Jan. 9, 1940. H. E. NOYES 2,186,077

HEAT TRANSFER DEVICE

Filed Nov. 1, 1935 2 Sheets-Sheet 1

Fig. 1.

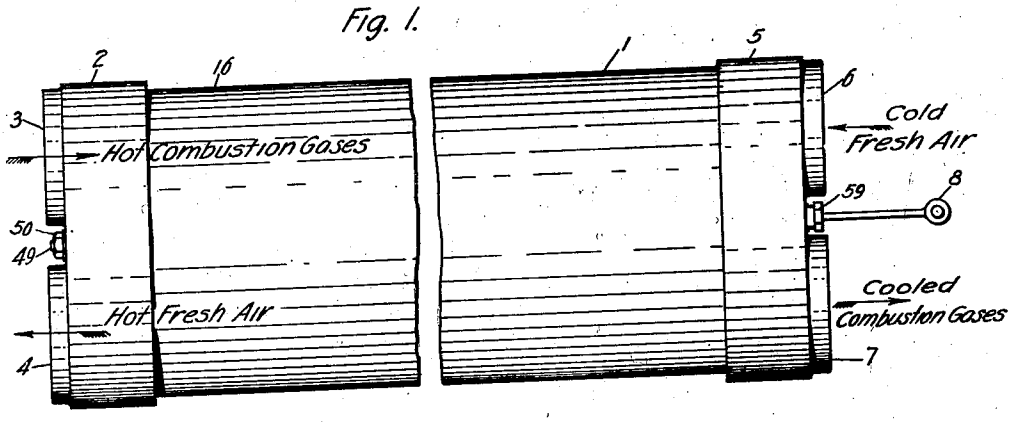


Fig. 2.

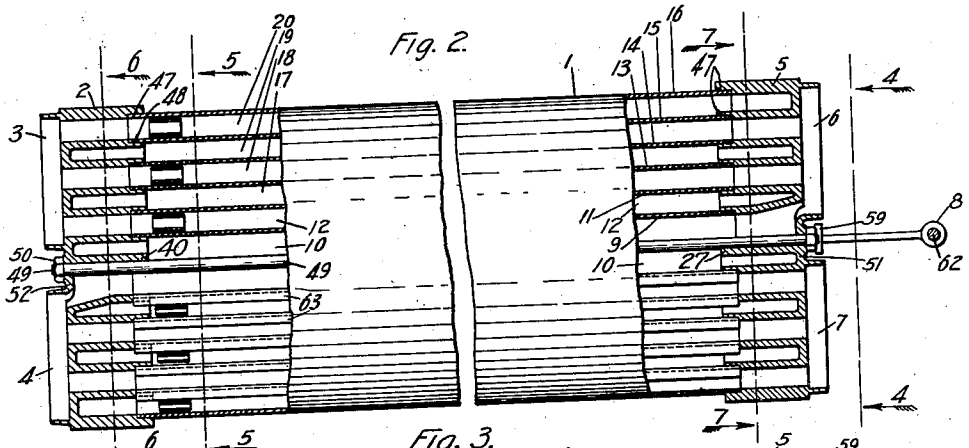
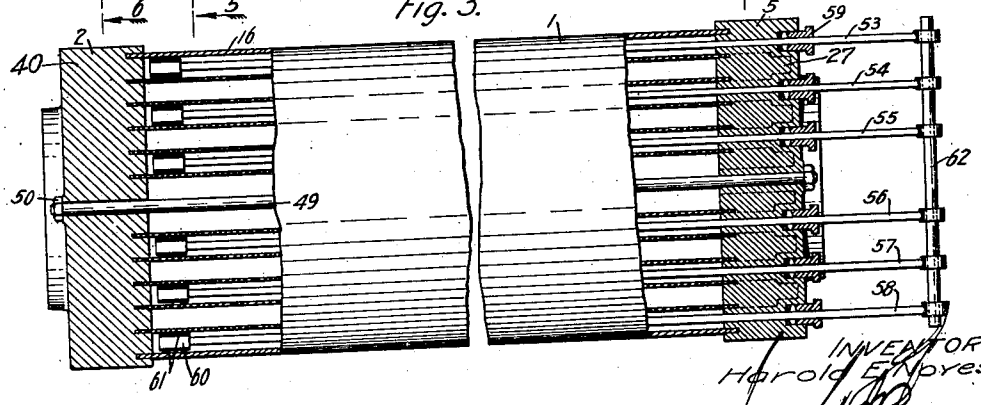


Fig. 3.



