June 1, 1926. 1,586,816

F. LJUNGSTRÖM

REGENERATIVE AIR OR GAS PREHEATER

Filed August 3, 1922

Fig. 1.

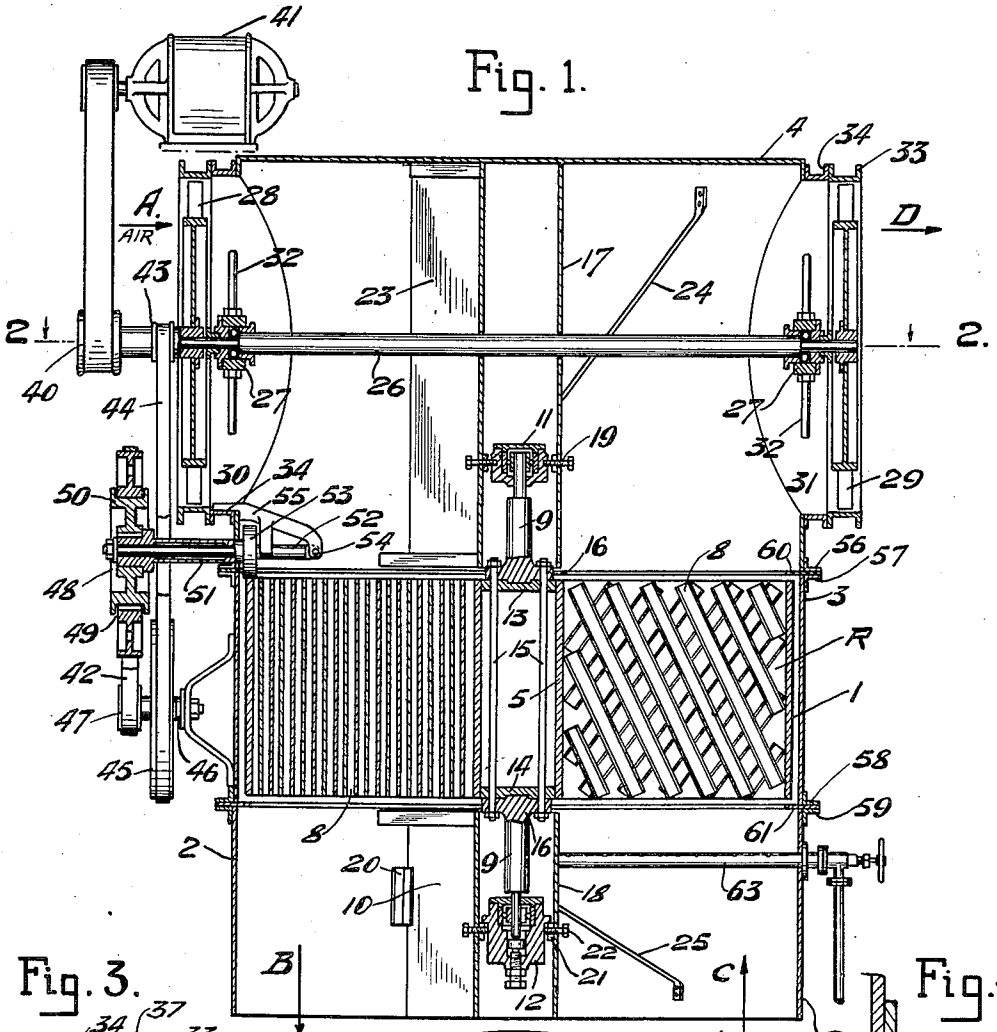

Fig. 3.

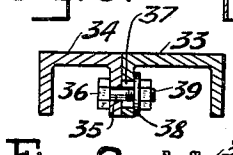

Fig. 4.

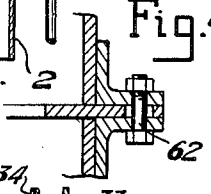

Fig. 2.

Inventor
Fredrik Ljungström
By Marks & Clerk
Attorney

Patented June 1, 1926. 1,586,816

UNITED STATES PATENT OFFICE.

FREDRIK LJUNGSTRÖM, OF LIDINGO-BREVIK, SWEDEN, ASSIGNOR TO AKTIEBOLAGET LJUNGSTROMS ANGTURBIN, OF STOCKHOLM, SWEDEN, A CORPORATION.

REGENERATIVE AIR OR GAS PREHEATER.

Application filed August 3, 1922, Serial No. 579,544, and in Sweden October 11, 1921.

The present invention relates to regenerative heat exchange apparatus of the type wherein a rotor containing a regenerative mass is caused to rotate partly in a gas from which heat is to be extracted and partly in a gas to be heated, the two gases both passing through the rotor.

