June 28, 1932. N. R. FORSSBLAD 1,864,724

REGENERATIVE HEATING DEVICE

Filed Sept. 30, 1924 3 Sheets-Sheet 1

Fig. 1

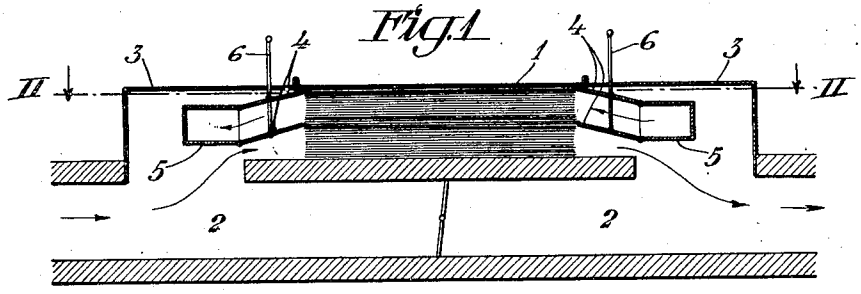


Fig. 2

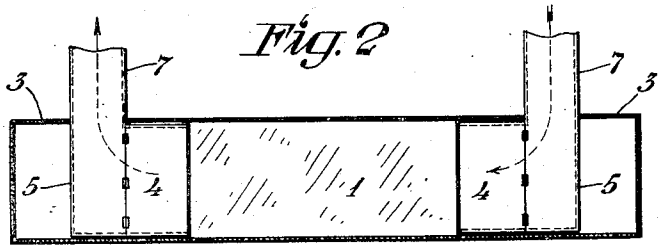
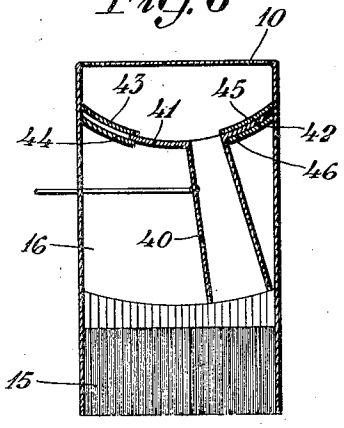


Fig. 6



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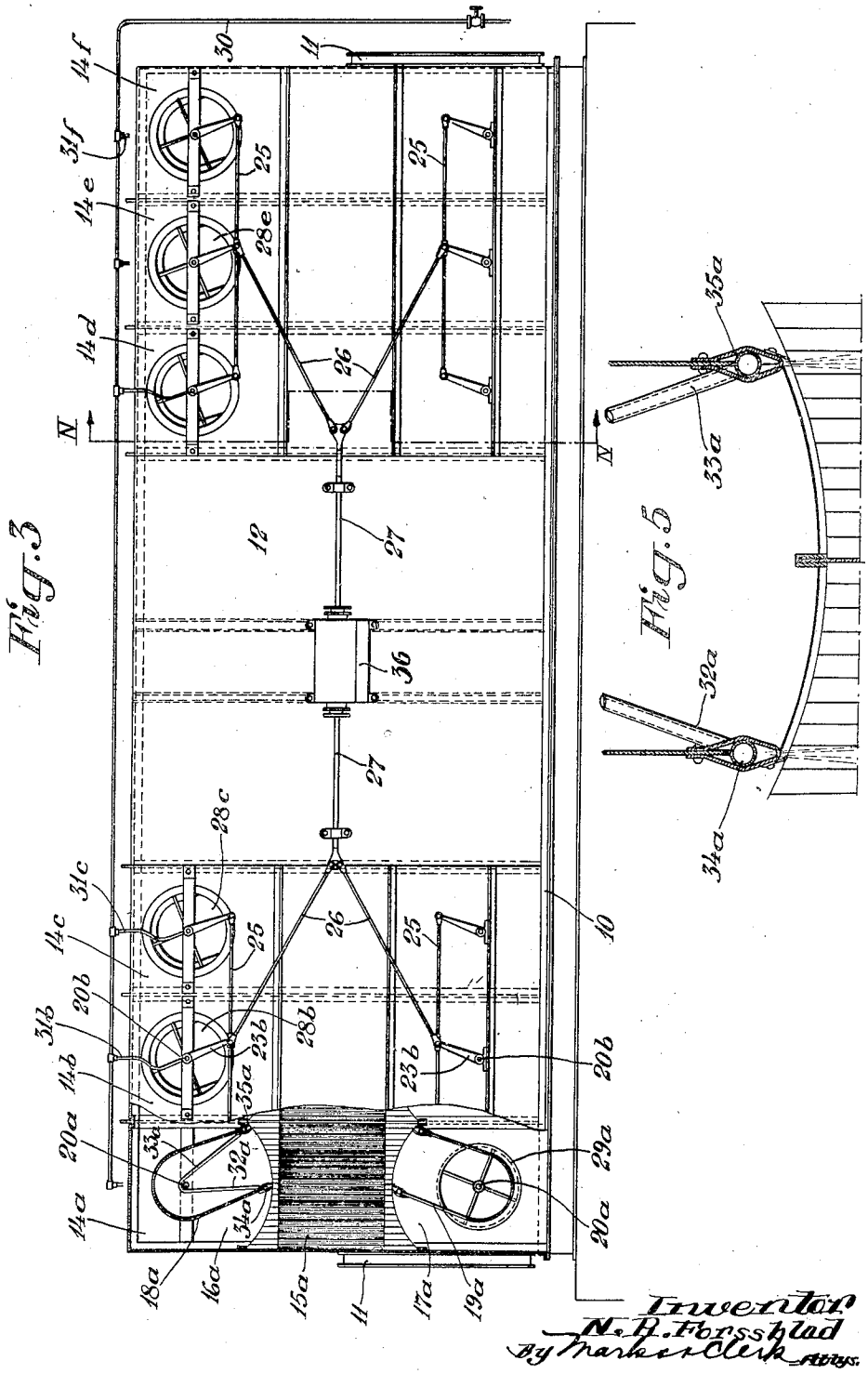


