

Dec. 31, 1929.

H. C. HEATON

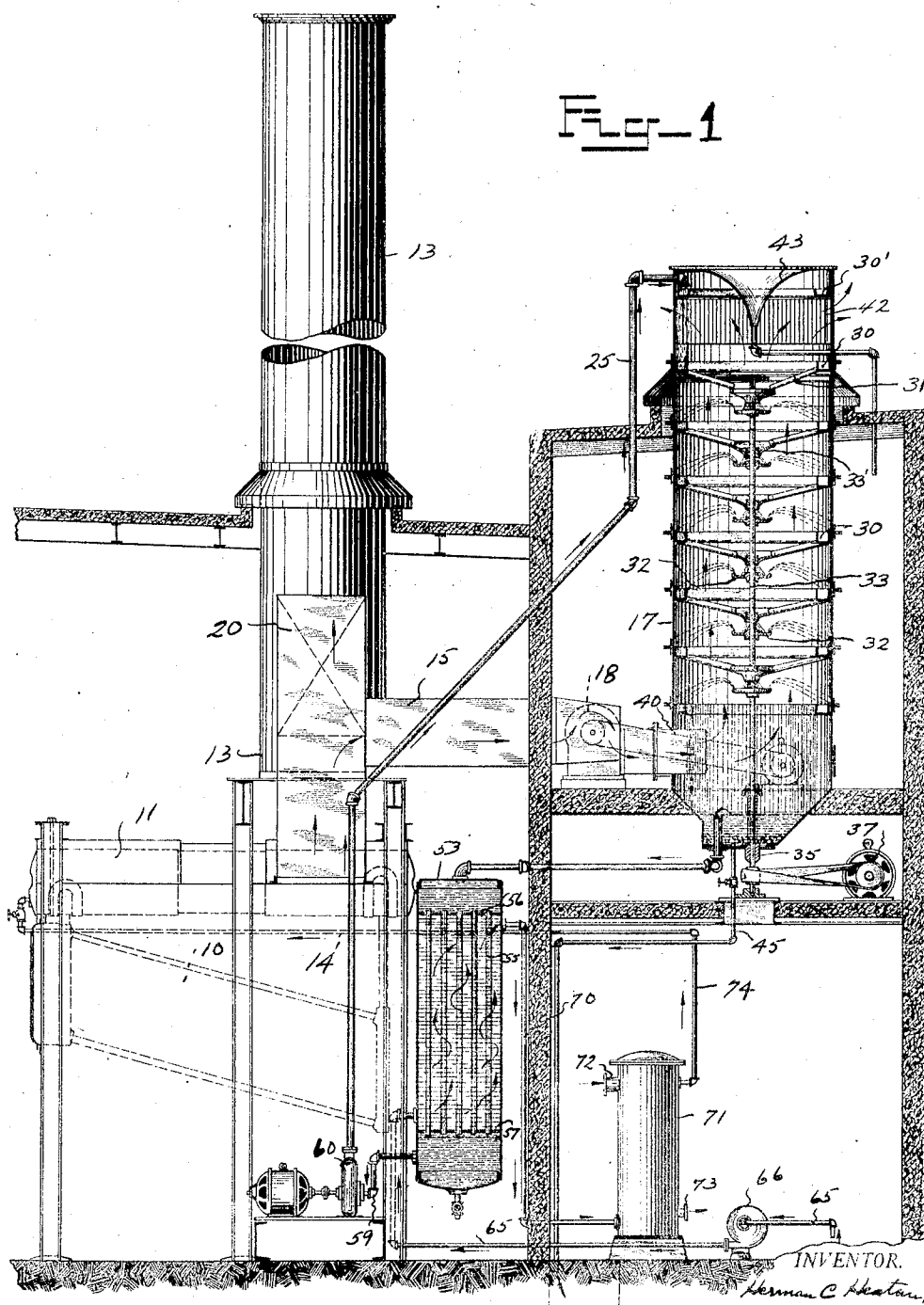
1,741,567

METHOD AND APPARATUS FOR HEAT RECOVERY

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4 Sheets-Sheet 1

