Feb. 2, 1932. K. TOENSFELDT 1,843,252

HEAT RECOVERER

Filed April 30, 1926 2 Sheets-Sheet 1

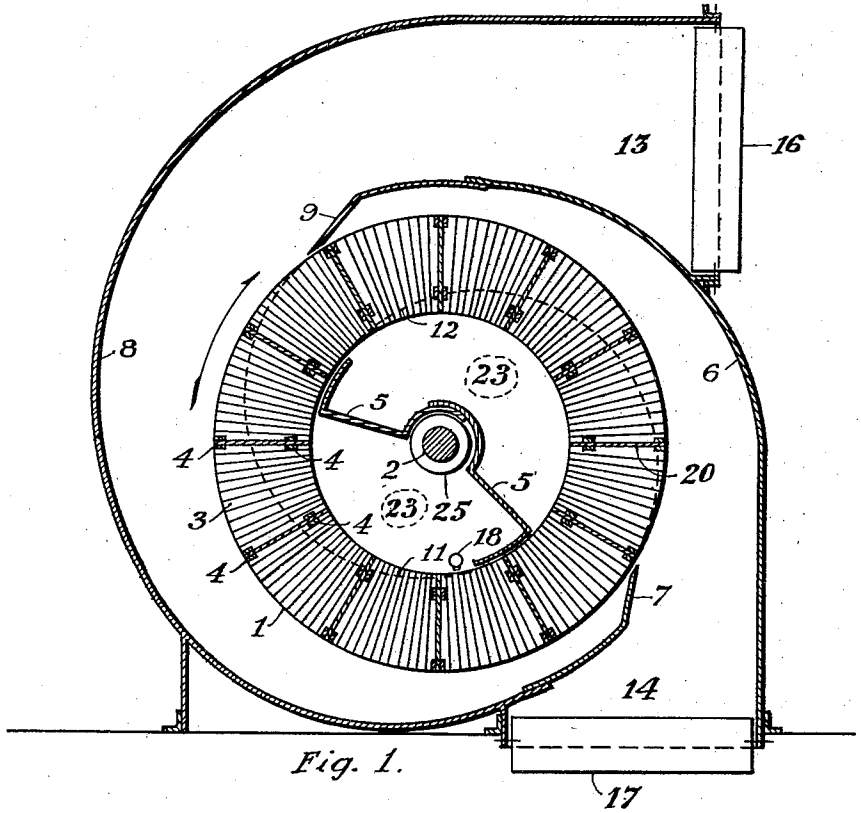



Fig. 1.

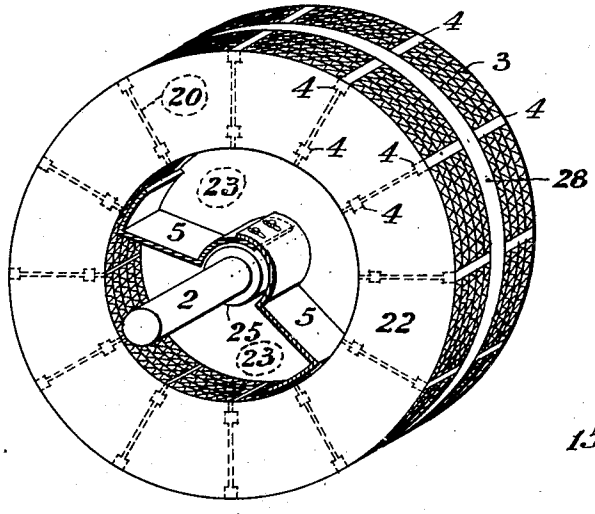



Fig. 2.

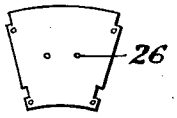



Fig. 3.

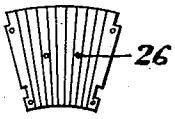



Fig. 4.

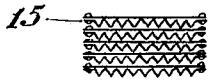



Fig. 5.