Fig. 3

Fig. 5

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REGENERATIVE HEATING DEVICE

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Fig. 4

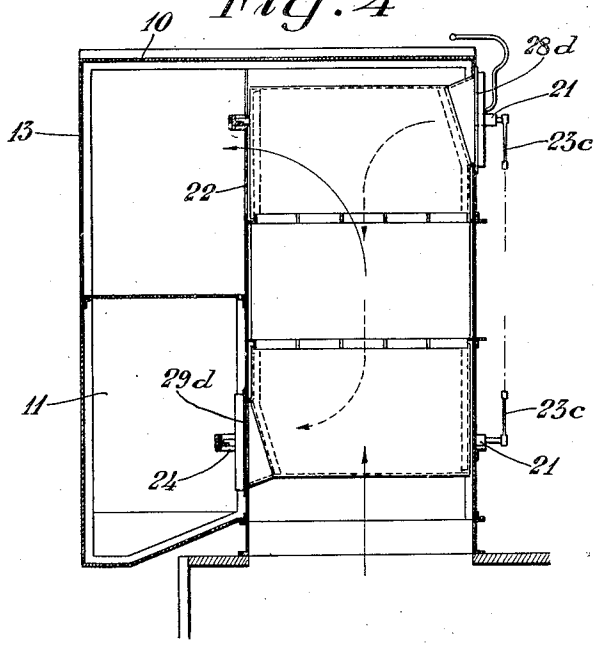
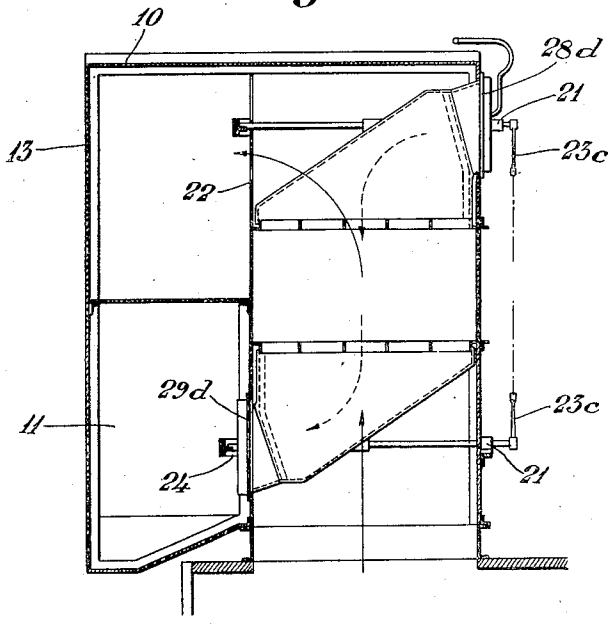


Fig. 7



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UNITED STATES PATENT OFFICE

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REGENERATIVE HEATING DEVICE

Application filed September 30, 1924, Serial No. 740,864, and in Sweden October 4, 1923.