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Fig. 4.

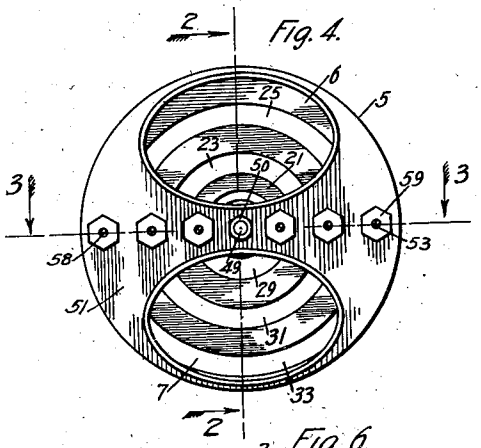


Fig. 5.

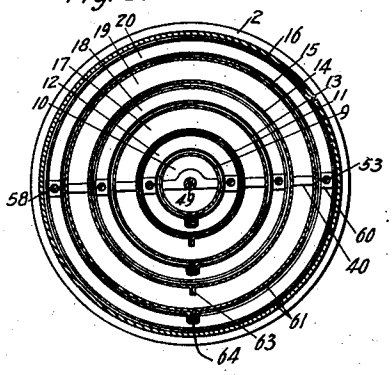


Fig. 6.

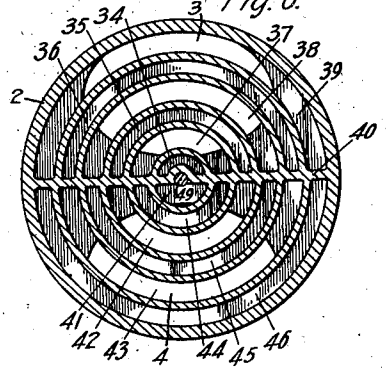


Fig. 7.

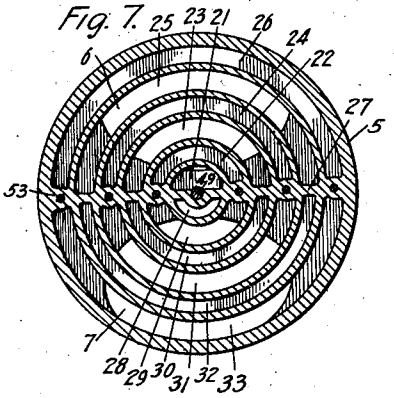
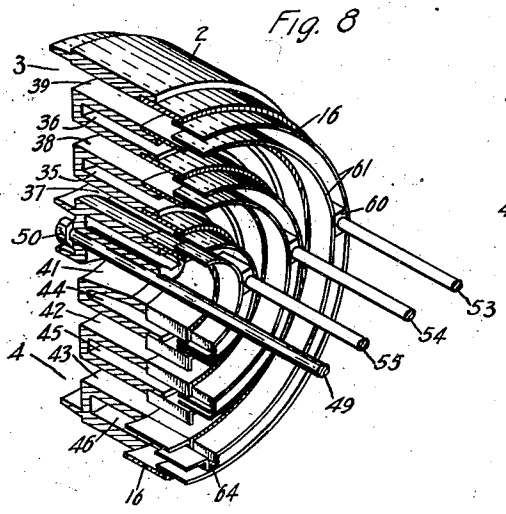