Fig. 1



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Fig-2

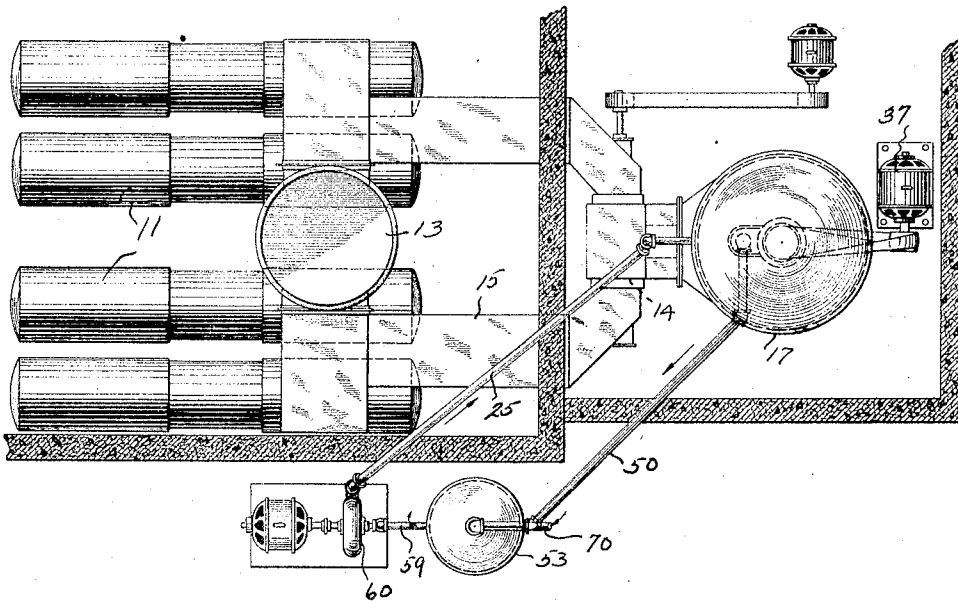
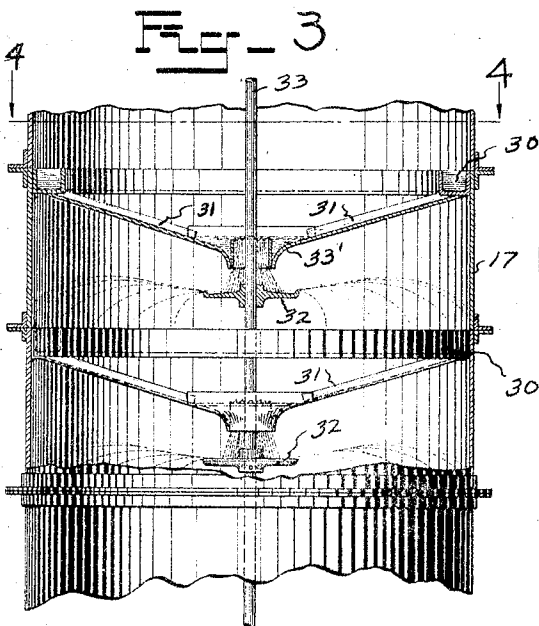
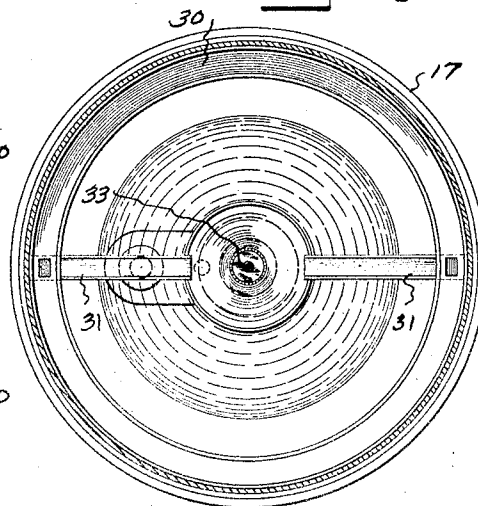