The present invention relates to regenerative heating devices for transmitting heat from one fluid to another, and aims, broadly, at providing a highly efficient heating device of the above-mentioned type.

Regenerative heating devices as heretofore known are of two different kinds. The material effecting the exchange of heat has either been stationary, in which case valves are provided to conduct the two fluids to and from said material, said valves being generally built as seat valves which are entirely open or entirely closed with the exception of the periods of time necessary for their adjustment, or, such material has been arranged in a rotating frame and provided with a plurality of axially extending channels through which the two fluids pass alternately.

The main object of the present invention is to provide a regenerative heating device which, while having a stationary arrangement of the regenerating material, permits a faster and more simple change of the fluid currents in the heater. In order to attain this object a movable distributor conduit is provided at each end of the regenerating material to conduct the one fluid through a plurality of channels and to simultaneously permit the other fluid to pass throught other channels. Preferably, a stationary chamber for the one fluid is arranged at each end of said material, a swingable distributor conduit for the second fluid being situated in each of the stationary chambers.

With the above and other objects in view, the invention further consists in the construction, combination and arrangement of parts all as hereinafter more fully described, specifically claimed and illustrated in the accompanying drawings, in which

Fig. 1 shows diagrammatically a longitudinal section of one form of regenerative heater according to the invention.

Fig. 2 is a section taken on line II—II, Fig. 1.

Figs. 3 and 4 show, more in detail, a side view and a section on the line IV—IV in Fig. 3 respectively, of another embodiment of a regenerative heating device according to the invention.

Fig. 5 shows on an enlarged scale the lower part of a distributor conduit with adjacent regenerating material.

Fig. 6 shows a cross section of a regenerative unit slightly modified, only the upper part thereof being disclosed, and

Fig. 7 shows a modification of the construction and mounting of the distributor conduits.

With reference to Figs. 1 and 2, the regenerating heating device comprises regenerating material 1 which, in the embodiment shown, consists of metal plates arranged in parallel planes and forming channels between them, such channels extending from the one end of the material to the other. Said regenerating material 1 is arranged above the flue 2, and the channels of the material communicate with said flue by means of caps 3. Arranged in each cap 3 are two dampers 4 operatively connected with each other, said dampers 4 being at their one end pivotally connected to a chamber 5, while their other ends may be moved up and down by means of a rod 6, in front of the end of the regenerating material 1. Packing means—not shown—are arranged between said dampers and the sides of the caps 3, while the chambers 5 communicate with air channels 7 by means of openings in said sides, as shown in Fig. 2.

The operation of the device is as follows:

In the position of the dampers 4 shown in Fig. 1, the flue gases pass through the lower portion of the regenerating material, causing heating of said material, whereas air enters one of the channels 7 and the corresponding chamber 5, after which it passes through the upper portion of the regenerating material and is exhausted through the other chamber 5 and the corresponding channel 7. When the dampers 4 are now lowered into their lower position, the air is caused to pass through the lower portion of the regenerating material and will thus absorb the heat stored in said material, whereas the flue gases are conducted by the dampers 4 through the upper portion of the regenerating material so as to heat the latter. It is evident that the change of the two fluid currents will take place without

interruption of anyone of the currents, and by using suitable packing means between the dampers 4 and the ends of the regenerating material a slow operation of the dampers may be permitted, or the dampers may even be continuously operated by subjecting the same to a constant oscillatory or reciprocating movement. The dampers 4 situated at the different ends of the regenerating material may and preferably are mechanically connected with each other, and may be driven automatically in a suitable manner from a suitable driving means—not shown. Instead of using only one damper device at each end of the regenerating material, a plurality of dampers may be used which are preferably operatively connected with each other, each moving in front of a portion of the regenerating material.

