

March 26, 1940.

C. S. ANDERSEN ET AL

2,194,733

AIR HEATING FURNACE

Filed Sept. 8, 1937

2 Sheets-Sheet 1

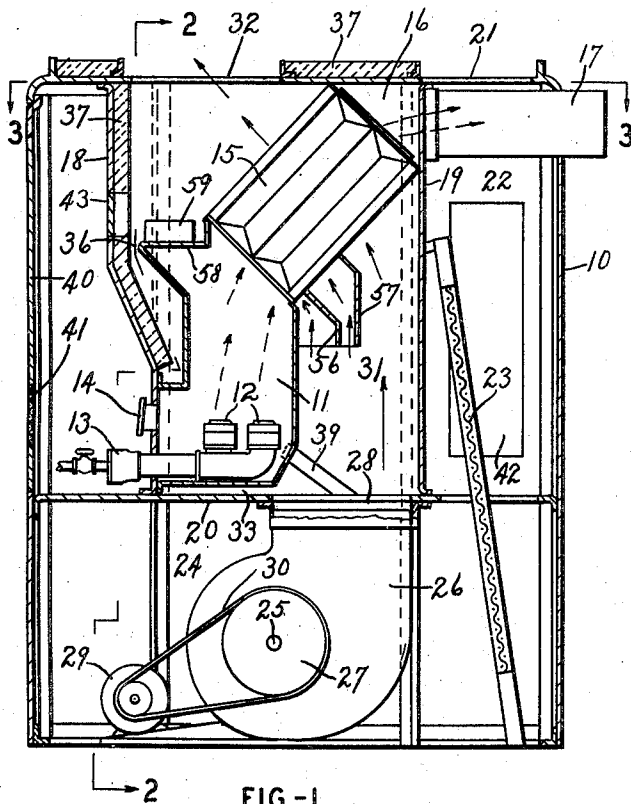


FIG.-1

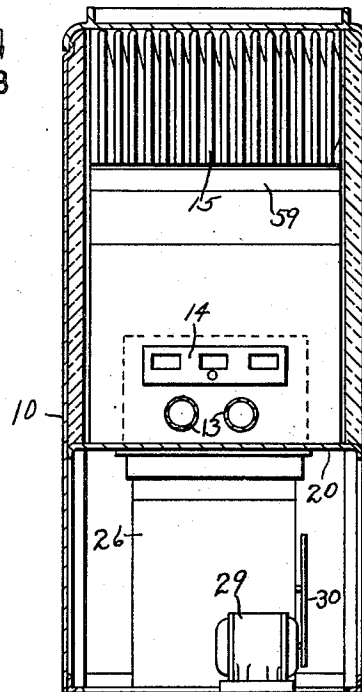


FIG.-2

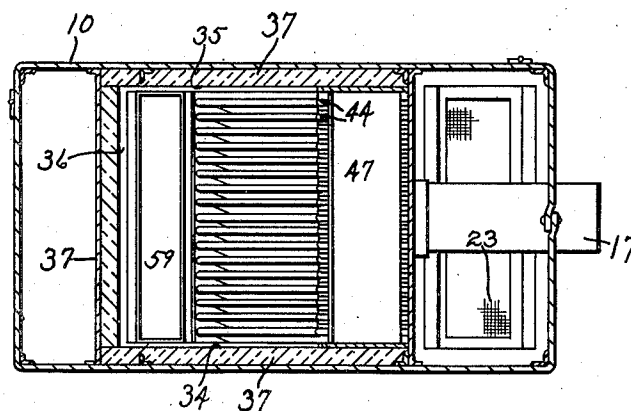


FIG.-3

INVENTORS
CHRISTIAN S. ANDERSEN
ALFRED L. SCHELLHAMMER
BY
Brockett, Hyde, Higley & Mager
ATTORNEYS

March 26, 1940.

