May 5, 1925. 1,537,016

S. H. KRØYER

RECUPERATOR

Filed Nov. 5, 1924 2 Sheets-Sheet 1

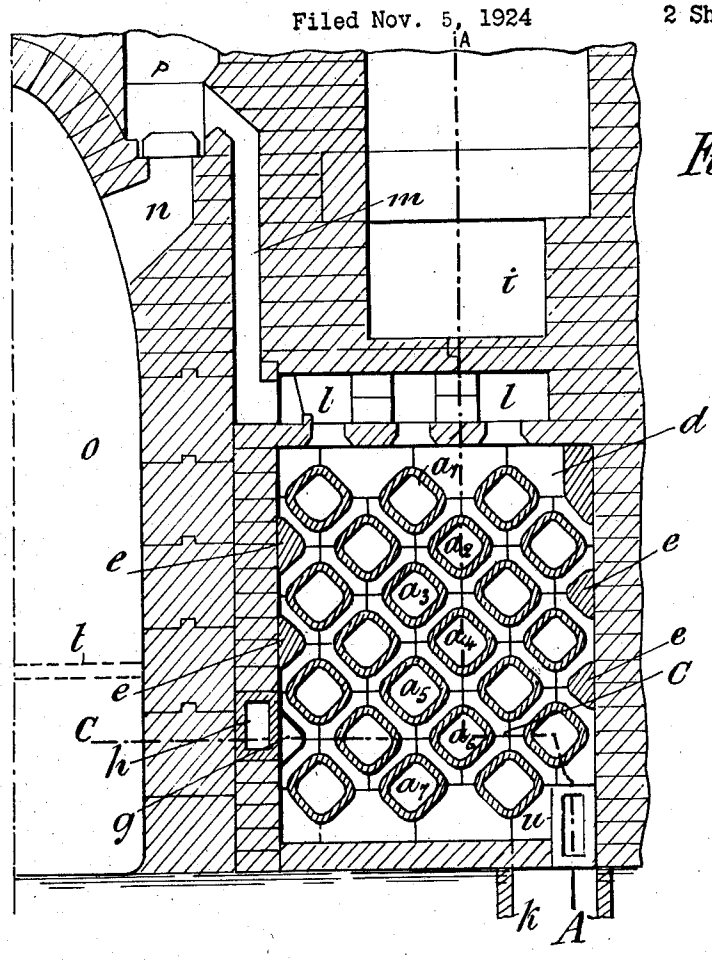


Fig 1.

Fig 3.

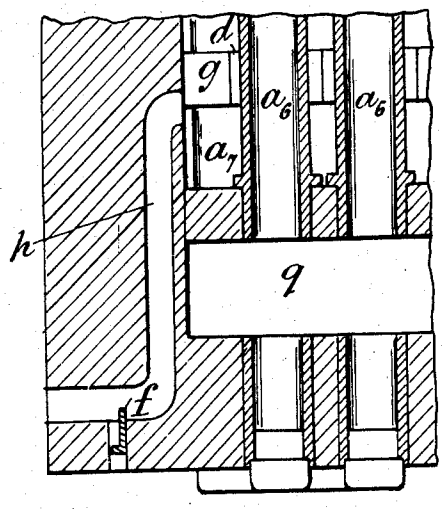
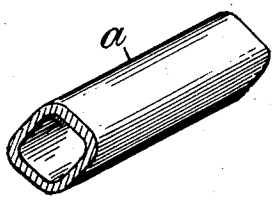


Fig 4.