Fig-4



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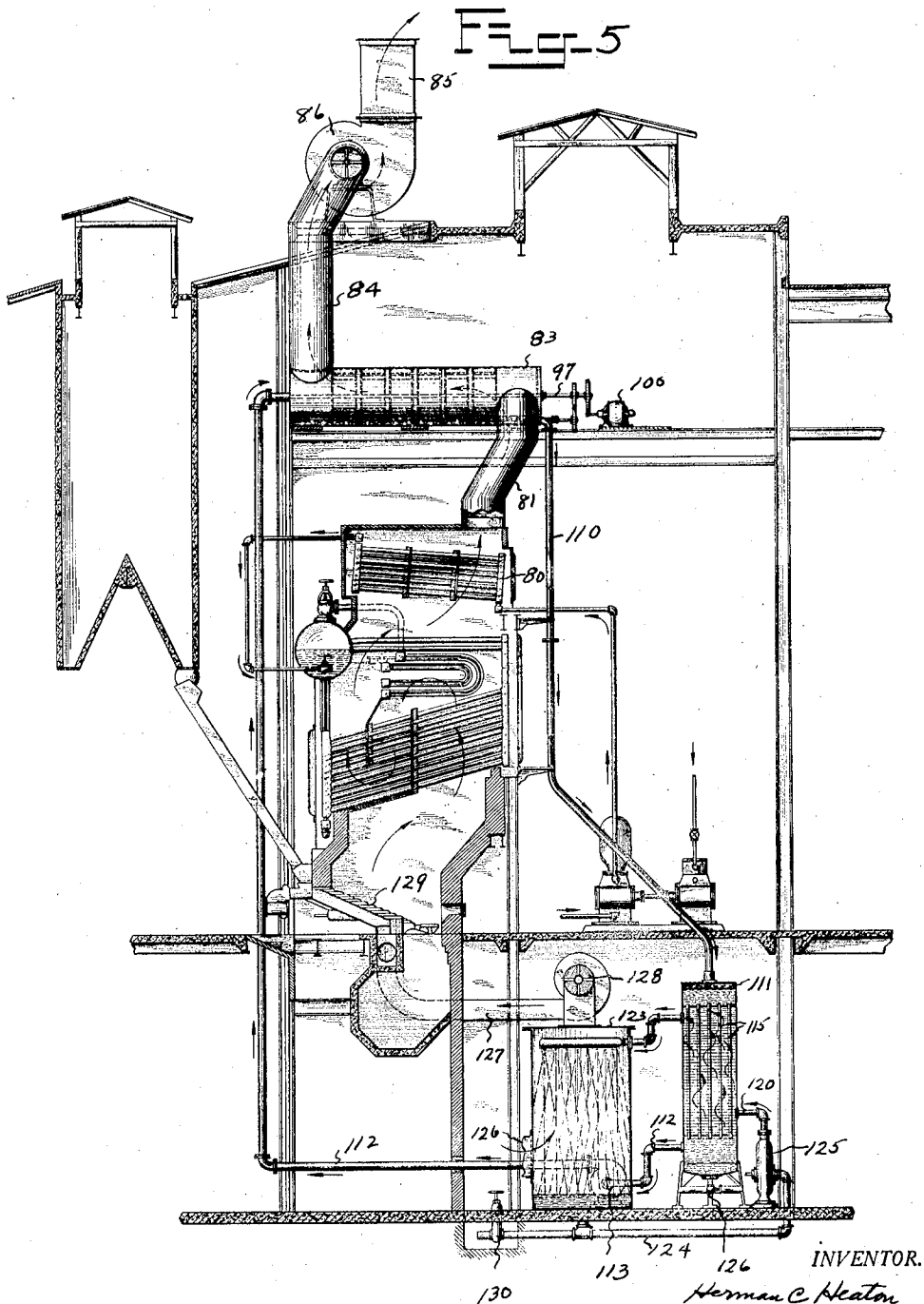
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METHOD AND APPARATUS FOR HEAT RECOVERY

