

Aug. 7, 1928.

1,680,145

N. R. FORSSBLAD

HEAT EXCHANGER

Filed Jan. 27, 1925

4 Sheets-Sheet 1

Fig. 1.

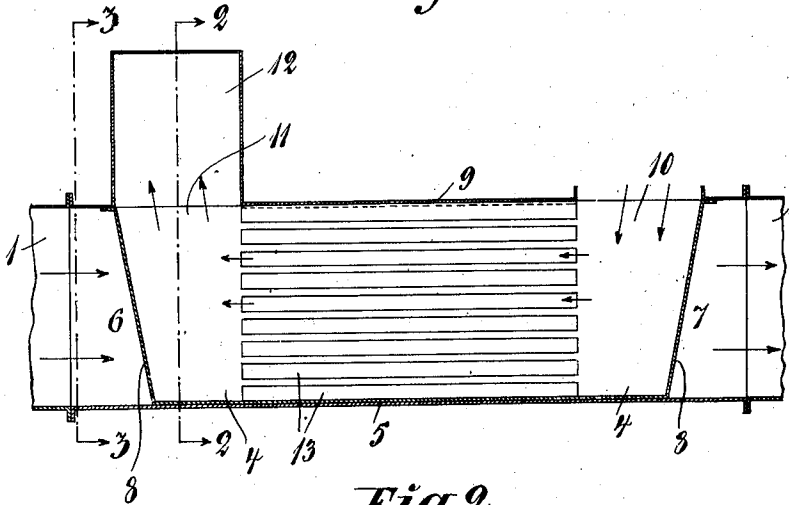
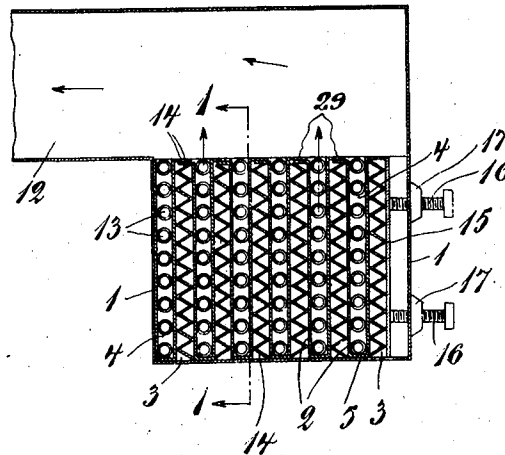


Fig. 2.



Inventor
N. R. Forssblad
by MarksoClerk
ATTYS.

Aug. 7, 1928.

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N. R. FORSSBLAD

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4 Sheets-Sheet 2

Fig. 4.

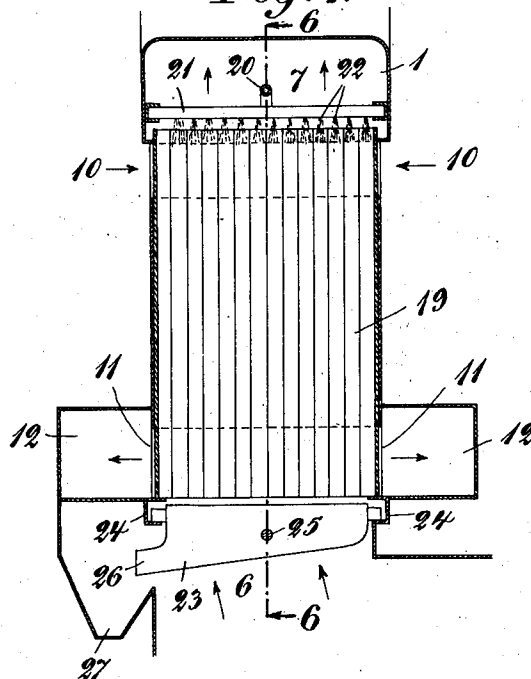
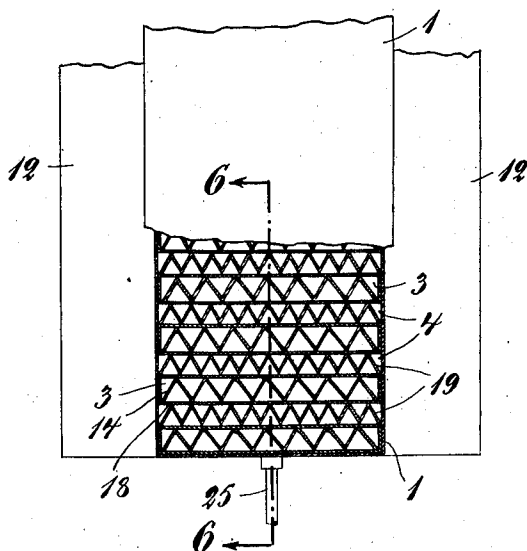


