Dec. 22, 1953

P. S. OTTEN

2,663,549

SPIRAL HEAT EXCHANGER

Filed July 14, 1950

3 Sheets-Sheet 1

Fig. 1.

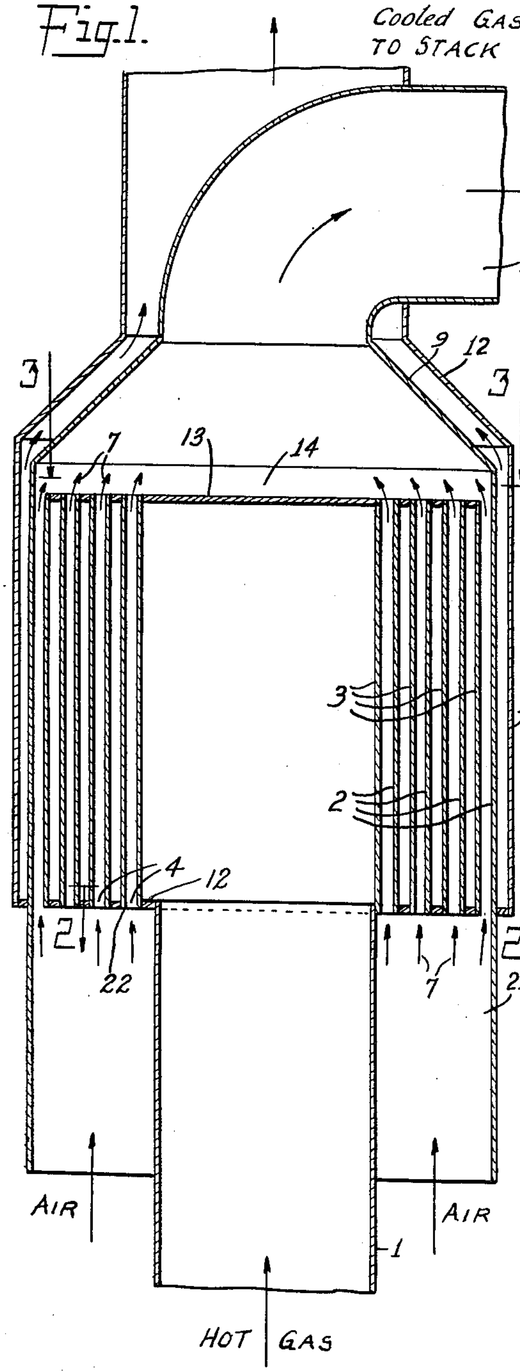


Fig. 2.

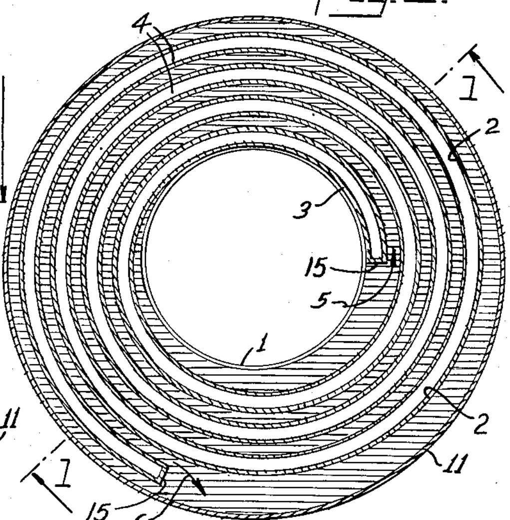
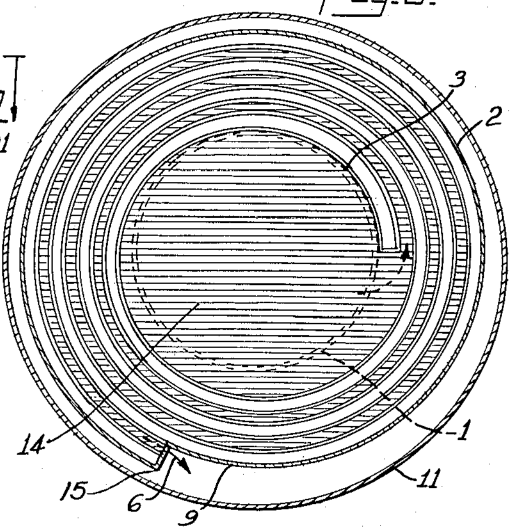


Fig. 3.