C. S. ANDERSEN ET AL

2,194,733

AIR HEATING FURNACE

Filed Sept. 8, 1937

2 Sheets-Sheet 2

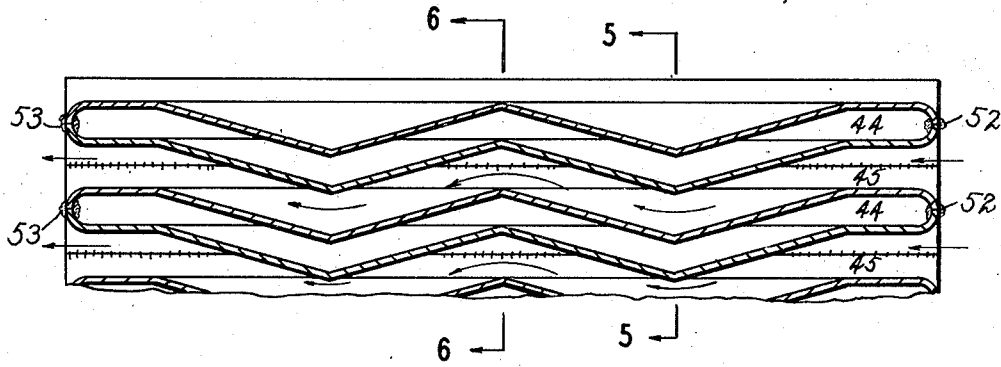


FIG. -4

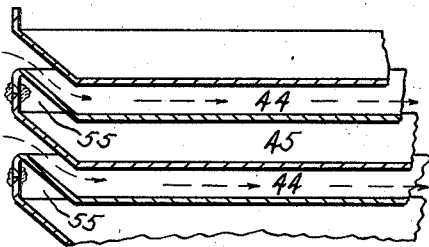


FIG. -5

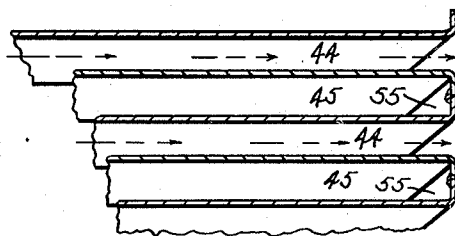
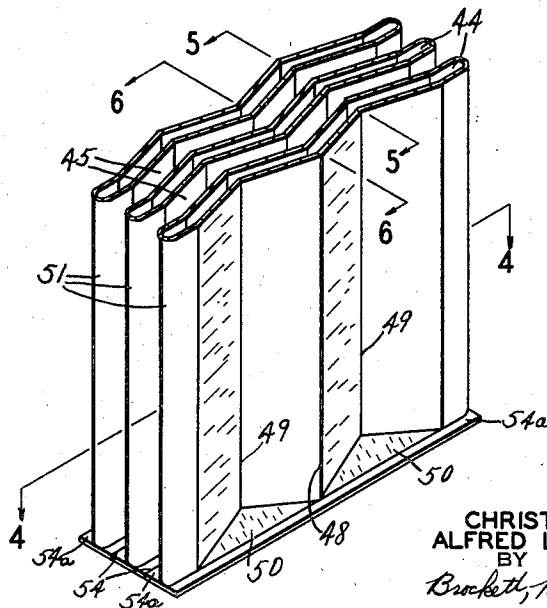


FIG. -6

FIG. -7



INVENTORS
CHRISTIAN S. ANDERSEN
ALFRED L. SCHELLHAMMER
BY
Brockett, Hyde, Higley & Meyer
ATTORNEYS

UNITED STATES PATENT OFFICE

2,194,733

AIR HEATING FURNACE

Christian S. Andersen and Alfred L. Schellhammer, Warren, Pa., assignors to Pennsylvania Furnace & Iron Co., Warren, Pa., a corporation of Pennsylvania

Application September 8, 1937, Serial No. 162,858

2 Claims. (Cl. 257—245)

This invention relates to improvements in air heating furnaces.