Fig. 8



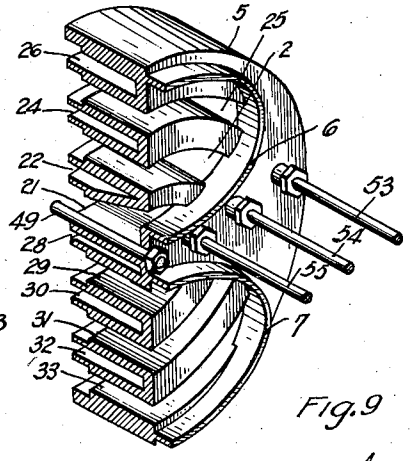


Fig. 9

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UNITED STATES PATENT OFFICE

2,186,077

HEAT TRANSFER DEVICE

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Application November 1, 1935, Serial No. 47,839

10 Claims. (Cl. 257—233)

My invention relates to heat transfer devices.

It has among its objects to provide an improved heat transfer device and one especially adapted to change the temperature of one fluid by another. A further object of my invention is to provide such an improved device having improved flow passages disposed in an improved arrangement adapted to effect a maximum heat transfer, while affording free flow through both sets of passages and obtaining a counter flow. A further object of my invention is to provide an improved and simplified preheater construction having improved coaxially disposed air and gas passages, whereby an effective heat transfer is obtained and free flow of the air and gas permitted, while providing improved counterflow means in the path of the flow in such manner as to produce an exceedingly effective distribution of the flow. A still further object of my invention is to provide such improved heat transfer means having improved coaxial passage means, and improved end members connected thereto and having improved inlet and outlet means, as well as improved connections between the end members and the intermediate passage means. Still another object of my invention is to provide improved cleaning means for one of the sets of flow passages, such, for example, as the gas passages of an air preheater, which are adapted effectually to clean any accumulation from the passages without interfering with the flow therethrough, and while enabling the cleaning means to remain in the passages throughout the use of the device, and yet to be readily and conveniently operated to effect cleaning whenever desired. These and other objects and advantages of my improved construction will, however, hereinafter more fully appear.

In the accompanying drawings, I have shown for purposes of illustration one embodiment which my invention may assume in practice.

In these drawings—

Figure 1 is a side elevation of my improved preheater with the air and gas inlets and outlets indicated thereon and the operating means for the soot cleaner also illustrated, a portion of the preheater being broken away to facilitate illustration;

Figure 2 is a like view, but with the opposite ends of the preheater shown in section, the section being taken on line 2—2 of Figures 4;

Figure 3 is a view similar to Figure 2, but with the end sections taken on line 3—3 of Figure 4;

Figure 4 is a sectional view and end elevation of the right-hand end of the preheater shown in Figure 2, the section being on line 4—4 of that figure;

Figure 5 is a sectional view on line 5—5 of Figure 2;

Figure 6 is a sectional view on line 6—6 of Figure 2;

Figure 7 is a sectional view on line 7—7 of Figure 2;

Figure 8 is an isometric view of one end plate showing the portion thereof to the left of section line 5—5 in Figure 2 and the soot cleaner in "in" position therein; and

Figure 9 is an isometric view, partly in section, of the end plate shown in Fig. 4.

In this illustrative construction, I have shown a preheater including an intermediate pipe section, generally indicated at 1, and having an end plate or member 2 at one end, provided both with an inlet 3 for hot combustion gases and a separate outlet 4 for hot fresh air, and, at the opposite end, an end member 5 having an inlet 6 for cold fresh air and a separate outlet 7 for cooled combustion gases, while an operating member for the soot cleaner, generally indicated at 8, also projects from this end member 5; these elements and the various parts thereof hereinafter described being constructed and arranged in an improved manner as hereinafter more fully appears.