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HEAT RECOVERER

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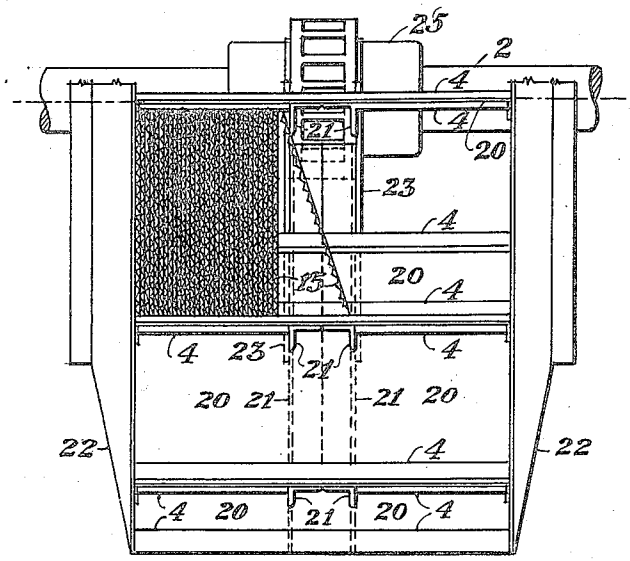



Fig. 6.

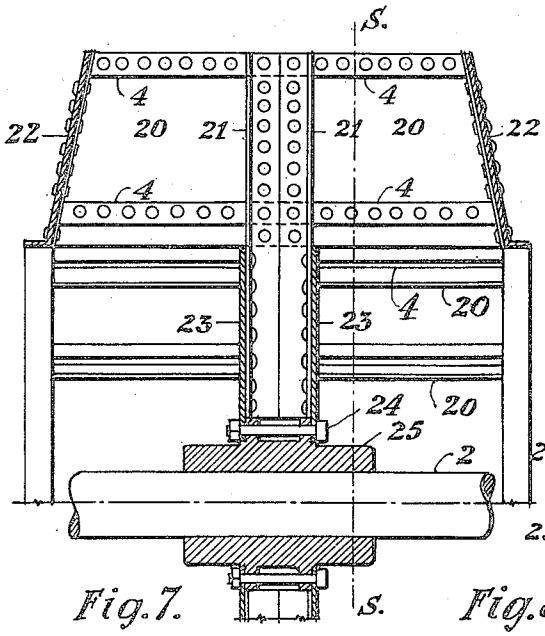



Fig. 7.

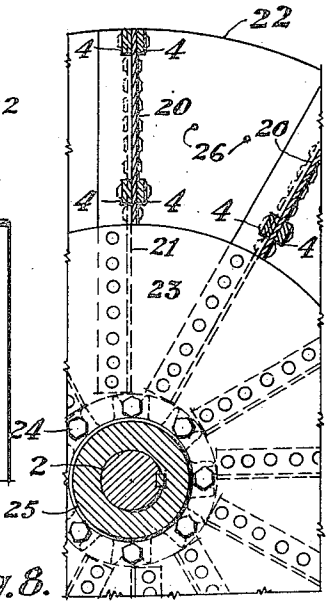



Fig. 8.

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# UNITED STATES PATENT OFFICE

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## HEAT RECOVERER

Application filed April 30, 1926. Serial No. 105,736.

Another object of my invention is to provide a device which is adapted to simultaneously handle a plurality of different fluids and keep them separated one from another or intermingle them in predetermined quantities as desired.

A further object of my invention is to provide a heat recoverer or air preheater of the regenerative type which will recover heat from hot fluids and add the recovered heat to cool fluids and in which the heat absorbing body is not subjected to extreme temperature variations.

A still further object of my invention is to provide a centrifugal fan type heat recoverer or air preheater which may be easily cleaned.

For the purpose of illustrating my invention, I have shown in the accompanying drawings, one form thereof which is at present preferred by me, since the same may immediately be put to practice.

It is to be understood that the various instrumentalities of which my invention consists and the precise form, shape or construction shown can be variously altered, arranged and organized and that my invention is not limited to the precise arrangement and organization of these instrumentalities, or to the several parts thereof, as herein shown and described.