One of the objects of the present invention is the provision of an air heating furnace wherein the parts are so arranged that the air to be heated and the products of combustion from the fuel burner are arranged to travel in crossed paths so that each path sweeps upwardly and laterally in a substantially smooth curve.

Our invention also provides a novel heat exchanger for transferring heat from the products of combustion to the air passing through the casing, this heat exchanger being arranged with two sets of passages substantially normal to each other and placed in the furnace at the point where the paths of the air and the products of combustion cross.

One of the novel features of our invention is the positioning of this novel heat exchanger at an angle between the vertical and the horizontal whereby certain advantages in furnace construction are provided.

Our invention also comprises a novel sheet metal heat exchanger of a form hereinafter disclosed and described and wherein the air to be heated is baffled to a greater degree than the products of combustion. One of the features of our novel heat exchanger is the arrangement of a set of generally baffled passages for the air to be heated while travelling through the heat exchanger with direct passages for the air at the end of the heat exchanger nearest the fuel burner so that the metal subjected to the highest temperature of the products of combustion is also in contact on the opposite face of the metal with a sufficient volume of cooling air to protect the metal against deterioration. In combination with such a heat exchanger we also provide a novel baffle means for insuring a flow of air through the hottest portion of the heat exchanger so as to increase the efficiency of the heat exchanger and to insure the protection of the hottest portions of the metal.

Another novel feature of our invention is the arrangement of the combustion chamber about the fuel burner in such a manner as to provide a novel shelf of considerable area directly subjected to the hot gases on its under surface and in heat transmitting contact with a water pan on its upper surface. By this arrangement we utilize a water pan of large area and shallow in depth, thereby increasing the evaporation of water.

Another feature of our invention is the provision of a closed combustion chamber within

an outer casing through which the air to be heated is passed. At one point this air to be heated passes through a heat exchanger and at the other sides of the combustion chamber a slight space is provided between the chamber and the casing, thus permitting and compelling a flow of air at relatively high velocity between the combustion chamber and the outer casing by which the air passing through such spaces is heated and the outer casing is protected from the hot combustion chamber. By the provision of a blower or fan for forcing the air through the casing and the restricting of the air passages through the heat exchanger certain relatively small amounts of air are forced to pass around the hot walls of the combustion chamber while of course a major portion of the air passes through the heat exchanger.

Other novel features of our invention will be apparent from the accompanying drawings and description and the essential features thereof will be set forth in the claims.

In the drawings, Fig. 1 is a central section through a furnace embodying our invention; Fig. 2 is a transverse section taken along the line 2—2 of Fig. 1; Fig. 3 is a horizontal section taken along the line 3—3 of Fig. 1; Figs. 4, 5, and 6 are enlarged sectional views through our novel heat exchanger and taken along similarly numbered lines of Fig. 7, the position of the sections of Figs. 5 and 6 being also indicated on similarly numbered lines in Fig. 4; while Fig. 7 is a partial perspective view of our novel heat exchanger.

Referring to Figs. 1, 2 and 3, within an outer casing 10 is housed a fire pot providing a combustion chamber 11 in the lower portion of which are burners 12 which are supplied with gas and primary air through the mixers 13. The combustion chamber has a door 14 for access to the burners. The products of combustion pass through a heat exchanger 15 through a triangular chamber 16 and out through a stack connection 17. It will be noted that the products of combustion pass generally upwardly and laterally as indicated by the broken line arrows of Fig. 1. This fuel burning equipment is housed within the upper portion of the casing 10 and separated therefrom by a front wall 18, a rear wall 19 and a horizontal partition 20 below which is located the blower or fan chamber. The air to be heated enters at the top and rear of the furnace through an opening 21, passes downwardly through chamber 22 and filter screen 23 and into the blower chamber 24. In this cham-

ber is located a rotatable blower fixed to shaft 25 and housed in casing 26, the inlet to which is at 27 and the outlet at 28. A motor 29 is connected by belt 30 to a pulley on shaft 25 so as to rotate the blower and deliver air through the chamber 31. This air travels upwardly and laterally as indicated by the full line arrows of Fig. 1 being heated during its travel, and passes outwardly at the top of the furnace through the opening 32.