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4 Sheets-Sheet 3



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METHOD AND APPARATUS FOR HEAT RECOVERY

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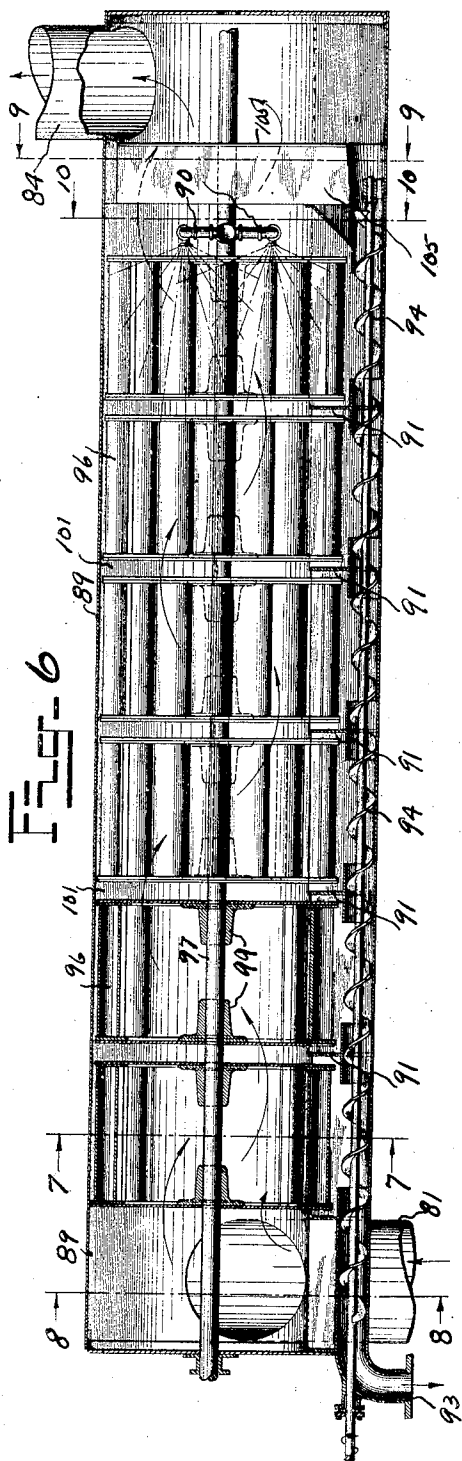
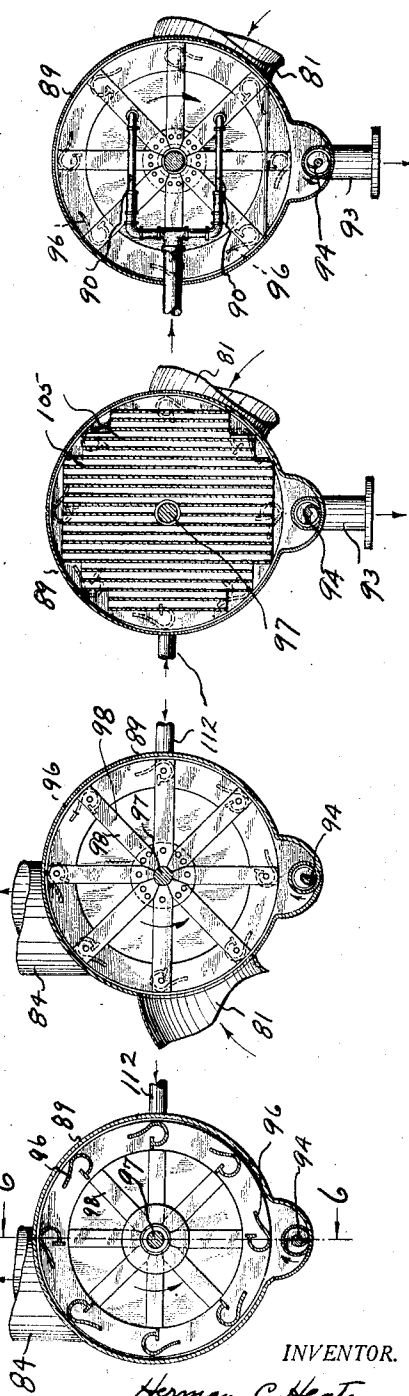