The invention relates more specifically to an air preheater wherein the gas to be heated is cold air and the gas from which heat is to be extracted is hot products of combustion.

One feature of the invention consists in the fact that the rotor is surrounded by a casing in which are arranged fans which drive the air and flue gases and which are preferably arranged so that they are in the cooler parts of the fluids passing through the heat exchange apparatus.

Other features of the invention reside in: different sizes of compartments and passages to compensate for change of specific volume of fluids; means for adjustment of various parts of the apparatus relative to each other; the combination, in a single unitary structure with a rotor containing regenerative material, of means to regulate the speed of rotation of the rotor and flow of gases thereto in proportion to each other; and means for varying the relative volumes of heated and heating fluids passing through the apparatus.

The invention also comprises other details of construction, arrangement and combination of parts, all as hereinafter fully described and specifically pointed out in appended claims.

In the accompanying drawing which illustrates a preferred embodiment of my invention:

Fig. 1 is a vertical cross sectional view of the preheater.

Fig. 2 is a cross-section of the preheater taken on line 2—2, Fig. 1, parts being shown in full.

Figs. 3 and 4 show details of construction which will be more specifically explained hereinafter.

In the preferred form of the invention the preheater comprises a casing made in three major sections, a lower section 2, an intermediate rotor section 3, and an upper section 4.

The rotor designated by R consists of a cylindrical outer drum 1 and a core 5 between which extend radial partition walls 6. The partition walls, the outer drum and the core form chambers 7 in which is placed regenerative material 8, preferably in the form of metal pieces, the outer drum, core and partition walls thus forming a sort of frame for carrying the regenerative material. The metal pieces may be arranged in various ways. Figs. 1 and 2 of the drawings show a different arrangement of the regenerative material in each of the several chambers 7 but ordinarily the said material would be arranged in the same way in each of the chambers. As shown at the right hand side of the rotor in Fig. 1 and various of the chambers of the rotor in Fig. 2 the metal pieces may comprise channel irons placed in alternate crosswise rows as set out and claimed in my copending application Ser. No. 579,545 filed on even date with this application. These channels are connected at crossing points as for example, by means of welding, thus forming gratings having passages extending obliquely to each other and obliquely to the axis of the rotor. The channels of one set of alternate rows are directed upwardly from the outer drum toward the core and the intermediate channels are directed upwardly from the core to the outer drum. The fluid passing into the rotor will thus have free passage through the channels of the regenerative mass, the fluid being divided into several streams some of which are directed obliquely outward toward the outer drum and others of which are directed obliquely inward toward the core. These metal pieces are preferably arranged so that some of the rows are parallel to certain of the partition walls 6.

As shown at the left hand side of the Fig. 1 and in various chambers of Fig. 2 the regenerative mass may comprise alternate rows of straight and corrugated plates as set out and claimed in my copending applications, Ser. No. 460,600 filed April 1, 1921 and Serial No. 657,991 filed August 17, 1923. As is obvious the regenerative mass may have a great variety of forms.

Core 5 consists, in the form shown, of a cylindrical tube which constitutes a shaft for the rotation of the rotor. This shaft comprises, besides the core 5, the parts 9 which are journaled in bearings 11 and 12. Parts 9 are firmly connected to core 5 by means of metal pieces 13, 14, which may be

fastened to the core 5 in any manner, as by welding, and bolts 15 which extend through flanges 16 integral with parts 9 and through the metal pieces 13 and 14, thereby firmly uniting the various parts of the shaft. Tube 17 in the upper section 4 of the preheater is co-axial with core 5 and tube 18 in the lower section of the preheater is also co-axial with core 5. These parts, 17 and 18 however, do not rotate as does core 5, but are stationary. Bearing 11 is situated within tube 17 and is adjustable by means of screws 19. Bosses 21 and screws 22 serve to support and adjust the lower bearing 12.

In the upper section 4 are walls 23 which divide this section into two compartments, one being for the medium which is to be heated and the other for the medium from which heat is abstracted. When my apparatus is used as an air pre-heater these walls 23 are preferably arranged so that there is a smaller compartment for the incoming air than for the outgoing hot gases of combustion. This is to allow for increase in volume between the air entering a furnace and the products of combustion leaving the same. The walls 23 may be made in a number of ways. I have shown them as straight plates to the bottom of which are attached special horizontally disposed flanged strips extending over radial portions of the rotor, these strips being described and claimed in my copending application Serial No. 460,600 filed April 1, 1921. In the lower section 2 are similar walls 10 in the same planes as walls 23 and serving the same purpose. I have shown walls 10 supported by means of angle strips 20 attached to the walls and casing. The lower section is thus divided into two compartments coextensive with those of the upper section.