In Figs. 3 and 4 a preferred embodiment of a regenerative heating device according to the invention is shown. This heating device consists of a casing 10 which is open at the bottom and is provided in its lower part with a channel 11 extending throughout the length of the casing 10, said channel being open at both ends and in its upper part with a channel 13. At each side of a middle compartment 12, which is provided with an opening communicating with channel 13 serving as an outlet for the one fluid, there are three regenerative heating units according to the invention, i. e. 14*a*, 14*b*, 14*c* and 14*d*, 14*e*, 14*f* respectively, each of which comprises regenerating material 15*a* (see the unit 14*a* to the left in Fig. 3, where the casing 10 is in part broken away to show the interior of the unit) which also in this case consists of metal plates arranged in parallel planes and forming channels between them. Arranged at each end of said regenerating material 15*a* is a chamber 16*a* and 17*a* respectively, and within each of said chambers there is arranged a distributor conduit 18*a* and 19*a*, each of which consists of an approximately cylindrical cap swingably mounted on a shaft 20*a* by means of stays arranged like the spokes of a wheel. The caps open towards the regenerating material 15*a* and are provided with an inlet or outlet respectively for the one fluid. Some of the plates of said material are extended upwards and downwards in such a way that their end edges terminate in the surfaces described by the swinging end edges of the distributor conduits. By this means a tightening effect is obtained between the distributor conduits and the regenerating material, so that mixing of the fluids is prevented when changing the position of the distributor conduits. In order to bring about more effective tightening, the end edges of the distributor conduits or the lengthened plates may be provided with thin strips of known kind.

The other five regenerative units are constructed in the same way. The shafts 20*a*, 20*b*, etc. of the distributor conduits are journalled at their one ends in the casing 10 as at 21, and at their other ends in suitable stays 22 fixed to the casing 10, and in the wall of the channel 11 at 24 respectively. Secured onto each shaft 20*a*, 20*b* etc. is a crank of which one, designated by a reference character 23*b* is connected to shaft 20*b*, said cranks being interconnected by coupling rods 25 which are connected by means of other rods 26 to a common connecting rod 27, which may be given a reciprocating movement by means of any suitable driving means 36.

Each of the upper distributor conduits communicates by means of an opening (28*b*, 28*d*, 28*e*) in the casing 10 with the open air, and each of the lower distributor conduits communicates with the channel 11 by means of an opening. The chambers (29*a*, 29*d*) surrounding any set of three adjacent distributor conduits communicate with one another and, in fact, form only one chamber corresponding to the cap 3 shown in Figs. 1 and 2.

The operation of this device is as follows:

Flue gases enter the casing 10 at the bottom and flow into the lower chambers such as 17*a*. From said chambers the gases flow through those channels of the regenerative material which are not in communication with the interior of the distributor conduits, thereby causing the corresponding regenerating material to be heated. From said channels the flue gases enter the upper chambers such as 16*a*, and exhaust through the channel 13. The air enters the upper distributor conduits such as 18*a* through the openings such as 28*b*, passes then through the remaining channels of the regenerating material which lie between the contacting edges of the distributor conduits, enters the lower distributor conduits 19*a*, 19*b*, etc., flows therefrom into the channel 11 through the openings such as 29*a*, and may be taken out at the ends of said channel 11. On turning the distributor conduits, channels of the regenerating material which previously were passages for flue gases will now communicate with the distributor conduits and form passages for air which will absorb the heat stored in the corresponding material, and thus become heated, whereas other channels through which air previously passed, will now communicate with the chambers such as 16*a*, and are now, consequently, passages for flue gases, causing the corresponding regenerating material to be heated.

Of course, it is not necessary that the regenerative heating device has the form shown in Figs. 3 and 4. For instance, the middle compartment 12 may be dispensed with. Further, the device may only consist of, for instance, the left half of Fig. 3. The number of regenerative units depends upon prevailing circumstances. In manufacturing regenerative heating devices according to the

invention the units may be given a standard size, whereby the great advantage is gained, that regenerating heating devices of different outputs may be obtained by assembling a greater or less number of such units. Further, a preheating aggregate which is already in operation but which is found to be insufficient, may easily be augmented by adding one or more additional units.