Referring first to pipe section 1, it will be noted that the same herein comprises a series of coaxial pipes, one within another. While not limited thereto, these pipes are preferably of cylindrical cross section as shown. Further, the air and gas pipes are preferably alternately arranged, so that air passes through one, gases through the next, and air through the next, etc. While a reverse construction may be used if desired, I herein provide the smallest or central pipe 9 to form an axial air passage 10; next, a larger outer pipe 11 to form a coaxial gas passage 12 surrounding the pipe 9, and like successively larger outer pipes 13, 14, 15 and 16, providing alternate air and gas passages 17, 18, 19 and 20. Thus, it will be noted that herein the annular, alternate air and gas passages 12, 17, 18, 19 and 20 are of the same length and the same width between their opposite walls, and that each of the pipes 11, 13, 14, 15 and 16 is of the same progressively greater diameter, while all surround the axial air passage 10.

As shown, the end members 2 and 5 are fitted onto the ends of the several pipes heretofore described. Of these members, the member 5 is provided with suitable openings for delivering air

from the inlet 6 to the air passages 10, 17 and 19, and other openings for delivering gas from passages 12, 18 and 20 to the outlet 7. Similarly, the end member 2 is provided with passages for delivering gas from the inlet 3 to the passages 12, 18 and 20, and other passages for delivering air from the passages 10, 17 and 19 to the outlet 4.

Referring more particularly to the construction of the end member 5, it will be noted that this member is provided with semi-circular passages 21, 22, 23, 24, 25 and 26, of which the passages 22, 24 and 26 are closed at their outer ends, while the passages 21, 23 and 25 are open at their outer ends and communicate with the inlet 6. Note also that the end member 5 is divided into two parts separated by a transverse diametrical septum 27, and that the above described passages 21 to 26 are in the upper half of the member as head above the septum. The lower half comprises like passages 28, 29, 30, 31, 32 and 33, of which the passages 28, 30 and 32 are closed at their outer ends, while the passages 29, 31 and 33 are open at their outer ends and communicate with the outlet 7.

Referring to the end member 2, it will be noted that the same is provided with like passages save that the passages therein are such that open passages are provided in the member 2 opposite closed passages in the member 5, and vice versa. Thus, the closed passages in the top half of the member 2 are indicated at 34, 35 and 36, while the open passages therein are indicated at 37, 38 and 39, while the passages in the bottom half below the septum 40 comprise open passages 41, 42 and 43 and closed passages 44, 45 and 46. It will thus be evident that the septum provided on each end member marks the dividing line between the open-semi-circular passages and the closed end portions of the spaces between adjacent concentric pipes. Further, it will be evident that the septums, being adjacent the inlets 3 and 6, constitute flow directing baffle means for the incoming gases and air passing through the inlets 3 and 6 respectively. Thus, cold air entering inlet 6 is prevented by septum 27 from initially moving laterally into contact with the relatively cold surfaces of the pipes adjacent the exit 7 for the cooled combustion gases. Instead, the air is directed first in a direction longitudinally of the pipes so that when it subsequently moves laterally in the spaces it will come in contact with more highly heated surfaces of the pipes. Similarly, the hot combustion gases are prevented from too quickly beginning their lateral movement in the vicinity of the exit 4 for heated air, where the heat transfer would be slow, and are instead directed by septum 40 to move laterally across the intermediate surfaces of the pipe where the oppositely flowing air is cold and a greater transfer of heat results.

Attention here is also directed to the fact that insofar as these passages are concerned, these end members 2 and 5 are substantially identical and merely oppositely disposed. Each is also provided with suitable shoulder portions for receiving and locating the ends of the pipes in the intermediate section 1, such, for example, as illustrated at 47 on end member 2 to receive the outer pipe 16, and an oppositely disposed shoulder 48 to receive the pipe 15, with such inner and outer shoulders alternating toward the center in such manner as to permit the end members to be slipped on the ends of the pipes, as illustrated in Figure 2.