Fig. 5.



Inventor
N. R. Forssblad
By Marks & Clerk
Attys.

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N. R. FORSSBLAD
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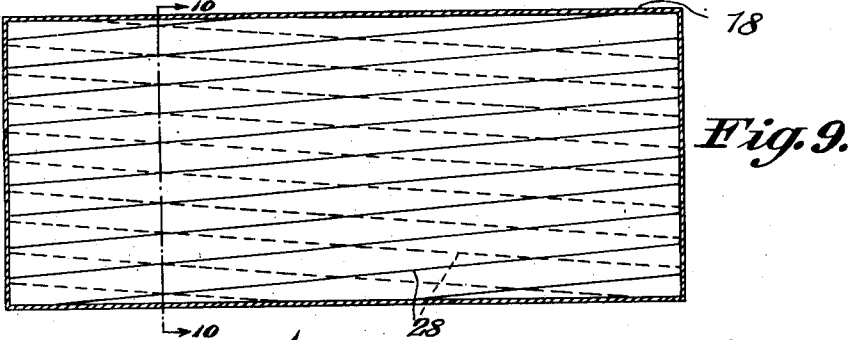


Fig. 9.

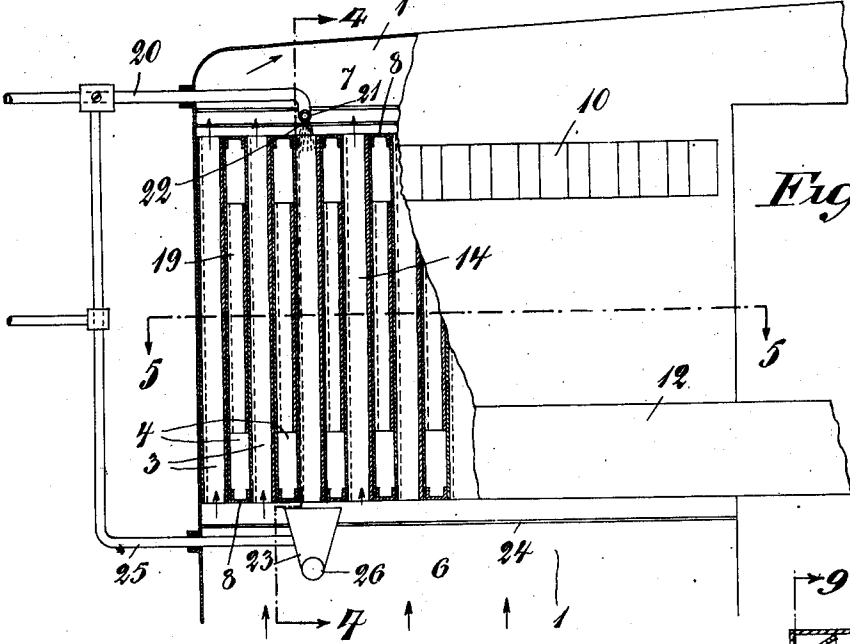


Fig. 6.