30 designates a pipe connected to flexible branch pipes, such as 31*b*, 31*c* and 31*f* communicating by means of sets of pipes such as 32*a*, 33*a*, with channels such as 34*a*, 35*a*, which are arranged longitudinally in the end edges of the distributor conduits, and provided with downwardly directed openings. Of course, the connection of the longitudinal channels 34*a*, 35*a* etc. with the pipe 30 may be effected in any other suitable way. By connecting the pipe 30 with a source of steam, compressed air or the like, the regenerating material may be effectively cleaned from soot or the like. The operation of this sweeping arrangement is shown more fully in Fig. 5. Evidently it is necessary to provide such a blowing channel in each of the edges of the distributor, as otherwise only a part of the material would be cleaned. It is clear that by means of a soot blowing device as described above it will be possible to effect cleaning of the material during the operation of the heating apparatus, this possibility being, of course, of great importance.

Fig. 6 shows a modification of a regenerative unit according to the invention. In this embodiment the distributor is journalled in such a manner, that the radius of curvature of the contact surface between the distributor and the regenerating material may be increased. The distributor conduit is composed of two parts, a stationary part consisting of the outer portion of the chamber 16 or 17 respectively, and a movable box 40 open towards the said part of the chamber 16 or 17 and towards the regenerating material. The box 40 is provided with flanges 41 and 42 which are guided between partitions 43, 45 and 44, 46, a pair of said partitions, for instance 44 and 46, extending only along a part of the length of the distributor conduit. The partitions 43, 45 and 44, 46 and the flanges 41, 42 of the box 40 form parts with coaxial cylindrical surfaces, and by suitably selecting the radius of curvature of said cylindrical surfaces, the contact surface between the distributor conduit and the regenerating material may be given the desired radius of curvature.

The swinging movements of the movable box 40 may be brought about in any suitable manner.

In the embodiment disclosed in Figs. 3 and 4, the distributor conduits are shown embracing the regenerating material to the half of the width thereof. In some cases, however, another division of the fluid currents may be conceived, for instance, when preheating the air of combustion for a boiler furnace by means of the heat of the flue gases, especially where moist fuel is used, in which case the volume of air necessary for the combustion is much smaller than the volume of the flue gases. Assuming the ratio between said volumes to be 1:2, and the air to be heated to pass through the distributor conduits, the latter must not embrace more than ⅓ of the total width of the regenerating material. If the distributor conduits move intermittently, it will be suitable in this case to divide the path of travel of the distributor conduits into two portions. That is, the distributor conduits should be held at one extreme end position for a given length of time, then moved to a central intermediate position, such that if constructed in accordance with Fig. 3, the sides of the conduits would be in line, and held in this position for a given length of time, and then moved to the other extreme position for another period of rest. In this manner, the regenerative material would be evenly utilized.

Fig. 7 illustrates a modification of the form of distributor conduit shown in Figs. 3 and 4, and a different way of mounting the same. The distributor conduit no longer has the form of a cylindrical cap such as shown in Figure 4, but its height increases in the direction towards the inlet 28 and the outlet 29 respectively. By this means a uniform flow of the fluid to and from the regenerating material is secured and, further, a larger space is obtained around the distributor conduit, whereby the size of the unit may be correspondingly decreased.

Any means such as fans and any arrangement of such means may be used for forcing or inducing the air and flue gases through the heating device. Opening 28 is adapted to contain an air supply fan.

While a regenerative heating device is shown and described above in which the distributor conduits are swingably arranged, the invention is in no way limited to such movement of the distributor conduits. Obviously, they may also be so arranged as to perform a reciprocating rectilinear movement. Such a movement may for instance be effected when in the embodiment shown in Fig. 6 the partitions 43, 45 and 44, 46 and the flanges 41, 42 of the box 40 are plane instead of curved.

Obviously any known arrangements to prevent a mixing of the fluids, to move the fluids through the regenerating device etc., the form and the arrangement of the regenerating material etc. may be used in combination with the described embodiments without departing from the principles of the invention.

What I claim as new and desire to secure by Letters Patent of the United States of America is:—

1. A regenerative heating device for transmitting heat from one fluid to another, comprising regenerating material provided with channels extending from one end of said material to the other, and a movable distributor conduit at each end of said material to conduct the one fluid through a plurality of said channels and to simultaneously permit the other fluid to pass through other channels.

