a lineal movement of the split nut 42, which, in turn, causes the nozzle 9 to progress along the track 15.

As indicated, the track 15 is located above the duct 6, and consequently the cleaning liquid (with the removed soot and dirt) upon leaving the rotor will fall into the duct 6. As also mentioned above, such liquid and soot would enter the combustion chamber of the furnace unless steps are taken to remove them from the system.

To accomplish this, a dam 45 is provided in duct 6, which is adapted to trap the mixture of soot and liquid after a liquid has passed over the heat exchange surfaces of the rotor. In the construction disclosed in the drawings the dam 45 is positioned in a horizontal portion of the conduit and the trapped liquid is removed from the system through a pipe 46. It will be noted that the dam 45 is located relatively close to the preheater in order to remove the liquid from the system as soon as practicable after it has served its function of cleaning the soot from the heat exchange surfaces.

It will be noted from Figure 2 that the duct 6 is curved and for a short length is substantially horizontal. While this is preferable under most circumstances, if it is desired to remove the liquid from the portion of a duct that is vertical, or substantially vertical, this may be effected although the necessary damming required will be somewhat more involved than the single dam 45 shown in Figure 2. In such a case two dams may be mounted in the vertical section of pipe, each dam extending from an opposite side of the duct and the two being generally parallel and overlapping to a certain extent, one below the other. In this construction the liquid may be removed by means of a pipe, similar to pipe 46, from a point directly above the lower dam.

The operation of the device is believed to be apparent from the foregoing. While the frequency of cleaning will depend upon the type of preheater, conditions of combustion, etc., it has been found that cleaning from once a day to once every week will suffice to maintain the heat exchange surfaces sufficiently free from soot. In initiating the cleaning operation it may be assumed that the nozzle and associated elements will be out of position to the left of Figure 3 so that the discharge port 12 will be adjacent the periphery of the rotor—which would be the position of the device upon completion of the preceding operation.

Preparatory to actually starting the operation the cap 43 will be unscrewed to free the split nut and thus permit the movement of socket 41 to the right of the feed screw 20. Thereupon the nozzle 9 will be moved inwardly of the rotor until the discharge port 12 is adjacent the center of the rotor, at which point the socket 41 will be abutting the thrust bearing 22. The cap 43 will thereupon be likewise moved to the right of the feed screw and the split nut 42 assembled upon feed screw 20 adjacent the socket, and the socket thereafter moved to receive the split nut, and the cap 43 then threaded upon the socket.

Substantially simultaneously, the water is introduced to the nozzle 9 through the hose 10 and the motor 31 is started. Thereupon the nozzle commences its travel radially from the center of the rotor and at the same time water is ejected from the outlet port 12 at a high velocity and in a substantially vertical jet of relatively limited size. This jet is obviously confined to a small section of the rotor at any given moment, and yet it is sufficient to dissolve, wash or flush the soot and other foreign matter that may be adhering to such section of the preheater. This radial movement of the nozzle continues until the discharge port 12 is at the periphery of the rotor, at which time the split nut assembly will ride off the threaded section of the feed screw onto the smooth section 20'. The motor 31 may then be stopped and the water to the nozzle 9 shut off.

The speed of the rotor and the lineal movement of the nozzle 9 of course may be varied within wide limits, but in general the speed of lineal movement of the nozzle should be such that an adequate cleaning of the rotor elements is effected. Incidentally, inasmuch as the peripheral speed of the rotor will vary at different points on its radius, it may be desirable to vary the lineal speed of the nozzle by any well known means such as variable speed transmissions, variable speed motors, suitable control devices, variable pitch threads on the feed screw, etc.

As an illustration of the efficiency of the operation just described, the following comparative tabulation of actual test runs is of interest:

	Use of soot blowers twice a day
Average temperature of flue gas to preheater__deg. F__	502
Average temperature of exit gas from preheater deg. F__	270
Average temperature of preheated air________do____	377
Average percent station load____________________	48

The data below indicates actual averages from one heater during a 162-day continuous run, May 26 to Oct. 5, 1938, and this heater cleaned only by the new method previously referred to:

	Process of present application once every 48 hours
Average temperature of flue gas to preheater__deg. F__	525
Average temperature of exit gas from preheater deg. F__	281
Average temperature of preheated air________do____	411
Average percent station load____________________	57

From the above it will be noted that, notwithstanding an increase of nine points in percentage station load, the temperature difference (difference between preheater exit gas and preheated air) is 23° F. more when following the present invention than when following the conventional cleaning operation of the prior art. It will be appreciated that the difference between the temperature of the flue gas from the preheater and the preheated air is a function of the cleanliness of the rotor—that is the amount of soot preventing heat absorption by the rotor elements.