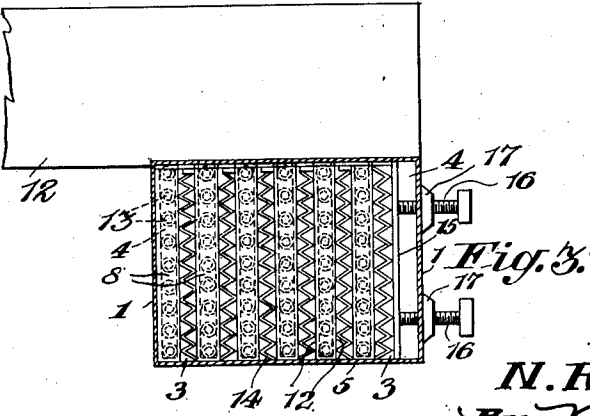


Fig. 3.

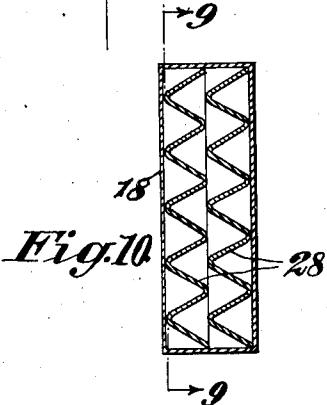


Fig. 10.

Inventor
N. R. Forssblad
By Markos Clerk
FEB 7 1928

Aug. 7, 1928.

1,680,145

N. R. FORSSBLAD

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Fig. 7.

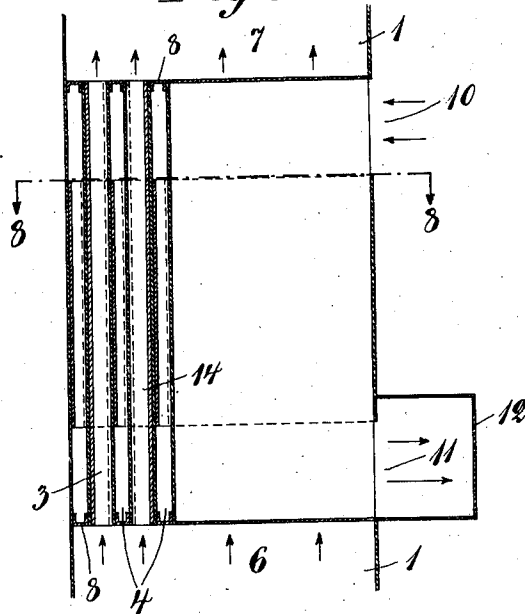
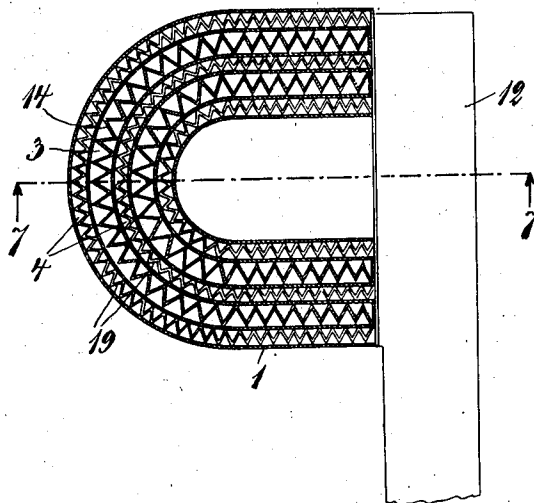


Fig. 8.



Inventor
N. R. Forssblad
by *Markes Clerk*
ATTYS.

Patented Aug. 7, 1928.

1,680,145

UNITED STATES PATENT OFFICE.

NILS RICHARD FORSSBLAD, OF VASTERAS, SWEDEN.

HEAT EXCHANGER.

Application filed January 27, 1925, Serial No. 5,143, and in Sweden January 30, 1924.

This invention relates to heat exchangers for gaseous mediums and has particularly for its object to provide, in steam plants, improved means for preheating air for combustion by means of the waste gases.