Extending horizontally across the upper section 4 is a fan shaft 26 which is mounted in bearings 27 and which carries two fans 28, 29 arranged in openings 30, 31, one for the incoming gases to be heated and the other for the outgoing gases. The fans are preferably of the propeller or axial type, as illustrated. The fans are located outside the bearings. The bearings 27 are supported from the casing 4 by rods 32. Each fan is surrounded by a ring 33. These rings are removable and are adjustably connected to the flanges 34 of the openings 30, 31. A form of this connection is shown in Fig. 3. In this figure flange 34 is shown as having bolt holes 35 through which bolts 36 pass. These bolts pass through bolt holes 37 in ring 33 which are of greater diameter than the diameter of the bolts so that the ring may have movement with relation to the bolts, and consequently with relation to the upper section 4. The bolts pass through washers 38 and are secured by nuts 39. By this means the fan openings can be centered with respect to the fan and the upper section 4 itself need not be made with too great exactness and only the removable centering rings 33 have to be machined.

Because of the difference in volume between the cold air entering a furnace and the hot products of combustion discharged therefrom, either of the fans 28 or 29 or both may be provided with adjustable blades in order that the capacity of the fans at a given speed may be varied. By this means I am able to adjust the relative capacity of the fans so that, with a common shaft driving them at the same speed, the fans can take care of the different relative volumes of gas resulting from different temperature ranges. Moreover, this feature of my invention enables a unit, without structural changes, to be applied in installations having widely differing proportions of heating and heated gases to be passed through the apparatus.

On one end of the fan shaft 26 is a driving pulley 40 which is driven, for example, by an electric motor 41. A pulley 43 is also connected to shaft 26 over which a belt 44 passes which rotates pulley 45 on shaft 46. A smaller pulley 47 on this shaft 46 is connected with a clutch pulley 48 by means of belt 42. Clutch pulley 48 is made up of two parts, an outer ring 49 and an inner wheel 50. These two parts 49 and 50 are adapted to have relative movement due to the fact that there is a looseness between them allowing slipping of one with respect to the other. This pulley 48 constitutes a clutch between the source of power and the rotor. The inner wheel 50 is firmly secured to the sleeve 51 which is rotatable about member 52. Firmly secured to the sleeve 51 is a friction roller 53, which rests on the outer drum 1 of the rotor. Rotation of this roller 53 causes rotation of the rotor. Member 52 is pivoted at 54 to the bracket 55 attached to the casing of the pre-heater. By means of the pivot 54 the roller 53 may be lifted out of engagement with the rotor, or pressed into engagement of the same. The tension of the belt 42 draws the roller 53 into engagement with the drum 1.

Between the flanges 56 and 57 connecting the intermediate rotor section 3 with the upper section 4 and between the flanges 58 and 59 connecting the intermediate and lower portions are loose rings 60 and 61 respectively. The purpose of these rings is to allow less exactness in the manufacture of the intermediate portion 3 of the casing than would be necessary without these rings. These rings serve to prevent the passage of gases between the outer drum and the casing. By this construction only the rings 60 and 61 have to be machined. These rings are adjustable and serve to adjust the rotor with respect to the casing. A manner of ar-

ranging this adjustment is shown in Fig. 4, where the ring is clamped between the flanges by means of bolts 62 passing through holes in the flanges with ordinary tight fit and through holes in the rings of much larger diameter.

It is possible to clean the rotor while in rotation in its place within the casing, by means of a sootblower device, such as designated at 63. This device consists of a steam pipe provided with apertures directed toward the regenerative mass of the rotor, through which apertures steam of high pressure and velocity may be blown through the passages of the rotor.

The operation of the device as an air preheater is as follows:

Cold air enters at A and is forced through the smaller compartment of the upper section 4, then downwardly through the passages of the regenerative mass, then out at B to the place of use as, for example, a boiler furnace. Hot products of combustion enter the preheater at C passing up through the regenerative mass in the rotor and are drawn out through fan 29 as indicated by arrow D. The rotor is rotated by means of the motor 41 through the intermediary of the various belts, pulleys and shafts as is readily apparent. The hot products of combustion passing up through the right hand side of the regenerator heat the regenerative mass therein. Upon rotation this heated regenerative mass changes its position with relation to the casing and moves around to the left hand side of the regenerator where the heat in the regenerative mass is given up to the incoming air.