With these and other objects in view, my invention consists in the novel construction, arrangement and combination of parts as hereinafter fully, clearly and concisely described, definitely pointed out in my claims, and illustrated by the accompanying drawings, in which:—

Fig. 1 is a cross sectional view of my device, taken through the fan wheel in the plane of rotation; Fig. 2 is a perspective view of the fan wheel removed from its housing and bearings; Figs. 3 and 4 show, in elevation, respectively, a preferred form of a flat metal plate and a corrugated metal plate, both shaped to fit any segment of the fan wheel; Fig. 5 is a plan view of an assembly of the plates shown in Figs. 3 and 4, the plates being packed together to make up the fan blading or heater units of a segment of the fan wheel; Fig. 6 is a half plan of the fan wheel shown in Fig. 1, certain parts having been omitted for clearness; Fig. 7 is a half section through the fan wheel taken in a plane of its axis, showing certain partition members omitted from Fig. 6; and Fig. 8 is a partial section of the fan wheel on the line S—S of Fig. 7.

Referring to the drawings, my device consists of a bladed, rotatable fan wheel, 1, suitably mounted on and revolvable with a shaft 2, which is supported by suitable bearings and adapted to be driven or rotated at a proper speed by a suitable motive power. This fan wheel preferably consists of a number of built up segments, 3, each of which preferably comprises a number of metal plates such as those shown in Figs. 3 and 4. I prefer to form units, 15, by fastening together, in any suitable manner, a corrugated metal plate, Fig. 4, to a flat metal plate, Fig. 3, both of said plates being shaped to fit a segment of the fan wheel. These units are preferably held in the segment by shoulders, 4, which engage with suitable slots provided for that purpose in the units. The shoulders, 4, may be fastened to and form a part of a suitable fan wheel mounting.

I have shown the illustration of the unit structure 15 in Fig. 5 as simply as possible and it is obvious that stiffening members may be added to the unit structure where and when they become necessary or advisable. For example, bolts may be passed through the holes 26 in these plates, these bolts serving to stiffen the corrugated blades against radial deflection. It is likewise obvious that the units 15 may be arranged and fastened differently within the segments than as illustrated by me. For instance, instead of having the plates of the units 15 arranged and secured within the fan wheel segments in planes parallel to the plane of rotation, they may be arranged in planes parallel to the axis of rotation.

I preferably shape the corrugated plates illustrated in Fig. 4 so that the edges of the corrugations will be straight lines, thereby maintaining the flat plates, Fig. 3, in a perfect plane when the units 15 are assembled and

fastened together in a pack such as shown in Fig. 5. By the use of this construction, all the flat plates will have a maximum strength for resisting the bending due to the centrifugal force produced by rotation of the mast.

Fig. 6 shows the heater units 15 supported by shoulder pieces 4 in the manner previously explained in the references to Figs. 1 and 2. One segment, on one side of the fan wheel, is shown packed with these units excepting the last unit which is shown entering diagonally and radially inwards through the central opening on the outer circumference of the fan wheel. In this way, all units may be assembled into the segments. The outer central circumferential opening of the fan wheel may be finally sealed with the circumferential plate 28 shown in Fig. 2. By preference, this plate is removable so that access may be had to the central opening for replacing units. The shoulder pieces, 4, may be suitably fastened to the plates 20, which preferably extend across the width of the fan wheel to the annular end ring plates 22. Near their center, the plates 20 are fastened to angles 21, which extend radially from the hub 25 to the outer circumference of the wheel. The angles 21, in turn, are suitably fastened to the annular plates 23. These annular plates 23, and the annular end plates 22 are attached in such manner to the angles 21 and plates 20 that the plates 20 are equally spaced around the fan wheel and the units 15 will fit into any segment of the fan wheel.

The fan wheel may be constructed as indicated in Figs. 2, 6 and 7, in which case fluids may enter the blading from either side of the central mounting, or it may be arranged so that fluids enter the blading from only one side of the central mounting.

The annular plates 23 are fastened to the hub 25 against a finished flange by bolts 24, or other suitable means, and are seated, on their inner circumference, on a finished surface of the hub 25. This hub is suitably mounted on and fastened to the shaft, 2, as by the key shown in Fig. 8.