2. A regenerative heating device for transmitting heat from one fluid to another, comprising regenerating material provided with channels extending from one end of said material to the other, a chamber at each end of said material conducting the one fluid and movable distributor conduits conducting the other fluid within each of said chambers, said distributor conduits communicating with each other by means of a plurality of said channels, whereas other channels effect communication between said chambers.

3. A regenerative heating device for transmitting of heat from one fluid to another, comprising regenerating material provided with channels extending from one end of said material to the other, stationary chambers for the one fluid at the ends of said material, movable distributor conduits for the second fluid in said stationary chambers, said movable distributor conduits conducting the one fluid through a plurality of the channels of the regenerating material and simultaneously permitting the second fluid to pass through the remaining channels of said material.

4. A regenerative heating device for transmitting heat from one fluid to another, comprising regenerating material provided with channels extending from one end of said material to the other, a stationary inlet chamber for the one fluid at one end of said material, a stationary outlet chamber for the same fluid at the other end of said material, a movable inlet conduit for the second fluid lying within the outlet chamber for the first fluid, a movable outlet conduit for the second fluid lying within the inlet chamber of the first fluid, said movable conduits conducting the one fluid through a plurality of the channels of the regenerating material and simultaneously permitting the second fluid to pass through the remaining channels of said material.

5. A regenerative heating device for transmitting heat from one fluid to another comprising regenerating material provided with channels extending through the same from one end to the other, conduits at the ends of said regenerative material for conducting a fluid through some channels of said regenerating material, chambers at the ends of said regenerative material surrounding said conduits and serving to conduct a second fluid through other channels of the regenerative material and means to move the conduits within the chambers to connect the conduits and the chambers with different channels.

6. A regenerative heating device for transmitting heat from one fluid to another, comprising regenerating material provided with channels extending from one end of said material to the other, distributor conduits at the ends of said material to conduct the one fluid through a plurality of said channels and to permit simultaneously the other fluid to pass through other channels and means to oscillate the distributor conduits.

7. A regenerative heating device for transmitting heat from one fluid to another, comprising regenerating material provided with channels extending from one end of said material to the other, a chamber at each end of said material conducting one of the fluids and distributor conduits within said chambers conducting the other fluid, said distributor conduits communicating with each other by means of a plurality of said channels, whereas the remaining channels effect communication between said chambers, means to oscillate the distributor conduits and means operatively interconnecting said distributor conduits.

8. A regenerative heating device for transmitting heat from one fluid to another comprising a plurality of members, regenerative material between said members, said members and regenerative material being arranged to form channels, distributor conduits at the ends of said members to conduct the one fluid through a plurality of said channels and to simultaneously permit the other fluid to pass through the remaining channels, the ends of said members terminating in inwardly curved surfaces and each conduit being positioned with one end adjacent one of said curved surfaces and adapted to oscillate so as to maintain its end adjacent said one of said curved surfaces.

9. A regenerative heating device for transmitting heat from one fluid to another, comprising regenerating material provided with channels extending from one end of said material to the other, movable distributor conduits at the ends of said material to conduct the one fluid through a plurality of said channels and to simultaneously permit the other fluid to pass through other channels, and means for cleaning said regenerating material.

10. A regenerative heating device for transmitting heat from one fluid to another, comprising regenerating material provided with channels extending from one end of said material to the other, a chamber at each end of said material conducting the one fluid, movable distributor conduits conducting the other fluid within said chambers, said distributor conduits communicating with each other by means of a plurality of said channels,

whereas other channels effect communication between said chambers, a pipe extending longitudinally of each of the end edges of one of the distributor conduits and provided with openings directed towards the regenerating material and means to connect said pipes with a source of cleaning medium.

11. A regenerative heating device comprising a stationary regenerative material having a multiplicity of passages through the same, a plurality of channels for different fluids at the ends of said passages, one channel at either end passing through another channel at the same end and means to successively establish communication between said channels and different groups of passages in said regenerative material.

12. In a regenerative heating device, the combination of regenerative material having passages through the same, and channels for fluids to be heated and giving off heat, of a mechanism to control flow between said channels and passages, a soot blower attached to and movable with said mechanism and having openings directed toward said passages.

13. A regenerative heating device comprising stationary regenerative material comprising a multitude of metal members arranged to form a multitude of separate passages between the same, a plurality of channels for different fluids at the ends of said passages, one channel at either end passing through another channel at the same end and slowly moving means continuously changing position, in normal operation, to successively establish communication between said channels and different passages in said regenerative material.