INVENTOR
PHILIP S. OTTEN
BY
Pennie, Edmonds, Morton and Barrows
ATTORNEYS

SPIRAL HEAT EXCHANGER

Filed July 14, 1950 3 Sheets-Sheet 2

Fig. 4.

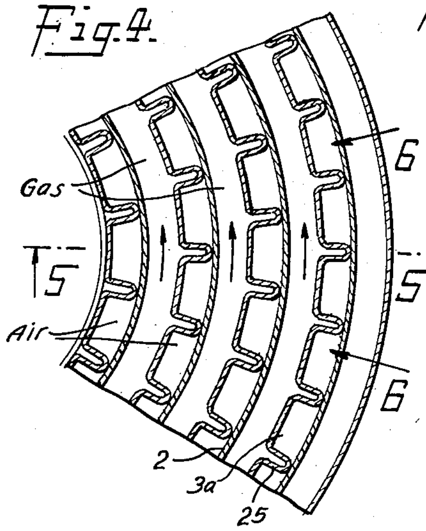


Fig. 5.

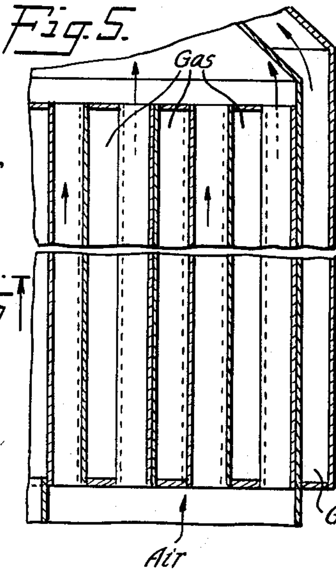


Fig. 6.

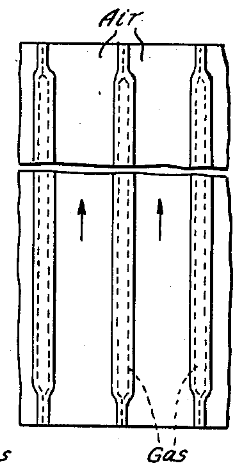
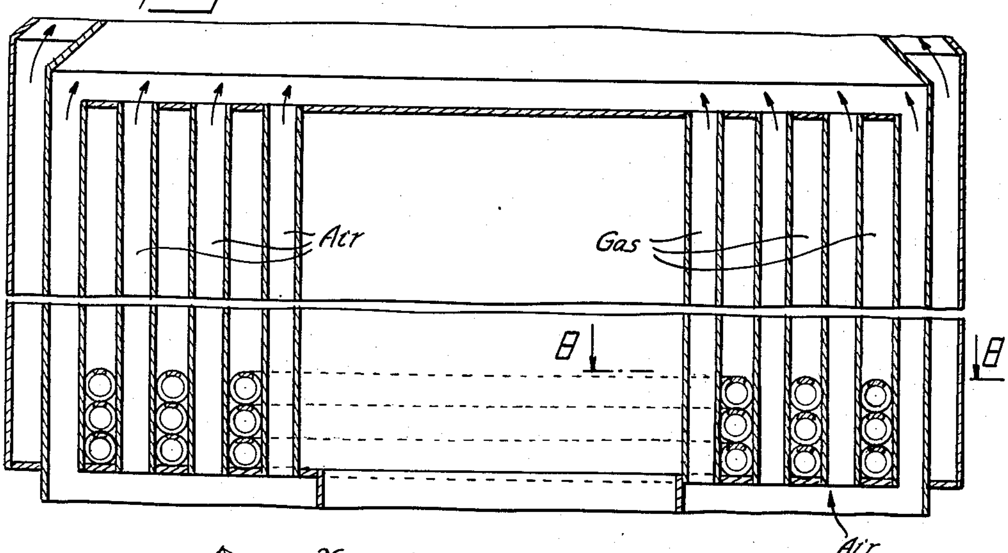


Fig. 7.