Referring to Figs. 1, 2 and 3, it will be noted that at the front, two sides and the bottom, the combustion chamber is slightly spaced from the outer casing 10 providing the narrow spaces 33 at the bottom, 34 and 35 at the sides and 36 at the front of the combustion chamber. The inner face of the casing 10 and wall 18 is lined with heat insulating material as indicated at 37 and the provision of the spaces just enumerated provides a flow of air between the hot fire pot and the outer insulated casing so as to provide the double effect of a heating of the air travelling through such spaces and the protection of the outer casing from the hot combustion chamber. A major portion of the air entering chamber 31 through the opening 28 travels as indicated by the full line arrows through the heat exchanger 15 and out the opening 32. However, the passage through the heat exchanger 15 is so restricted by baffling that a portion of the air is compelled to travel through the spaces 33 to 36 as just enumerated. Since these spaces are narrow, air velocity is high at these points which is advantageous for heat exchange.

It will be noted that air entering at 21 is first heated by contact with the stack pipe 17 and the hot wall 19 of chamber 16 and may absorb some heat from the rear wall 19 of the chamber 31. The air then passes through the blower and into chamber 31 where it is heated by direct contact with the outside walls of the combustion chamber, also by passage through the heat exchanger and then out through the opening 32 directly to the space to be heated or directed by suitable pipes thereto.

The combustion chamber is suitably supported in place partly by the rigid connection through the heat exchanger, partly by its connection with the plate 18 and partly by the supports 39 which rest on partition plate 20.

Suitable doors and openings are provided as is customary. For instance there is a large door 40 at the front of the furnace having a screened opening 41 for the entrance of air for combustion. Chamber 22 is provided with a door 42 for access to the filter screens. The plate 18 has a door 43 for access to the water pan, and chamber 24 is provided with a suitable door for access to the fan and motor.

The heat exchanger 15 is of novel construction which is clearly shown in Figs. 4 to 7. It comprises essentially a series of flattened tubes with their ends flanged outwardly as at 54a to form straight flanges. These tubes are secured together side by side and generally parallel by welding their flanges edge to edge in permanent assembly. This provides channels 44 within the tubes for the products of combustion and passages 45 between the tubes for the air to be heated. These channels and passages are substantially at right angles to each other.

In the preferred form shown, the intermediate wall portions of the tubes are bent laterally into corrugations providing alternate substantially parallel ridges 48 and grooves 49. Preferably

the ridges and grooves extend in the direction of travel of the products of combustion so that the path of travel of these products is relatively unimpeded, while the passages 45 for air are baffled. Since the ends of the tubes are straight, the corrugations do not extend all the way through but are battered at each end giving the triangular portions 50. This construction provides air passages 55 extending unimpeded through each end of the heat exchanger. At the end nearest the heat exchanger, where the temperatures are greatest, the passages 55 permit a sufficient flow of cooling air to protect the metal from deterioration. For directing air through these passages a baffle plate 56 extending across the transverse dimension of the heat exchanger is provided in chamber 31 and directs a portion of the air through the hottest end of the heat exchanger. Another baffle 57 is provided to insure a directed flow of air through that portion of the heat exchanger just back of the lower end.

The heat exchanger may be built up of a plurality of sections 51, each section comprising a pair of plates having the alternate ridges and grooves just described. Such a pair of plates may be formed from a single sheet of metal and welded at one end as at 52 or may be formed of two separate plates welded at both 52 and 53. A plurality of such sections are then secured together as by welding along the straight joints 54 between the edges of the end flanges 54a. Other ways of providing equivalent constructions will occur to those skilled in this art.