It will be appreciated that the present invention permits the removal of the soot without any discontinuance, or interfering in any wise, with the operation of the preheater or furnace—in itself, a decided advance over the prior art. It will also be noted that the present invention contemplates the subjecting of only a relatively small portion of the preheater surface to the cleansing medium at any given time, and therefore an unheated cleaning agent, such as water, can be used without chilling the rotor or lowering the temperature of the surfaces to any appreciable degree. Not only is this device more efficient than the prior art, as indicated above, with the consequent economy, but a further economy is effected due to the fact that the device is of simple and relatively inexpensive construction.

It is to be noted that the operation of the device is simple and largely automatic, permitting the quick arrangement of the various elements for starting the operation, and the economy of the operation will be realized not only because of its efficiency as above mentioned but also because it obviates the use of relatively expensive cleaning agents such as steam or compressed or heated air.

While for purposes of illustration and ease of description we have disclosed this invention as adapted to the use of one type of preheater, it is to be distinctly understood that it can be readily adapted for use with other types of heater. It will also be apparent of course that various changes in detail of construction will be obvious to persons skilled in the art. We therefore intend that this invention be limited only by the prior art and the scope of the appended claims.

We claim:

1. In a device for cleaning the heat exchange surfaces of a preheater which is arranged in cooperation with the combustion air system and the flue gas system of a furnace, for the flow of flue gas over the heat exchange surfaces to heat said surfaces and for the flow of air over the heated surfaces to heat the air, means for discharging a single small stream of a washing liquid progressively over small portions of said heat exchange surfaces, during the flow of air over said surfaces, to avoid cooling more than a very small portion of said heat exchange surfaces at one time, and means to trap and remove the liquid after it has passed through the preheater at a point in the combustion air system intermediate the preheater and the furnace.

2. In a device for cleaning the heat exchange surfaces of a rotor which forms a part of a preheater of the regenerative type which is arranged in cooperation with the combustion air system and the flue gas system of a furnace for the flow of flue gas over the heat exchange surfaces to heat said surfaces and for the flow of air over the heated surfaces to heat the air, means for discharging a single small stream of a washing liquid progressively over small portions of said heat exchange surfaces, during the flow

of air over said surfaces, to avoid cooling more than a very small portion of said heat exchange surfaces at one time, the combustion air system having a curved duct adjacent the rotor to conduct heated air to the furnace, a dam positioned in said curved duct to trap the liquid after passage through the rotor, an outlet in the said duct adjacent the dam, and means connected to the outlet to remove the liquid after it has been trapped.

3. In a device for cleaning the heat exchange surfaces of a preheater, which is arranged in cooperation with the combustion air system and the flue gas system of a furnace, a track mounted adjacent the said heat exchange surfaces, a nozzle member mounted on said track and connected to a liquid supply, a feed mechanism comprising a screw, means carried by the nozzle cooperating with the screw whereby the rotation of the screw will cause the nozzle to move on the said track, means placed in the combustion air system at a point intermediate the preheater and the furnace to trap the liquid after it has passed through the preheater, and means to remove the liquid from the system after it has been trapped.

4. In a device for cleaning the heat exchange surfaces of a rotor which forms a part of a preheater of the regenerative type which is arranged in cooperation with combustion air system and the flue gas system of a furnace, a track mounted adjacent the said heat exchange surfaces, a nozzle member mounted on said track and connected to a liquid supply, a feed mechanism comprising a screw, means carried by the nozzle cooperating with the screw whereby the rotation of the screw will cause the nozzle to move on the said track radially in respect to the rotor surface, means placed in the combustion air system at a point intermediate the preheater and the furnace to trap the liquid after it has passed the rotor, and means to remove the liquid from the system after it has been trapped.