While the end members 2 and 5 may be connected by various means, herein the same are preferably connected and positioned upon the several pipes of the section 1 by a single axially disposed rod or bolt 49 having external nuts 50 outside each of the end members and acting to hold the parts in assembled relation. Herein the rod 49 extends axially through the central air chamber 10, and the rod also at its opposite ends extends through plate members 51 and 52, herein integral with the end members 5 and 2, respectively, which close the latter except for the inlets and outlets heretofore described as carried on these end members. Thus, it will be evident that when the end members 2 and 5 are assembled on the ends of the several pipes, and the rod 49 has its nuts 50 suitably tightened, all the parts will be held securely together longitudinally, while providing for the desired air and gas flows previously indicated. Further, it will be evident that the parts are very quickly and readily assembled or taken apart whenever desired and that this operation is facilitated due to the use of end members reversely disposed at the opposite ends of the pipes.

In my improved construction, I preferably include in the gas passages 12, 18 and 20 improved soot cleaners adapted to remain permanently in these passages and to be operated from the exterior of the preheater to effect cleaning. Herein, this soot cleaner construction is of a longitudinally reciprocable type having soot cleaners normally disposed at one end of the gas passages and adapted to be moved longitudinally thereof in such manner as very effectually to clean the soot from the opposite walls of these gas passages. Referring more particularly to the construction illustrated, it will be noted that a series of rods 53, 54, 55, 56, 57 and 58 extends into the several gas passages from the outer face of the end member 5 to a point adjacent the inner face of the end member 2, three being on each side of the axis thereof and all being in alignment and passing through the septum 27 in the end member 5 in which they are reciprocable. Herein, these rods pass through suitable stuffing boxes 59 in the outer face of the end member 5 so that leakage of gases along these rods is effectually prevented. Moreover, it will be noted that these rods on their opposite or inner ends carry blocks 60 fixed to and between pairs of adjacent spaced, short, cleaner bands or rings 61 fitting the opposite walls of the gas passages, in such manner as to provide effective scrapers with the rings 61 adapted to scrape both walls of each gas passage simultaneously as the rods are moved longitudinally back and forth between their maximum in and out positions. Thus, the cleaner bands or rings 61 on the rods 53, 54 and 55 will be movable longitudinally in the gas passages, while, through a transverse connecting rod 62 connecting the outer ends of the rods, all of these rods will be movable together as the transverse rod or handle 62 is moved in or out. Here, attention is also directed to the fact that this construction is such as not to interfere with the free flow of the gas, while the short cleaner bands in their normal "in" position shown in Fig. 8, occupy only a minimum portion of the passages, and the gases are, of course, also free to pass around the blocks 60 which connect these bands to one another and to their operating rods.

Attention here is also directed to the fact that

the concentric pipes are each provided with a standing seam 63, comprising flanges suitably interconnected as, for example, by welding or the like, and herein, as preferably, all disposed in the same half of the pipes as shown in Fig. 5. As a result of this construction, it will be noted that these seams 63 tend to divide the flow, while the seams, also, in a welded construction, tend to eliminate warping. In connection therewith, it will also be observed that where these seams extend into the gas passages, the inner soot cleaner band or ring 61 is provided with a correspondingly grooved portion 64 receiving these standing seams and permitting the soot cleaner to be guided thereby as the cleaner is moved longitudinally in a cleaning operation.

In the use of my improved construction, it is made possible not only to provide a free flow of the air and gases but to utilize a counter current action to marked advantage in such manner as to obtain a most effective heat transfer. Further, due to the coaxial arrangement of the pipes and the alternate arrangement of the air and gas passages, it will further be noted that the heat transfer is so effective that only a relatively small percentage of the heat is radiated to the outside air surrounding the outer pipes. These features produce in practice a markedly effective preheater whereby, as distinguished from supplying cold air to the furnace, markedly more efficient heating is obtained by preheating the incoming air to a very substantially higher temperature before it reaches the combustion chamber.