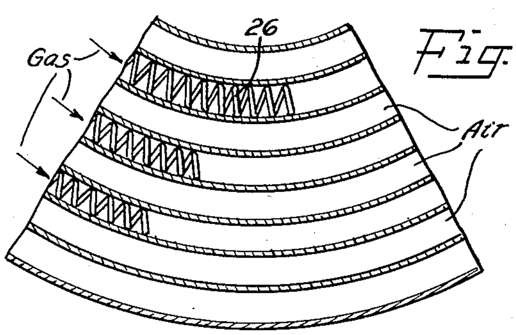


Fig. 8.

INVENTOR.
PHILIP S. OTTEN
BY
Pennie, Edmonds, Morton and Barrows
ATTORNEYS

Dec. 22, 1953 P. S. OTTEN 2,663,549

SPIRAL HEAT EXCHANGER

Filed July 14, 1950 3 Sheets-Sheet 3

Fig. 9.

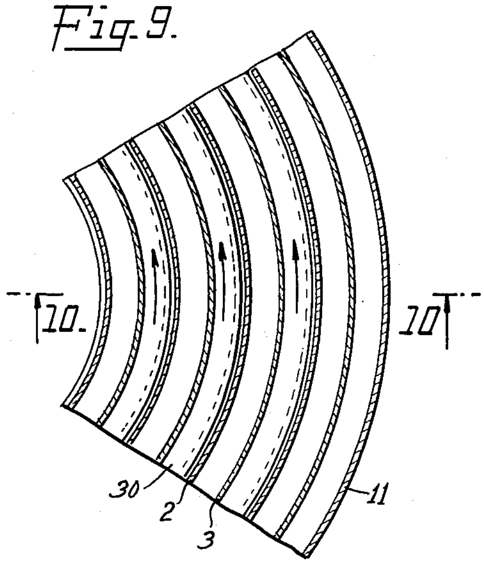


Fig. 11.

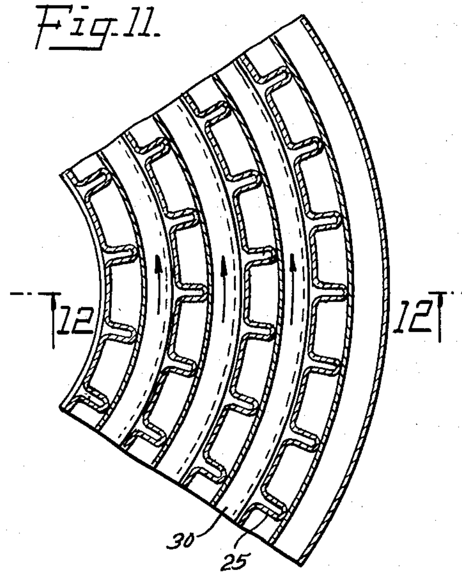


Fig. 10.

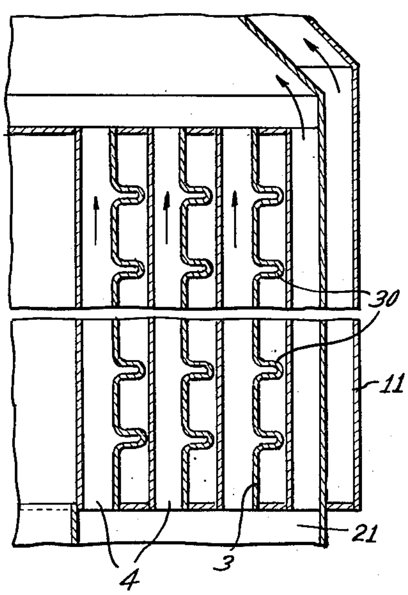
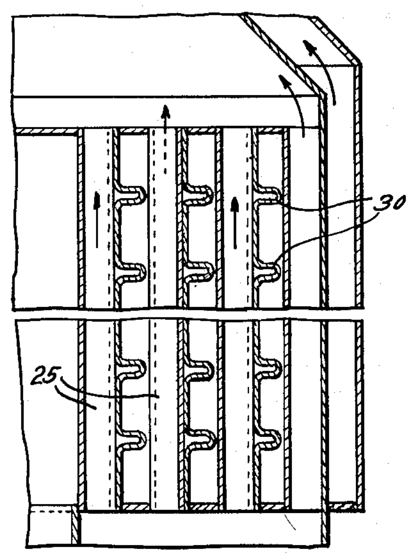


Fig. 12.