In normal operation the inner wheel 50 of clutch pulley 48 follows the rotation of the outer ring 49. If for some reason or other the rotor binds the two parts of the pulley 48 act as a clutch the part 49 slipping on the part 50, to prevent breakage of belts or other parts of power transmission. At first glance it would seem that this clutch mechanism would be unnecessary, in view of the fact that the roller 53 might slip on the outer drum of the rotor, the motor 41 then operating only the fans and the various transmission parts. However, as the roller 53 operates at a relatively high temperature a slipping between the roller and the rotor is highly undesirable, since this would injure these parts. Furthermore, if some equivalent connection is used in place of the roller 53 as, for example, a gear, such slipping could not take place. In view of the fact that the pulley 48 is more remote from the pivot point 54 than the roller 53 a greater moment is exerted on the pulley 48 due to the action of the belt 49, and, therefore, the belt tension gives a lower pressure between the two parts 49 and 50 than between the roller 53 and the outer drum. By this means a slippage in the clutch pulley 48 is assured rather than between the roller 53 and the drum.

In place of belts, chains or gear wheels may be used, provided the arrangement is such that a definite relation between the speed of the fan and that of the rotor can be determined, in order that the rotor may obtain a definite speed relatively to the quantities of gas or air passing therethrough.

Although I have described the preferred form of my invention it will be readily understood that details of construction and arrangement of parts may be changed within the scope of the invention, and my invention, therefore, is not to be limited to the precise embodiment shown.

I claim—

1. A regenerative heater comprising rotatable regenerative material, a fan to cause a relatively cold gas to pass through said regenerative material, a fan to cause a relatively hot gas to pass through said regenerative material, and common driving means to drive the fans and rotate the regenerative material.

2. A regenerative heater of the type described comprising a casing, a rotor in said casing, regenerative material in said rotor, a fan to cause a relatively cold gas to pass thru said heater, a fan to cause a relatively hot gas to pass through said heater and a common driving means to drive the fans and the rotor.

3. A regenerative heater of the type described comprising a casing, a rotor in said casing revolving about an axis, regenerative material in said rotor, a fan to cause a relatively cold gas to pass through said heater, a fan to cause a relatively hot gas to pass through said heater, a common shaft for said fans, said common shaft being arranged substantially at right angles to the axis of rotation of the rotor.

4. A regenerative heater of the type described comprising a casing, a rotor in said casing, regenerative material in said rotor, a compartment in said casing, means to cause a gas to pass through said compartment and through said rotor, a second compartment in said casing larger than the first compartment and means to cause a second gas to pass through the said second compartment and through the said rotor.

5. A regenerative heater of the type described comprising a casing, a rotor in said casing, regenerative material in said rotor, a shaft for said rotor, walls separating said casing into separate compartments for the passage of different gases and bearings for said shaft supported by said walls.

6. A regenerative heater of the type described comprising a casing, a rotor in said casing, regenerative material in said rotor, a

fan opening in said casing, a ring attached to said fan opening and means to permit relative adjustment of the ring with respect to the casing.

7. A regenerative heater of the type described comprising a casing, a rotor in said casing, regenerative material in said rotor, a friction roller to drive said rotor and means to drive said friction roller.

8. A regenerative heater of the type described comprising a casing, a rotor in said casing, regenerative material in said rotor, a passageway for a relatively cold gas through said casing and rotor, a fan in said passageway, a passageway for a relatively hot gas through said casing and rotor, a fan in said passageway, a common shaft for said fans, a friction roller to rotate said rotor and common means to drive said common shaft and said friction roller.

9. A regenerative heater of the type described comprising a casing, a rotor in said casing, regenerative material in said rotor, a friction roller to drive said rotor, means to drive said friction roller comprising a friction clutch consisting of parts adapted to slip relatively to each other.

10. A regenerative heater of the type described comprising a casing, a rotor in said casing, regenerative material in said rotor, a passageway for a relatively cold gas through said casing and rotor, a fan in said passageway, a passageway for a relatively hot gas through said casing and rotor, a fan in said passageway, a common shaft for said fans, means to drive said common shaft, a friction roller to rotate said rotor, power transmitting elements between said common shaft and said friction roller including a clutch device, said clutch device consisting of parts adapted to slip relatively to each other before slipping occurs between said friction roller and the rotor.

11. A regenerative heater of the type described comprising a casing, a rotor in said casing, regenerative material in said rotor, an outer drum for said rotor, a friction roller operating upon said outer drum to rotate the same, means to press the friction roller into engagement with the outer drum and clutch mechanism to drive said friction roller.