5. In a device for cleaning heat exchange surfaces of a rotor which forms a part of a preheater of the regenerative type which is arranged in cooperation with the combustion air system and the flue gas of a furnace, a track mounted adjacent and extending radially across the said rotor, a nozzle mounted on the said track and connected to a liquid supply, a feeding mechanism comprising a screw, a bracket connecting the nozzle to the said drive, a split nut adapted to engage the screw, and means to attach the split nut to said bracket whereby the rotation of the worm drive will force the nozzle to move on the said track, means placed in the combustion air system at a point intermediate the preheater and the furnace to trap the liquid after it has passed through the preheater, and means to remove the liquid from the system after it has been trapped.

6. In a device for cleaning heat exchange surfaces of a rotor which forms a part of a preheater of the regenerative type which is arranged in cooperation with the combustion air system and the flue gas of a furnace, a track mounted adjacent and extending radially across the said rotor, a nozzle mounted on the said track and connected to a liquid supply, a feeding mechanism comprising a screw, a bracket connecting the nozzle to the said drive, a split nut mounted on the bracket and adapted to engage the worm drive, and means to attach the split nut to said bracket whereby the rotation of the screw will force the nozzle to move on the said track, a dam placed in the combustion air system at a point intermediate the preheater and the furnace to trap the liquid after it has passed through the preheater, and a conduit operatively connected to an aperture in the combustion air system, said aperture being located above and adjacent the said dam to remove the liquid from the system after it has been trapped.

7. In a heat exchange device of the regenerative type, a rotating heat accumulating mass, stationary inlet and discharge ducts for the passage of a stream of hot gas axially through a portion of said mass, other stationary inlet and discharge ducts for the passage of a stream of gas to be heated through another portion of said mass, a nozzle positioned to discharge washing liquid substantially axially through said mass with the gas to be heated, said discharge duct for the gas to be heated having a substantially horizontally extending offset portion, and a dam forming baffle extending upwardly from the bottom of said horizontal portion of the duct to form a liquid collecting means in said duct.

8. In a heat exchange device of the regenerative type, a rotating heat accumulating mass, stationary inlet and discharge ducts for the passage of a stream of hot gas axially through a portion of said mass, other stationary inlet and discharge ducts for the passage of a stream of gas to be heated through another portion of said mass, a nozzle positioned to discharge a single jet of washing liquid substantially axially through said mass, said jet of washing liquid being discharged onto a small portion of said mass to avoid cooling of more than a very small portion of said mass by the liquid at one time, means for displacing said nozzle radially of the mass to progressively wash in small increments the body of said mass, and mean in the discharge duct for the gas to be heated for collecting the washing liquid after passage through said mass.

9. In a regenerative heat exchange device, a rotor formed of a heat accumulating mass positioned for rotation about a substantially vertical axis, means for conveying hot gas to and passing the same substantially axially through said rotary mass, means for passing a gas to be heated substantially downwardly through said mass including a duct extending downwardly from said rotor for the discharge of heated gas, means positioned above said rotor and directly over said duct for the discharge of heated gas, for discharging a single small stream of washing liquid, during rotation of said rotor and during the flow of the gas to be heated through said rotary mass, downwardly onto a very small portion of said rotary mass, to avoid cooling more than a very small portion of said heat accumulating mass at one time by said liquid, and means in said heated air discharge duct for collecting the washing liquid after it has passed downwardly through said rotary mass.

10. In a regenerative heat exchange device, a rotor formed of a heat accumulating mass positioned for rotation about a substantially vertical axis, means for conveying hot gas to and passing the same substantially axially through said rotary mass, means for passing a gas to be heated substantially downwardly through said mass including a duct extending downwardly from said rotor for the discharge of heated gas, means positioned above said rotor and directly over said duct for the discharge of heated gas, for dis-

charging a single small stream of washing liquid, during rotation of said rotor and during the flow of the gas to be heated through said rotary mass, downwardly onto a very small portion of said rotary mass, to avoid cooling more than a very small portion of said heat accumulating mass at one time by said liquid, means in said heated air discharge duct for collecting the washing liquid after it has passed downwardly through said rotary mass, and means for moving said liquid discharging means substantially radially over said rotary mass to progressively wash the entire rotary mass in small increments.

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