INVENTOR
PHILIP S. OTTEN
BY
Pennie, Edmonds, Morton and Barrows
ATTORNEYS

Patented Dec. 22, 1953 2,663,549

UNITED STATES PATENT OFFICE

2,663,549

SPIRAL HEAT EXCHANGER

Philip S. Otten, New Rochelle, N. Y., assignor to The Griscom Russell Company, New York, N. Y., a corporation of Delaware

Application July 14, 1950, Serial No. 173,793

4 Claims. (Cl. 257—245)

1

This invention relates to heat exchangers of the type particularly adapted for utilizing the heat in hot flue gases to heat air to supply the forced draft for the furnace or for other purposes.

The principal object of the invention is to provide a heat exchanger wherein a large area of heat transfer surface in a relatively small space is efficiently utilized.

A further object of the invention is to provide a heat exchanger of the character described which can be cheaply made of sheet metal without expensive machine work or extensive hand labor.

A further object of the invention is to provide a heat exchanger of the class described wherein the sheet metal heat transfer elements may readily expand and contract with changes in temperature.

A further object of the invention is to provide a heat exchanger of the type disclosed wherein a high rate of heat transfer is maintained by imparting high velocities to the two fluids in heat exchange relation.

A further object of the invention is to provide a heat exchanger of the class described which is adapted to be readily installed in the flues leading from the furnace to the stack.

Other objects of the invention will appear from the following specification and accompanying drawings wherein I have illustrated a typical heat exchanger embodying my improvements and also certain modifications thereof.

Referring to the drawings,

Figure 1 is a vertical sectional view of my improved heat exchanger on line 1—1 of Fig. 2;

Fig. 2 is a sectional view on line 2—2 of Fig. 1;

Fig. 3 is a similar view on line 3—3 of Fig. 1;

Fig. 4 is an enlarged horizontal sectional view of a portion of the heat exchanger showing a modified form whereby an extended heat transfer surface is obtained;

Fig. 5 is a vertical sectional view on line 5—5 of Fig. 4;

Fig. 6 is a vertical sectional view on line 6—6 of Fig. 4;

Fig. 7 is a vertical sectional view of a portion of the heat exchanger showing a further modification;

Fig. 8 is a horizontal sectional view on line 8—8 of Fig. 7.

Fig. 9 is a horizontal section of a portion of a heat exchanger showing a further modification;

Fig. 10 is a vertical sectional view on line 10—10 of Fig. 9;

Fig. 11 is a horizontal sectional view of a portion of the heat exchanger wherein the structures of Fig. 4 and Fig. 9 are combined in one installation; and

2

Fig. 12 is a vertical sectional view on line 12—12 of Fig. 11.

Referring to the drawings, particularly to Figs. 1, 2 and 3, 1 indicates a portion of the flue leading from the furnace, not shown, wherein the flue gases to be cooled are generated. The heat exchanger is attached to the upper end of the flue 1. As shown, the end of the flue is fitted into a central opening in the bottom sheet 12 of the heat exchanger. The heat exchanger comprises a sheet metal sleeve or drum 2 which, as shown in Fig. 3, is not quite circular, but has a contour constituting one turn of a spiral. The sleeve 2 extends downwardly below the bottom sheet 12 of the heat exchanger around the upper end of the flue 1 to provide an air intake passage 21 concentric with the flue 1. The heat exchanger within the drum or sleeve 2 is formed of two spirally wound sheets of metal, one of which is a continuation of the sleeve 2 and constitutes the outside turn. The other sheet is indicated at 3 in Figs. 1, 2 and 3. The sheet 3 throughout its length and the sheet 2 except for the outside turn which forms the air intake of the heat exchanger are of a height to provide the necessary area of heat transfer surface with a length or linear horizontal dimension equal to, in the example shown, five convolutions of the spiral, the inner convolution of the sheet 3 having its smallest radius substantially equal to the radius of the flue section 1. The bottom tube sheet 12 is fitted to the top of the flue 1 and a spiral slot 4 of a width equal to the space between the sheets 2 and 3 plus the thickness of the sheets is cut in the sheet 12. The lower edges of the sheets 2 and 3 are fitted in the slot 4 and brazed or welded to the edges of the spiral slot, as indicated at 22 in Fig. 1. An upper tube sheet 13 of similar design but with a closed central portion 14 is fitted and attached to the upper edges of the sheets 2 and 3, so that the only exit for the hot gases leaving the furnace in the flue 1 is horizontally into the space between adjacent turns of the spiral, as indicated by the arrow marked 5 in Fig. 2, and thence through the spiral passage to the discharge opening adjacent the outer edges of the sheets 2 and 3 as indicated by the arrow 6.