Partitions 5 may be mounted within the fan wheel as shown in Figs. 1 and 2 and are adapted to form a seal with the inner circumferential surface of the fan wheel and are preferably adjustable by rotating them about the axis of shaft 2 so that separate fluids, for example, air and flue gas, may be directed or delivered separately to any predetermined number of the blades of the fan wheel. The illustration of the partitions 5 shows the entire partitions to be movable. Obviously other arrangements of these partitions may be employed to direct or deliver the separate fluids, each to its selected arc of the fan wheel. As an illustration, instead of the radial parts of the partitions being made movable, as illustrated, these may be made into stationary partitions permanently fastened and fitted into the fan inlet and the seals may be made independently movable and adjustable. The fan wheel is encased within a housing with the scrolls 6 and 8, having adjustable inner ends 7 and 9, the scrolls forming separate passages for the different fluids leaving the fan wheel. The inner ends 7 and 9, are movable concentrically around the outer circumferential surface of the fan wheel and are adapted to form a seal with said surface. The scrolls or outlets of the fan, are preferably provided at their outer ends with dampers 16 and 17, whereby to vary the resistance of the fluids through the fan. These dampers may either be single, or louvered, as shown in Fig. 1. 18 is a perforated pipe which may be used as a soot blower for cleaning the blades.

The operation of my device is as follows: The separate fluids enter the fan inlet in the axial space between the shaft and the fan wheel, between the adjustable partitions 5. By adjusting these partitions, different volumes of the separate fluids may be led to selected arcs of the fan wheel limited by the partitions 5 and the leakage of one fluid to another and their diffusion along the paths of separation, 11 and 12, may be limited and controlled by the outer ends of the partitions, which are adapted to form seals of varying lengths. The position of the partitions may be varied by any suitable arrangement.

Another control of the fluids may be had by the dampers 16 and 17 shown in Fig. 1 which are located in the discharge outlets, 13 and 14, respectively. These dampers permit an increase or decrease in the resistance, as desired, to the flow of the respective fluids discharged by the fan. By partially closing damper 17 and permitting damper 16 to remain open, the total resistance of one fluid through the fan, and the system which it serves, may be varied while the total resistance of the other fluid through the fan will remain relatively constant. It is obvious that the converse situation applies when the setting of the dampers is reversed.

As shown in Fig. 2, the flat and corrugated metal plates, or blades, comprised in the units 15, form straight, radial, tubular passages, through which the fluids travel outwardly when moved by the rotation of the fan wheel. The fan revolves in the direction of the arrow, shown in Fig. 1, and the fluid particles travel outwardly through the blading, or units, 15, in paths substantially as shown by the dotted lines 11 and 12. The scroll end pieces or separators, 7 and 9, are so located that one fluid leaves the wheel on one side while another fluid leaves the wheel on the other side thereof, that is, the scroll end pieces serve as separators for the two fluids leaving the wheel. On leaving the fan wheel, the fluids are discharged respectively, one at the fan outlet 13 and the other at the fan outlet 14.

During the travel of the fluids through the fan wheel, as for example, hot flue gases and relatively cool air, the blades or heater units, which are in sufficient number to serve as a suitable heat absorbing body, take up heat from the hot gases and give up this heat to the relatively cool air. In this way, the device or apparatus functions as a heat recoverer or air preheater.

Because of the number of revolutions per minute of the fan wheel, the blades or heater units, will, in each revolution, be exposed to such small quantities of hot gases and cool air, alternately, that the heat added to or withdrawn from the blades during each revolution will be small and the temperature of the blades will remain practically constant. This feature of my device possesses an advantage over the types of air preheaters in which the heat absorbing elements are exposed to relatively large quantities of hot gases and cool air in alternation, in that the latter types have relatively large variations in temperature in the heat absorbing elements during each exposure to the hot gases and cool air. These large variations of temperature in the heat absorbing elements and their structural supports cause objectionable temperature strains in the structure of the apparatus.

Another advantage of my fan type heat recoverer or air preheater lies in the fact that the air and gases pass through the blading in the same direction, permitting the dirt, accumulated from the gases in the blading, to be blown by suitable soot blowers in the same direction as the flow of the air and gases and also in the same direction as the centrifugal force; whereas, in the type of air preheaters in which the air and gases pass through the heat absorbing elements, in alteration, and the air passes through in the opposite direction of flow to that of the gases, the dirt accumulations are blown through the heat absorbing elements separately in the air and gas passages, conforming to the directions of flow of the air and gases in the respective passages. In such devices, when handling very dirty gases, the cleaning is not as effective as with the fan type air preheaters because much of the dirt cannot be removed by the blowing in one direction and is consequently blown back into the heat absorbing elements when blown in the opposite direction. It is obvious that dirt, soot or tarry matter increases the resistance to flow of the fluids, thereby adding power consumption for moving the fluids through the preheaters.