Preheaters of this kind are known which consist of a system of channels for hot waste gases and a system of channels for the air to be preheated, one of said systems being formed by the intermediate spaces between the channels of the other system, so that the walls of the channels, which may be of sheet metal, will be in contact with the waste gases on one side and with the air on the other side. In cases where large heat exchange surfaces are required, a construction of this kind will be rather bulky and also very heavy, because a relatively great thickness of the walls of the channels is required to prevent the sheet metal from being bent by irregular heating. Moreover, the gases cannot be brought uniformly into contact with the heat exchange surfaces owing to the great width of the channels and this fact will, evidently, have an unfavourable influence on the efficiency of the preheater.

In order to overcome the aforesaid disadvantages and to increase the efficiency of the preheater, a heat conducting material consisting of corrugated sheet metal, tubes or the like is provided, according to this invention, within the channels in contact with the walls of the channels, said filling material being structured and disposed so as to form a great number of longitudinal passages for the gases through the channels.

This arrangement will greatly increase the efficiency without an increase of the volume and weight of the preheater, because it will be possible to provide a very large heat exchange surface within a given volume, while on the other hand the sheet metal walls may be made very thin as they are held in proper positions by the filling material. The possibility of using thin sheet metal affords the further advantage, that the walls of the channels are made flexible and yielding so that they may be brought into close heat-conducting contact with the filling material by applying pressure in suitable way. In order to ensure such contact, the whole assembled sheet metal partitions and intermediate filling material are preferably firmly compressed perpendicularly to the partitions so as to form one or more rigid channel bodies. In

some cases it may be suitable to join the filling members with the partitions, for instance by welding.

The invention will be more closely described with reference to the accompanying drawings, in which Fig. 1 is a longitudinal section of one embodiment of the invention, said section being taken on line 1—1 in Fig. 2 which latter is a cross section on line 2—2 in Fig. 1. Fig. 3 is a cross-section on line 3—3 in Fig. 1. Figs. 4, 5 and 6 represent a second embodiment, Fig. 4 being a longitudinal section on line 4—4 in Fig. 6, Fig. 5 is a section on line 5—5 in Fig. 6, while Fig. 6 is a cross-section on line 6—6 in Figs. 4 and 5. Figs. 7 and 8 are a longitudinal section and a cross-section respectively of a third embodiment. Figs. 9 and 10 represent a fourth embodiment of the invention, Fig. 9 showing separately in longitudinal section a single channel of the preheater, said section being taken on line 9—9 in Fig. 10, which is a cross-section of the channel on line 10—10 in Fig. 9.

Referring to Figs. 1—3, the heat exchange body of the preheater is adapted to be disposed as a whole in a conduit or flue 1 with rectangular cross section for the hot waste gases from a steam plant. The two channel systems are formed by dividing the interior of the flue 1 by means of a number of U-shaped sheet metal pieces 2 disposed parallelly and forming each a flat channel 3, extending in the direction of the flue 1. The U-shaped pieces 2 are spaced apart, as shown in Fig. 2, the intermediate spaces forming another system of channels 4 extending in the same direction. The edges of the upwardly turned sides of the U-shaped pieces 2 are bent to form flanges 29 each of which overlaps the corresponding flange of an adjacent piece 2. As will be seen, the width of the channels may be altered by compressing more or less the system of channels as a whole perpendicularly to the side walls. The channels 3, which are entirely covered at the bottom by the bottom wall 5 of the flue 1, serve to conduct the waste gases through the heat exchanger and, accordingly, are left open at their ends so as to communicate with the end portions of the flue at 6 and 7 respectively. The channels 4, on the other side, which serve to conduct the air to be preheated through the heat exchanger, are closed against the flue 1 by means of end walls 8, each of which is suitable