The air which enters the heat exchanger through the downwardly extending portion 2 of the outer wall of the spiral passes vertically upward through the spiral slot 4 in the tube sheet 12 and thence through the heat exchanger, as indicated by the arrows 7 in Fig. 1 in the alternate spaces between the sheets 2 and 3 making up the spiral. The adjacent vertical edges of the sheets 2 and 3 at the ends of the spiral slots in the tube sheets are connected by vertical strips 15 brazed or welded to the edges of the sheets 2 and 3. By this structure there is provided an extended spiral passageway for the flue gases leaving the furnace and a vertical passageway for the air to be heated through the spiral in a direction parallel with the axis of the spiral.

The hot gases leave the space between the sheets making up the spiral in a horizontal direction, while the air which passes vertically through the heat exchanger is caught by a hood 9 which is fitted over the upper edge of the outer turn of the sheet which is extended spirally above the upper tube sheet as shown in Figs. 1 and 3. The hood 9 is connected to a flue 10 through which the heated air is conveyed to the firebox of the furnace or to other points of use. If the heated air is used as combustion air in the furnace, a blower, as indicated in Fig. 1, is preferably provided to create a forced draft for the furnace and also to insure that the entering air has sufficient velocity for efficient heat transfer.

If desired, the flue gases from which the heat has been extracted may be discharged directly into the atmosphere at a point corresponding with the outer turns of the spiral, as indicated by the arrow 6. However, it is usually necessary to convey hot flue gases to a stack, and to that end I preferably provide an outside drum 11 of circular cross section which surrounds the entire apparatus and whose upper edge 2 is fitted into a hood 12 attached to the flue leading to the stack. As shown in Fig. 1, the flue 10 for the discharge of heated air from the heat exchanger is turned to a horizontal position and extends through the wall of the flue leading to the stack. To reduce the resistance to the flow of the flue gases through the spiral passage the gases may be discharged into a horizontal flue tangential to the outer wall of the heat exchanger at the discharge opening and thence to a stack or other discharge.

The operation of the apparatus will be clear from the foregoing description. The hot gases from the furnace which are discharged within the inner turn of the spiral portion of the heat exchanger are drawn by the suction of the stack at high velocity into the spiral passageway in the direction indicated by the arrow 5 in Fig. 2, and are discharged into the outer hood 12, whence they press upwardly through the hood into the flue leading to the stack.

In heat exchangers having entwined spiral passages as heretofore constructed, the passages for both fluids are spiral and the edges of the spiral sheets constituting the heat transfer elements are fixed at their top and bottom edges to transverse headers which hold the sheets against elongation and contraction in the direction of their length. With my improved construction there are no transverse headers except the narrow spiral strips which form the top and bottom walls of the gas passage and these strips expand and contract with the sheets 2 and 3. Even though the entwined spiral sheets may be anchored at each end, they will expand freely to a sufficient extent to take care of the temperature changes which will be encountered under most circumstances of industrial use. A small increase in the diameter of the turns of the spiral will allow sufficient elongation of the sheets without setting up any undue stresses at the inner and outer connections between the spiral sheets and the supporting structure.

Instead of making the exchanger of two sheets with separate end closures for the gas passage the two spirally wound sheets may have reversely extending marginal flanges which are welded together to form a closed spiral conduit with the intermediate space open at the ends for the passage of the air stream.