12. A regenerative heater of the type described comprising a casing made in three sections, a lower section, an intermediate rotor section and an upper section, a rotor in the intermediate section comprising an outer drum, a core, and regenerative material situated between said core and outer drum, means to divide the upper and lower sections into compartments of different size thereby forming a plurality of passageways through said casing and rotor, a fan in each of said passageways, a common shaft for said fans, a friction roller adapted to engage the outer drum of the rotor to rotate the same, power transmitting means to rotate said friction roller comprising a clutch device consisting of parts adapted to slip relatively to each other and means to press said friction roller into engagement with said outer drum, said power transmitting means being adapted to rotate said common shaft and said rotor simultaneously, the arrangement being such that slipping occurs in said clutch device before slipping will occur between said friction roller and said rotor.

13. A regenerative heater of the type described comprising a casing made in three sections, including a lower section, an intermediate rotor section, and an upper section, a rotor in the intermediate section comprising an outer drum, a core, and regenerative material situated between said core and outer drum, flanges on said sections for securing the same together, rings between said flanges and means whereby said rings are adjustable with respect to the flanges so that the rings may be alined with respect to the outer drum.

14. A regenerative heater comprising a casing, a rotatable frame in said casing, regenerative material carried by said frame, passages formed by said regenerative material, a shaft, fans mounted on said shaft for causing a fluid giving off heat and a fluid to be heated to pass alternately through the same said passages, said shaft being operatively connected with said rotatable frame.

15. A regenerative heater comprising rotatable regenerative material means to force a relatively cold gas through said regenerative material, means to draw a relatively hot gas through said regenerative material and a common mechanism to drive said means and rotate said regenerative material.

16. A regenerative heater comprising a casing, a rotor, regenerative material in said rotor, a partition wall in said casing forming a plurality of compartments, a fan in said casing to force a relatively cold gas into one of said compartments and thence through said rotor and a second fan in said casing to draw a relatively hot gas through said rotor and thence through a second of said compartments.

17. A regenerative heater comprising a casing, a rotor in said casing, regenerative material in said rotor and a plurality of fans, journaled in said casing and mounted adjacent the casing to form one unit with same.

18. A regenerative heater, comprising a casing, a rotatable frame in said casing, regenerative material carried by said frame, passages formed by said regenerative material, means for imparting a continuous rotation to said frame, a shaft, propeller fans mounted on said shaft for moving a fluid

giving off heat and a fluid to be heated through the same passages thereof, said shaft with the propeller fans being operatively connected with the said rotatable frame.

19. A regenerative heater comprising rotatable regenerative material, a fan to cause a relatively cold gas to pass through said regenerative material, a fan to cause a relatively hot gas to pass through said regenerative material, and means to drive the fans and rotate the regenerative material at speeds of given ratio whereby the speed of rotation of the regenerative material is varied proportionately with variations in the quantity of hot and cold gases passed through the regenerative material.

20. A regenerative heater comprising rotatable regenerative material, a fan to cause a relatively cold gas to pass through said regenerative material, a fan to cause a relatively hot gas to pass through said regenerative material, at least one of said fans having adjustable blades whereby the relative capacities of said fans may be varied to compensate for the difference in specific volume between said relatively cold and said relatively hot gases, and means to rotate the fans and the regenerative material at speeds of given ratio.

21. A regenerative heater of the type described comprising a casing made in three sections, a lower section, an intermediate rotor section and an upper section, a rotor in the intemediate section containing regenerative material having a series of passages through the same, means to divide the upper and lower sections into compartments of different sizes forming two passageways through said casing and rotor, a fan located in the smaller of said passageways to cause a relatively cold gas to pass through said regenerative material, a fan located in the larger of said passageways to cause a relatively hot gas to pass through said regenerative material, adjustable blades in said last-named fan whereby its capacity relative to that of said first named fan may be varied, a common drive shaft for said fans and common driving means for rotating said shaft and said rotor at speeds of given ratio.

22. A regenerative heater comprising a regenerative material having passages through the same, supply and discharge channels for a relatively hot gas and relatively cold gas, the supply and discharge channels for one gas being connected with certain of said passages at a given time and the supply and discharge channels for the other gas being connected with different passages than those to which the supply and discharge channels for the said one gas are connected, continuously operating means to change the communication of the passages with respect to the supply and discharge channels for the different fluids, a fan to cause the relatively hot gas to pass through the regenerative material, a fan to cause the relatively cold gas to pass through the regenerative material, and means to drive the fans and operate said continuously operating means at speeds of given ratio whereby the rate of change of communication of the passages with respect to the supply and discharge channels is varied proportionately with variations in the quantity of hot and cold gases passing through the regenerative material.

In testimony whereof I affix my signature.

FREDRIK LJUNGSTRÖM.