As a result of my improvement, it will be observed that not only are the above advantages obtained but that it is also made possible to produce an exceedingly simple and inexpensive construction of compact form. Moreover, it will be evident that the preheater is adapted for use not only in connection with ordinary coal furnaces, but also in connection with gas or oil furnaces, or wherever fluid flows of different temperature are available for heat transfer from one to another. Attention is further directed to the fact that the construction is such that the same is well adaped to withstand long use in service, and, further, is adapted to be readily and quickly freed from accumulations on one of the sets of passages, as, for example, soot, through operation of my improved passage cleaner or wall scraping means. This further forms a permanent part of the equipment and thus is accordingly operable at any time. Also, it will be noted that the rings thereof provide exceedingly effective scraping means and yet are of such small size and so disposed in the pipes as in no way to interfere with the functions of the latter as flow passages. Herein the operating member 62 is also at the cool end of the preheater, although it will be evident that the cleaner may be reversed if desired and operated from the other end. These and other advantages of my improved construction will, however, be clearly apparent to those skilled in the art.

While I have in this application specifically described one form which my invention may assume in practice, it will be understood that this form of the same is shown for purposes of illustration and that my invention may be modified and embodied in other forms without departing from its spirit or the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent is:

1. In a heat transfer device, coaxial counter-flow passage forming means having inlet and outlet means at each end thereof and flow dividing means in said passage forming means.

2. In a heat transfer device, a series of spaced coaxial pipes forming a plurality of annular flow passages, and end header members at opposite ends of said pipes each having open and closed portions on each side of a diameter of the device, each of said header members having its open portions communicating through said annular passages with diagonally opposite open portions of the other header member and each of said header members having its closed portions preventing escape from said annular passages on that side of said diameter which is open at the other header.

3. In a heat transfer device, a series of spaced coaxial pipes forming a plurality of annular flow passages, and end header members at opposite ends of said pipes each having open and closed portions on each side of a diameter of the device, each of said header members having its open portions communicating through said annular passages with diagonally opposite open portions of the other header member and each of said header members having its closed portions preventing escape from said annular passages on that side of said diameter which is open at the other header, said open and closed portions including coaxially and alternately disposed portions on each side of said diameter.

4. In a heat transfer device, a series of spaced coaxial pipes forming a plurality of annular flow passages, end header members at opposite ends of said pipes having inner spaced annular flanges each receiving the end of one of said pipes and providing annular passages forming extensions of said annular flow passages, said header members also having outer end webs connecting said flanges forming closures for said extensions and having separate inlet and outlet means disposed on opposite sides of the axis of said pipes, the inlet and outlet means at opposite ends of said device being disposed on opposite sides of said axis respectively, and the inlet and outlet means on the same end of the device communicating with different alternate annular flow passages.

5. In a heat transfer device, a series of spaced coaxial pipes forming a plurality of annular flow passages, end header members at opposite ends of said pipes each having open and closed portions on each side of a diameter of the device, each of said header members having its open portions communicating through said annular passages with diagonally opposite open portions of the other header member and each of said header members having its closed portions preventing escape from said annular passages on that side of said diameter which is open at the other header, one of said header members having a septum extending along said diameter, and cleaning means in certain of said annular passages including cleaner operating rods reciprocable through said septum.

6. In a heat transfer device, coaxial counter-flow passage forming means comprising a series of coaxially disposed pipes, end members coaxial with said pipes and each having end inlet and outlet means spaced apart from each other so as to lie wholly at opposite sides of the pipe axis and communicating with different sets of pipe passages, and axial means fastening together said end members and pipes.

7. In a heat transfer device, means forming coaxial heat transfer passages for combustion gas

and air respectively, and cleaning means for a gas passage enclosed in the latter and having external operating means.

8. In a heat transfer device, means forming a plurality of coaxial heat transfer passages for gas and air respectively, and cleaning means for the gas passages comprising annular scrapers enclosed in the latter and reciprocable therein and having external operating means.

9. In a heat transfer device, members presenting coaxial passages with inner and outer walls, and cleaning means for certain of the passages enclosed in the latter and comprising ring scraper means engageable with the inner and outer walls thereof.

10. A heat transfer device having members presenting coaxial passages with inner and outer walls, and cleaning devices for certain of the passages enclosed in the latter and each comprising spaced scraper rings engageable with opposite walls of the passage and blocks between said rings to which they are attached, and reciprocable operating members connected to said blocks.

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