In my device, both the cool air and hot gases pass through the heater units in the same direction, that is, radially outwards, the result being that the temperature of the heater units may be maintained practically constant and of such a degree as is well above the temperature at which dirt will be deposited due to condensation of the moisture which may be in the hot gases. This is not the case in air preheaters employing the counter-flow principle of heat transmission in which the temperature of the end of the heater plates, where the cool air enters, may be well below the dew point of the moisture in the hot gases.

By connecting or mounting several fan type heat recovers or air preheaters in series, stage heating may be accomplished and a higher heat recovery may be obtained with the same initial cold and hot fluid quantities and temperatures than with the single type fan heat recoverer. In this arrangement, the cold fluids may pass serially through several fan type heat recovers in one direction, absorbing heat in each stage while the hot fluids may pass serially through the same several fan type heat recoverers in the opposite direction giving up heat in each stage.

I claim:—

1. A fluid moving and heat-transfer device comprising a plurality of passages for fluids of different temperatures, a centrifugal fluid-moving member adapted to revolve in said passages and move the fluids and transfer heat from the fluid in one passage to the fluid in another passage, a partition member disposed for adjusting movement adjacent the periphery of said centrifugal member, and a movable damper forming a variable resistance to the fluid flow in one passage.

2. In a centrifugal fluid moving and heat transfer device adapted simultaneously to handle a plurality of different fluids, and to keep the fluids substantially separate, a rotary member having a central inlet passage, adjustable partitions therein, a plurality of outlet passages, partitions disposed between the outlet passages and adapted for adjusting movement adjacent the peripheral portion of said rotary member, and a damper forming an outlet pressure control means for the device, adjustable independently of said partitions.

3. In a centrifugal heat transfer device adapted simultaneously to move and transfer heat between a plurality of fluids, a fluid moving member having an axial inlet opening therein, and a peripheral outlet, a plurality of angularly adjustable fluid inlet partitions extending cross said inlet opening, discharge passages from the fluid moving member, partitions between said discharge passages, movable dampers in said passages and seals associated with the outer ends of said discharge partitions and adapted to coact with the inlet partitions to vary the proportion of the fluids handled by the device.

4. In a centrifugal device adapted to move a plurality of fluids, and effect changes in their relative heat content, a centrally chambered, rotary fluid moving member including freely interchangeable, sectional elements having a plurality of relatively small, tubi-

form passages, directed from the chambered portion of the rotary member to the periphery thereof, and adapted to transfer heat from one fluid to another fluid moved thereby, inlet passages associated with the chambered portion of the rotary member, a plurality of passages arranged for the discharge of the separate fluids from the periphery of the moving member, adjustable partitions between the discharge passages, and having end portions lying adjacent the periphery of the moving member, and dampers for separately controlling the rates of discharge of the several fluids.

5. In a centrifugal device adapted simultaneously to move a plurality of fluids and to effect changes in their relative heat content, a fluid moving member having freely removable and replaceable conducting elements including passages adapted for unidirectional fluid flow and adapted to transfer heat from one fluid to another fluid, an inlet opening in said member, angularly movable partitions in said opening, additional partitions adjustably disposed adjacent the periphery of the fluid moving member, seals associated with each of said partitions, adapted to limit the diffusion of the fluids in said device, passages for the separate discharge of the fluids, and dampers in said passages adapted separately to control the discharge of each of said fluids, said partitions adapted to vary the angular proportions of the moving member devoted respectively to movement of the several fluids.

6. In a centrifugal device adapted simultaneously to move a plurality of fluids and effect changes in the heat content thereof, a fluid moving member having an axial opening therein and comprising a plurality of freely interchangeable radiating elements adapted to transfer heat from one fluid to another fluid, separately adjustable partitions extending across said opening, seals carried by said partitions and adapted to limit the diffusion of the fluids in said device, a scroll member substantially surrounding the fluid moving member and forming passages for the separate discharge of the fluids, and movable scroll ends disposed in said passages to control the discharge of said fluids and the transfer of heat therebetween.

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