14. A regenerative heating device comprising stationary regenerative material having a multitude of passages through the same, a plurality of channels for different fluids at the ends of said passages, one channel at either end passing through another channel at the same end and slowly moving mechanism to successively establish communication between said channels and different passages in said regenerative material.

15. A regenerative heating device comprising stationary regenerative material having a multiplicity of passages through the same, a plurality of channels for different fluids at the ends of said passages, one channel at either end passing through another channel at the same end and means to successively establish communication between said channels and different groups of passages in said regenerative material and substantially preventing intermixture of the different fluids between the different channels therefor at all times.

16. A regenerative heating device comprising stationary regenerative material comprising a multitude of metal members arranged to form a multitude of separate passages between the same, a plurality of channels for different fluids at the ends of said passages, one channel at either end passing through another channel at the same end and slowly moving means continuously changing position, in normal operation, to successively establish communication between each of said channels and different passages in said regenerative material and substantially preventing intermixture of the different fluids between the different channels therefor at all times.

17. A regenerative heating device for transmitting heat from one fluid to another comprising regenerative material having a fluid thoroughfare system including a plurality of channels extending through the regenerative material and means comprising a movable distributor conduit communicating successively with the channels of said system to permit passage of one fluid through the portion of the system communicated with and to simultaneously permit passage of the other fluid through another portion of said system.

18. The combination of a plurality of compartments, heat absorbing material disposed therein, means for supplying two fluid media of different temperatures to, and for discharging same from, said compartments, and relatively continuously moving valves operating in unison to control the flow of such media through said compartments, said valves being arranged and constructed to open each compartment in succession to the flow of one such medium and then the other without interrupting or by-passing such flow.

19. The combination of a plurality of compartments, heat absorbing material disposed therein, means for supplying two fluid media of different temperatures to, and for discharging same from, said compartments, and interconnected continuously moving rotary valves operating to control the flow of such media through said compartments, said valves being arranged and constructed to open each compartment in succession to the flow of one such medium and then the other without interrupting or by-passing such flow.

20. A furnace air preheater comprising furnace gas flues adapted to be connected with a furnace and a stack and a flue adapted to be connected to feed air to the furnace, a series of heat exchange masses having passages therethrough and a rotary conduit mechanism cooperating therewith arranged to connect the furnace gas flues and the air flue successively and alternately with the passages through the heat exchange masses.

21. In a regenerative heating device for transmitting heat from one fluid to another, a casing, a plurality of compartments in said casing, regenerative material in said compartments, and distributor mechanism mov-

able with relation to said compartments to guide one fluid through a plurality of such compartments and to simultaneously guide another fluid through other compartments, said mechanism being arranged and constructed to communicate each compartment in succession to the flow of one fluid and then the other.

22. In a regenerative heating device for transmitting heat from one fluid to another, a casing, a plurality of compartments in said casing, regenerative material in said compartments, and distributor mechanism oscillatable with relation to said compartments to guide one fluid through a plurality of such compartments and to simultaneously guide another fluid through other compartments, said mechanism being arranged and constructed to communicate each compartment in succession to the flow of one fluid and then the other without interrupting or bypassing such flow.

23. In a regenerative heating device for transmitting heat from one fluid to another, regenerative material provided with channels therethrough, movable distributor mechanism at the ends of said material to guide one fluid through a plurality of said channels and to simultaneously guide another fluid through other channels, and means for guiding cleaning fluid through said channels.

24. In a regenerative heating device for transmitting heat from one fluid to another, regenerative material provided with channels therethrough, movable distributor mechanism at the ends of said material to guide one fluid through a plurality of said channels and to simultaneously guide another fluid through other channels, and means associated with said distributor mechanism for guiding cleaning fluid through said channels.

25. In a regenerative heating device, a casing, regenerative material in said casing having passages therethrough, means for supplying two fluids of different temperatures to, and for discharging same from, said regenerative material, distributor mechanism movable relatively to said regenerative material and controlling flow of said fluids through said regenerative material, and means for bypassing a portion of one fluid around said casing.

In testimony whereof I affix my signature.

NILS RICHARD FORSSBLAD.