Fig. 7

Fig. 8

Fig. 9

Fig. 10



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UNITED STATES PATENT OFFICE

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METHOD AND APPARATUS FOR HEAT RECOVERY

Application filed September 6, 1923. Serial No. 661,162.

My present invention relates to a method and apparatus for recovering heat, particularly as applied to a boiler furnace.

My invention will be best understood by reference to the following description and accompanying drawings, in which Fig. 1 is a more or less diagrammatic view in elevation of an installation embodying one illustrative form of my invention; Fig. 2 is a plan view of the layout shown in Fig. 1; Fig. 3 is an enlarged view of a portion of the gas and liquid contact apparatus; Fig. 4 is a view taken on the line 4—4 of Fig. 3; Fig. 5 is a view analogous to Fig. 1 of a modified form; Fig. 6 is a view, partly in section, of the gas and liquid contact apparatus used therein, the section being taken along the line 6—6 of Fig. 7, and Figs. 7, 8, 9 and 10 are sectional views taken on the lines 7—7, 8—8, 9—9 and 10—10, respectively, of Fig. 6.

In carrying out my invention, I first pass the furnace gases, which may previously have passed over an economizer, through some form of gas and liquid contact device, by means of which a large portion of the heat in these gases is absorbed and returned to the boiler system. As an absorbent for the heat in the gases, I preferably use a liquid of relatively high boiling point in order that there may be little or no evaporation of this liquid and consequent loss of heat, as latent heat of evaporation. As one liquid available for this purpose, I have chosen concentrated sulfuric acid, but it will be understood that my invention is not limited to any specific liquid. Concentrated sulfuric acid has the advantage of not attacking the metal surfaces with which it contacts in the apparatus.

After the heat has been absorbed by the liquid, e. g., sulfuric acid, the latter may be passed into thermal contact with the entering feed water, or it may be utilized to heat the combustion air in a manner to be hereinafter described.

Referring now to Fig. 1, the surface gases after passing over the boiler tubes 10 of the boiler 11 are admitted to stack 13, whence they may pass through conduit 15 into the gas and liquid contact device or absorber 17, being propelled therein by means of the fan

18. When desired, the gases may be cut off from the absorber 17 by means of the valve 20 and will then pass directly up and out of the stack. The absorbing liquid, e. g., sulfuric acid, enters the absorber through the pipe 25 and is distributed by the annular trough 30' from which it falls upon an annular trough 30, whence it flows down the troughs 31, 31 onto a dish-shaped disc 32, being guided thereon by means of an annular funnel-shaped member 33', as is best shown in Fig. 3. Several of these troughs and discs are superimposed in the absorber. The discs are rotated by means of the central shaft 33 to which they are attached. The shaft passes through a suitable gland 35 and is driven by motor 37. It will be seen that the liquid striking the rotating discs 32 will be thrown therefrom by the centrifugal force onto the next lower trough 30, and will thus descend the various discs and troughs in series and be sprayed one for each time that it passes from one of the funnel-shaped members 33' to one of the annular troughs 30. The gases enter at the bottom of the absorber through the opening 40 and pass out through longitudinal restricted openings 42 at the top of the absorber which serves to remove entrained particles of the liquid, the gases being deflected from the vertical by means of the curved surface 43. In order to drain the absorber, a pipe 45 is provided at the bottom thereof and leads into a sump 46.