In Figs. 4, 5 and 6 I have shown a slight modification of the structure above described wherein the heat transfer surface is increased without increasing the overall dimensions of the exchanger. To this end the strip 3*a* forming the inner strip of the two strips which form the spiral is provided at intervals with ribs 25 extending parallel with the axis of the spiral. The portion of the spiral formed by the sheet 2 is flat and serves, with the ribs 25 of the other sheet, to form a series of separate longitudinal vertical passages through which the air flows.

A further modification of the structure is shown in Figs. 7 and 8. As here shown, a series of coils of wire 26 wound helically in a manner similar to an extension spring and of a length equal to the length of the spiral gas passage are stacked one on another in the gas passage to thus greatly increase the metal surface available for the absorption of heat from the gases.

The heat absorbed by the coils of wire is transmitted as radiant heat and also to some extent by conduction to the metal walls of the spiral gas passage and thus serves to increase the temperature of these walls and thereby increase the heat transferred to the air passing upwardly through the intermediate passages.

Instead of providing the alternate partition sheets with vertical ribs to increase the heat transfer surface in the manner shown in Fig. 4, one of the two sheets, for example sheet 3, may be formed with horizontal corrugations as shown at 30 in Figs. 9 and 10. By this arrangement an effective extended heat transfer surface is provided for the flue gases or other gases traveling spirally through the heat exchanger.

Also, if desired, both spiral sheets may be formed with corrugations, as shown in Figs. 11 and 12, thereby providing effective extended heat transfer surfaces for both gases.

While I have described my improved heat exchanger as used for the transfer of heat from hot flue gases to air, it will be understood that this is but a typical use of the apparatus and that the heat exchanger may be used with like advantage for the exchange of heat between gases and vapors of any character. It will also be understood that whereas the heat exchanger is primarily designed for transfer of heat from one gaseous medium to another, it may also be used for the transfer of heat between liquids or between a gaseous medium and a liquid medium, and that the liquid medium may be circulated through either the vertical passages above described as air passages or through the spiral passage through which, in the above described installation, flue gases are circulated. It will also be understood that in addition to the modified structures herein illustrated various other modifications of the design may be made without departing from the spirit of the invention as defined in the appended claims.

I claim:

1. A heat exchanger for preheating combustion air by extracting heat from flue gas comprising in combination a pair of entwined spiral plates

spaced apart to form entwined spiral passages in heat exchange relation with each other, a central generally cylindrical chamber within said spirals, a central inlet conduit for flue gas coaxial and communicating with said chamber, a lower sealing sheet surrounding said conduit and closing off one of the spiral gaps between said plates at the bottom thereof, a cylindrical outer shell sealed to the lower sealing sheet enclosing said plates, a downwardly depending circumferentially continuous extension of the outermost wall of said plates substantially concentric with and surrounding said plates, an upwardly extending circumferentially continuous extension of the outermost wall of said plates, an upper sealing sheet within said upward extension sealing the top of said chamber and the spiral gap at the top of the plates forming the passageway which is sealed by said lower sheet, an exhaust stack for flue gas sealed to the top of said outer shell, and a delivery pipe for heated air sealed to the top of said upward extension, whereby flue gas entering the chamber from the conduit moves spirally outward through the passage formed between the upper and lower sheets to the space between the shell and the plates and thence upward to the stack and the air entering the downwardly depending extension moves axially upward between the unsealed plates into the upwardly extending extension.

2. A heat exchanger as set forth in claim 1 in which one of said entwined spiral plates forming the air passage is provided with axially extending ribs for increasing its heat transfer surface.

3. A heat exchanger as set forth in claim 1 in which one of said entwined spiral plates forming the flue gas passage is provided with circumferentially extending ribs for increasing its heat transfer surface.

4. A heat exchanger as set forth in claim 1 in which one of said entwined spiral plates forming the air passage is provided with axially extending ribs for increasing its heat transfer surface and the other of said plates forming the flue gas passage is provided with circumferentially extending ribs for increasing its heat transfer surface.

PHILIP S. OTTEN.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
9,690	Tillman	Apr. 26, 1853
731,469	Pontois	June 23, 1903
747,072	Human	Dec. 15, 1903
1,056,932	Olson et al.	Mar. 25, 1913
1,654,294	Ljungstrom	Dec. 27, 1927
1,823,481	Zander	Sept. 15, 1931
2,470,860	Parrish	May 24, 1949