Another way of describing the heat exchanger construction would be to say that it is a series of sheet metal plates in parallel spaced nested relation, each plate being substantially rectangular in form and having a central portion thereof offset inwardly from the sides and ends of the plate in prismatic shape. Referring to Fig. 7, one of said prisms is offset inwardly to the central line 49, the offset end portion being marked 50. If two such prisms are formed side by side as shown in Fig. 7 then we have parallel corrugations in the plate whose offset portions as indicated at 49 lie in one plane and the offset portions 48 and the equivalent parts near the side walls lie in another plane parallel to the plane containing the lines 49. Thus the corrugations provide a plurality of prismatic shapes which are concave on one face and convex on the other face. These plates, of which six are shown in Fig. 7, are secured together in parallel spaced nested relation with the convexity of one plate entering the concavity of the adjacent plate, and with each plate in a series having a continuous web connection with the adjacent plates along opposite parallel edges, each plate having such a connection with the preceding plate in the series along its end edges as shown at 54 and having such a connection with the succeeding plate in the series along its side edges as shown at 52 and 53. The depth of the corrugations as measured between the planes containing the lines 48 and 49 is greater than the spacing between adjacent parallel plates so as to give greater tortuosity to the passages 45 as indicated in Fig. 4.

This heat exchanger is preferably placed in the furnace as shown in Fig. 1 so that the passages and channels are at an angle to the vertical and horizontal, the channels 44 being a portion of the path of travel of the products of combustion and the passages 45 forming a portion of the path of travel for the air to be heated.

Referring to the sections shown in Figs. 5 and 75

6, it will be noted that the passage of the products of combustion through the heat exchanger is in lines varying but slightly from straight lines. Preferably, however, a baffle plate 47 is provided at the outlet end of the heat exchanger where the products of combustion pass to the stack so as to restrict the flow of the products of combustion. The arrangement is such that the total area of the openings 44 along both sides of plate 47 is substantially equal to that of the stack pipe 17.

One of the novel features of our invention is the provision of the hollow shelf 58 at the top of the combustion chamber which is almost directly above the burners 12 and subjected to very hot gases. On this shelf is placed the water pan 59 which because of the design and arrangement of the parts may be of relatively large area and relatively shallow so as to more rapidly heat and evaporate the water in the pan. It will be noted that these water vapors are liberated near that side of the heat exchanger where the stream of heated air is delivered on its passage toward the outlet 32 and this warm air picks up quite a volume of moisture as it passes the pan 59.

What we claim is:

1. A heat exchanger comprising a series of sheet metal plates in parallel spaced nested relation, each plate being substantially rectangular in form with a central portion thereof offset inwardly from the sides and ends of the plate in prismatic shape, each plate having a web connection with the adjacent plates in the series, the first and second plates in the series being so connected continuously along their side edges, the second and third plates in the series being so

connected continuously along their end edges, said side and end edge connections being alternately repeated throughout the series, and the depth of said offset portions being greater than the spacing between parallel plates, whereby to provide greater tortuosity of the path between the plates transversely of the side edges at all points except near the end where the portion offset inwardly from the ends provides a path straight through.

2. A heat exchanger comprising a series of imperforate sheet metal plates in parallel spaced nested relation, each plate being generally rectangular and having corrugations parallel to the sides thereof, the offset portions of the corrugations extending to parallel planes, each plate near its end edges having an inclined portion beginning at a point in one of said planes and spaced slightly from the end of the plate and sloping toward the end of the plate and ending in the other of said planes to bring the end edge of the plate substantially to a straight line, whereby each plate comprises a plurality of prismatic shapes concave on one face and convex on the other face, said plates being connected to form a unit with the convexity of one plate entering the concavity of the adjacent plate, and each plate in the series having a continuous web connection with the adjacent plates along opposite parallel edges, each plate having such a connection with the preceding plate in the series along its end edges and having such a connection with the succeeding plate in the series along its side edges.

CHRISTIAN S. ANDERSEN.
ALFRED L. SCHELLHAMMER.