The liquid having passed through the tower, is led off through the pipe 50 which terminates a slight distance above the bottom of the tower in order to provide for the settling of mud and the like in the absorber, and passes therethrough to the heat-exchanger or feed water heater 53. This heater is provided with a series of longitudinal pipes 55 which are joined to headers 56 and 57. The liquid passes through the pipes 55 to the bottom of the heater and is lead therefrom through pipe 59, centrifugal pump 60 and pipe 25, back to the absorber 17. The feed water enters the system through pipe 65, being propelled therethrough by means of pump 66 and passes therefrom into the spaces between the headers 56 and 57 and the pipes 55 of the

heater 53. The now heated feed water leaves the top of the tank through pipe 70 and passes through an auxiliary heater 71 which may be heated by a heating medium, such as waste steam and the like, which enters the heater at 72 and leaves at 73, the feed water passing therefrom through pipe 74 into the boiler 11.

The heater 71 may or may not be used, as desired, or may be used only when the heat absorbing system is not in use and the gases pass directly into the stack.

In Fig. 5 I have illustrated a somewhat modified system in which the absorbed heat is delivered to the combustion air entering the furnace. In this embodiment the furnace gases after passing over the boiler and superheater surfaces, pass over the economizer 80 and thence through conduit 81 into the absorber 83, conduit 84 and stack 85, the propulsion of the gases being aided by the fan 86.

The absorber illustrated comprises a drum 89 into which is sprayed the heat absorbing liquid through nozzles 90. The acid flows over a series of weirs 91 to the outlet 93.

Provision is made for the removal of the solid particles washed out of the gases by means of a screw conveyor 94, the liquid and solid particles or mud both leaving the drum at the outlet 93. To bring about an intimate contact of the liquid and gases, scoop-like members 96 are provided to pick up a quantity of the liquid and shower it downwardly through the path of the gases. These scoop-like members are connected to a central rotatable shaft 97 by means of arms 98 and hubs 99. The shaft 97 is rotated by means of motor 100 and appropriate gearing. It will be noted that the scoops 96 are arranged so as to form transverse spaces 101, thereby allowing for the weirs 91. By means of this arrangement, it will be seen that the liquid is caused to shower in the path of the gases, while, at the same time, there is a gradual flow of the liquid through the apparatus, this flow being controlled by the weirs 91 which progressively decrease in height, as shown. In order to prevent entrained particles of the liquid from escaping, I have provided eliminators near the end of the drum in the form of narrow, closely spaced vertical plates 105.

The liquid leaving the drum passes downwardly through a pipe 110 into the heat-exchanger 111, leaving the same through pipe 112, and passing therethrough back to the absorber 83, being propelled by pump 113. This liquid from the absorber 83, which it will be convenient to denominate a "first liquid" passes, in the form illustrated, through the pipes 115 in the exchanger 111. In case a corrosive liquid, such as sulfuric acid, is used as the first liquid, it is preferable to use a second liquid for accomplishing the heating of the entering combustion air. This second liquid, which may be a hydrocarbon oil of

relatively high boiling point, enters the exchanger 111 through pipe 120 and is heated by the thermal contact with the hot first liquid. From the exchanger 111 the hot oil passes into a chamber 123 into which it is sprayed. The oil collecting at the bottom of chamber 123 passes through pipe 124 and pump 125 and back into the exchanger again. Air for combustion enters the chamber 123 through the conduit 126 (only a portion of which is shown) at the bottom thereof and passes up through the descending shower of hot oil and out of the chamber through conduit 127 at the top thereof, being propelled therethrough by fan 128 into the stoker boxes 129. When desired, the oil or second liquid may be drained from the system through conduit 124 and valve 130. The first liquid and mud may be drained from the heat-exchanger through valve 126.