bly formed by an extended portion of a sheet metal piece 2 bent to cover the end of the channel and, if required, welded to the edge of the adjacent piece 2. The channels 4 are partly covered at the top by the upper wall 9 of the flue 1, while the ends of the channels communicate at their upper sides with openings 10 and 11 in the upper wall 9 of the flue 1, which openings form the inlet and the outlet respectively for the air. The air, which is drawn directly from the atmosphere, enters through the inlet opening 10 and leaves through the outlet 11, where it enters a pipe 12 branched off laterally from the flue 1 and leading the air in preheated condition to the fire box. In each of the channels 4 there are inserted a number of metal pipes 13 having about the same width as the channels and extending in the direction of the flue 1 so as to divide up the channel into a large number of small parallel passages. Said pipes 13 only extend over the entirely covered portion of the channels 4, so that the ends of the channels below the openings 10 and 11 will be left free, in order to ensure an unobstructed communication between the filled portions of the channels on one hand and the air inlet and outlet on the other hand. A similar dividing of each of the channels 3 into a great number of small parallel passages is obtained in the embodiment illustrated by means of a single piece 14 of corrugated sheet metal, the folds of which have about the same width as the channels, the corrugations extending in a longitudinal direction of the channel. The filling material 14 in the channels 3 may occupy portions corresponding to the filled portions of the channels 4 or may, if desired, be extended to the ends of the channels. The whole heat exchange body composed of the U-shaped sheet metal plates 2 and the filling material 13, 14 is compressed between one of the side walls of the flue 1 and a pressing plate 15 by means of screws 16 threaded in bosses 17 secured to the opposite side wall. The heat exchange body thus forms a rigid packet or the like, the different parts of which are brought into close heat-conducting contact with one another. Accordingly the heat absorbed from the hot gases by the filling material 14 in the channels 3 is easily conducted off to the channel walls and through the filling material 13 of the air channels 4 to the air to be preheated.

The embodiment illustrated by Figs. 4-6 differs from the arrangement just described mainly by the heat exchange body being placed in a vertical portion of the flue 1 and, further, by there being provided double inlets 10 and outlets 11, viz, one on each of two opposite sides of the flue. The flue 1 is bent, above the heat exchanger, so as to extend further in horizontal direction. The channels 3 for the waste gases, instead of being

formed by sheet metal pieces bent in U-shape as shown in Fig. 2, are formed in this case as flat tubes 18 disposed longitudinally within the flue 1 and spaced apart so as to form intermediate channels 4 for the air to be preheated. The channels 4 are closed against the hot waste gases, which are introduced at 6 and conducted off at 7, by means of end walls 8, as in the case described above, the end walls 8 in this case, however, consisting of channel-shaped profile iron pieces jammed between the side walls of the tubes 18 and, if required, welded or riveted to said walls. The filling members 14 of the tubes 18 are similar to those of the corresponding channels in Figs. 1-3, a folded or corrugated sheet metal piece being inserted in each of said tubes so as to bear against the side walls of the tube. The filling members of the air channels 4, as shown in Fig. 6, also consist of corrugated sheet metal 19 arranged in an analogous way and serving at the same time to determine the distances between the flat tubes 18. Obviously, the sheet metal filling 19 has quite the same effect as the pipes 13 in Figs. 1, 2.

A heat exchanger arranged vertically according to Figs. 4-6 may be provided with advantage with means for removing flue dust or soot collected in the channels for the combustion gases. For this purpose a pipe 20, Figs. 4, 5, is slidably introduced through the wall of the flue 1 above the heat exchange body, said pipe being provided at its free end with a transversal distributing pipe 21 forming a nozzle with downwardly directed distributing openings 22 which, by displacing the pipe 20 in its longitudinal direction, may be brought to register with the upper end of any desired one of the channels 3. The ends of the distributing pipe 21 are guided in the side walls of the flue 1. At the lower end of the heat exchanger there is provided a soot collecting vessel 23 slidably mounted in lateral guides 24 and adapted to be displaced by means of a rod 25 or any other suitable means parallelly with the distributor 21 in such a manner that it will always be located just below said distributor. The pipe 20 and the rod 25 are preferably connected so as to be moved together. The vessel 23 is provided with a lateral spout 26 opening above a gutter 27 running in the direction the sliding motion. When using this sweeping arrangement, steam or compressed air is supplied to the pipe 20 and blown through the distributor 21 into the channels 3, whereby the soot collected therein will be swept away and collected in the vessel 23 which is emptied through the spout 26 into the gutter 27 from which the soot may be readily removed.