It will be seen that by my invention, important advantages are secured, in that the furnace gases are washed clean of soot and dust, while, at the same time, a large quantity of heat is returned to the system, which otherwise would be lost. Furthermore, this system is highly efficient, since by the use of a high boiling point liquid in the absorbers, there is no loss of heat due to substantial vaporation of the absorbing liquid. It will also be found that a considerable quantity of potash and ammonia is removed from the gases and may, therefore be recovered and utilized. In the illustrative arrangements, the gases and the heat absorbing liquid pass through the absorbers in opposite directions, so that as the gases are progressively cooled, they contact with progressively cooler liquid. This is advantageous in securing a better heat transfer than if the gases and liquid flowed in the same direction.

I claim:

1. The method of furnace operation, which consists in absorbing heat from waste flue gases with concentrated sulfuric acid and returning a part of the heat to the furnace.
2. The method of furnace operation, which consists in scrubbing waste flue gases with concentrated sulfuric acid and returning the absorbent heat to the furnace.
3. The method of furnace operation, which consists in scrubbing waste flue gases with concentrated sulfuric acid, passing said acid in thermal contact with a second liquid having substantially no corrosive properties, returning the acid for reuse, and utilizing said second liquid for heating the combustion air.
4. The method of furnace operation, which consists in scrubbing waste flue gases with sulfuric acid, passing said acid in thermal contact with a second liquid having substantially no corrosive properties, returning the acid for reuse, utilizing said second liquid for heating the combustion air, and returning

said second liquid into thermal contact with said first liquid.

5 5. The method of furnace operation, which consists in scrubbing waste flue gases with concentrated sulfuric acid, passing said acid in thermal contact with oil, utilizing said oil for heating the combustion air, and returning said oil into thermal contact with said acid.

10 6. In a steam boiler plant, a chamber to which the waste flue gases are delivered, means for spraying a first liquid into said chamber, means for passing the heated first liquid into heat-exchange relationship with a second liquid, means for utilizing said second liquid to heat the combustion air, and
15 means for delivering the air thus heated to the boiler furnace.

20 7. In a steam boiler plant, a chamber to which the waste flue gases are delivered, means for spraying a first liquid into said chamber, means for passing the heated first liquid into heat-exchange relationship with a second liquid, means for spraying said second liquid into the combustion air, and means
25 for delivering the air thus heated to the boiler furnace.

30 8. In a steam boiler plant, a chamber to which the waste flue gases are delivered, means for spraying a first liquid into said chamber, means for removing entrained particles of said first liquid from the gas leaving said chamber, means for passing the heated first liquid into heat-exchange relationship with a second liquid, means for utilizing said
35 second liquid to heat the combustion air, and means for delivering the air thus heated to the boiler furnace.

40 9. In a steam boiler plant, a chamber to which the waste flue gases are delivered, means therein for scrubbing the gases with sulfuric acid, means for transferring the heat acquired by said acid to oil, means for spraying said oil into the combustion air, and means for delivering said air to the
45 boiler furnace.

50 10. In a steam boiler plant, a chamber to which the waste flue gases are delivered, means for spraying a first liquid into said chamber, means for passing the heated first liquid into heat-exchange relationship with a second liquid, means for utilizing said second liquid to heat the combustion air, means for delivering the air thus heated to the boiler furnace, means for recirculating said
55 first liquid, and means for recirculating said second liquid.

60 11. In a steam boiler plant, a scrubber for the waste flue gases, a heat-exchanger, means for circulating a first liquid through said scrubber and said exchanger, a chamber in the path of the combustion air to the boiler furnace, and means for circulating a second liquid through said exchanger and said chamber into contact with said air.

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