The arrangement according to Figs. 7, 8 is substantially the same as illustrated in Figs. 4-6, differing therefrom by the flue

and the channels of the heat exchange body being bent in such a manner as to obtain a U-formed or horseshoe-shaped cross-section, as shown in Fig. 8. The air is introduced as in Fig. 4, through two inlets 10 at the upper end of the heat exchanger, and is conducted off by a pipe 12 communicating with both of the outlets 11.

In the case of forming each of the filling members 14 or 19 respectively of a single corrugated sheet metal piece the channels must be relatively thin, a great number of channels being then required which makes the manufacture rather expensive. This inconvenience may be overcome by inserting two or more corrugated sheet metal members into each of the channels as shown in Figs. 9 and 10, said members being disposed in such a manner as to prevent the folds from falling into one another. To this end the corrugated members 28 of each channel may be separated from one another by plates. Such intermediate plates which do not considerably contribute to the heat exchange may, however, be dispensed with by arranging the corrugations of adjacent plates so that they will extend obliquely relatively to each other thus bearing against each other at their cross points, being thereby held in proper positions.

In order to prevent oxidation or corrosion of the material by the influence of the burnt gases the heat exchanger may be manufactured of uncorrodible material. The effect of the corrosion of the filling material being, however, less harmful than the destruction of the channel walls, it will be sufficient in many cases, in order to reduce the costs, to make the channel walls of uncorrodible sheet metal while using ordinary sheet metal for the filling material.

Obviously, a heat exchanger of the kind described above may also be used for other purposes than for preheating air for combustion purpose. A heat exchanger of this kind may, for instance, be used with advantage in a ventilating system in order to recuperate heat from waste air carried off from a locality. To this end the fresh air may be preheated in the manner described by means of the waste air.

I claim:

1. In a heat exchanger for gaseous mediums in combination, a parallel arrangement of sheet metal partitions providing flat channels for the heat delivering gaseous medium and alternately therewith providing flat channels for the heat absorbing gaseous medium, all of said channels being substantially parallel with one another and communicating at their ends with inlets and outlets respectively, heat conducting filling material interposed between the partitions and forming thin gas passages extending

substantially longitudinally in each channel, and means for pressing together said sheet metal partitions and intermediate filling material perpendicularly to the partitions so as to establish uniformly distributed contact pressure between each partition and the filling material along longitudinal contact surfaces parallel with said gas passages.

2. A heat exchanger as claimed in claim 1, in which the filling members between two adjacent partitions consist of a number of corrugated sheet metal plates placed one on the other, the corrugations of adjacent plates extending at oblique angles to each other.

3. In a heat exchanger for gaseous mediums in combination, a parallel arrangement of sheet metal partitions providing flat channels for the heat delivering gaseous medium and alternately therewith providing flat channels for the heat absorbing gaseous medium, all of said channels being substantially parallel with one another and communicating at their ends with inlets and outlets respectively, heat conducting filling material interposed between the partitions and forming thin gas passages extending substantially longitudinally in each channel, and a pressing device arranged in such a manner that the two external channel walls are subjected to a uniformly distributed pressure which is propagated by means of the filling members throughout the whole of the exchanger so as to establish uniformly distributed contact pressure between each partition and the filling material along longitudinal contact surfaces parallel with said gas passages.

4. In a heat exchanger in combination, a conduit for a gaseous medium, a number of sheet metal partitions arranged therein parallelly to the longitudinal direction of the conduit, means for admitting said gaseous medium through every other one of the channel spaces formed between the partitions, means for admitting another gaseous medium through the remainder of said channel spaces in a direction substantially parallel to the longitudinal direction of the conduit, heat conducting filling material interposed between the partitions and arranged so as to divide up the channel into a number of thin gas passages extending substantially in the direction of the conduit, and means for pressing together the sheet metal partitions and intermediate filling material so as to establish uniformly distributed contact pressure between each partition and the filling material on both sides thereof along longitudinal contact surfaces parallel with said gas passages.

In testimony whereof I affix my signature.
NILS RICHARD FORSSBLAD.