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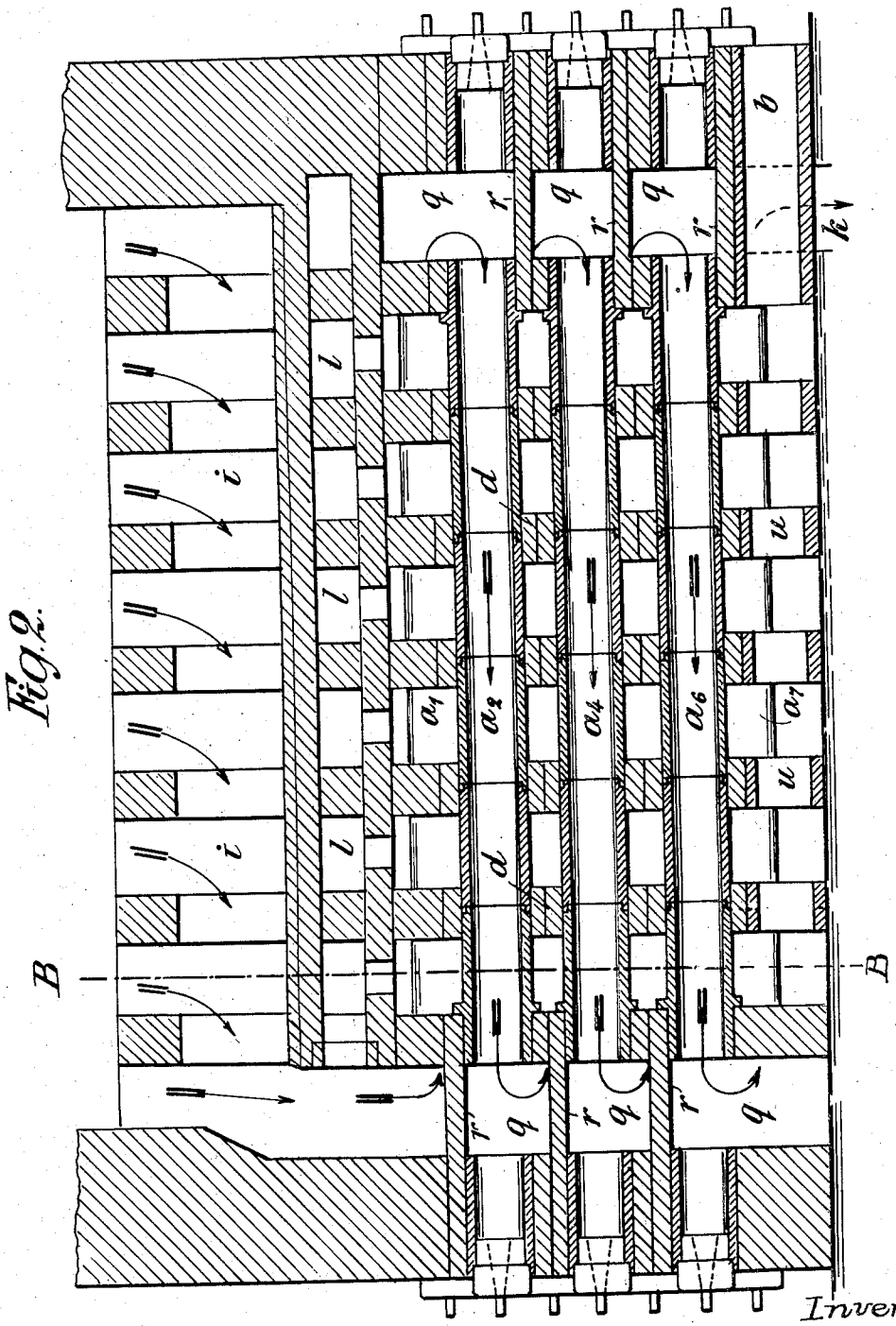


Fig. 2.

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UNITED STATES PATENT OFFICE.

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RECUPERATOR.

Application filed November 5, 1924. Serial No. 747,949.

To all whom it may concern:

Be it known that I, SIGURD HJALMAR KRØYER, citizen of the Kingdom of Denmark, and residing at Hellerup, near Copenhagen, Denmark, have invented certain new and useful Improvements in Recuperators, of which the following is a specification.

This invention relates to a recuperator of that kind having horizontal series of tubes and around the same channels limited by vertical walls, and in which the horizontal tubes have approximately quadratic cross section and are so arranged that the plane portions of their walls lie at an angle of 45° with a vertical plane and that each series of tubes extends into the spaces between the tubes of the next series upwards and downwards. The characterizing feature of the invention is that the horizontal series of tubes serve to lead the warm combustion gases, the latter being first led through the uppermost series, then through the next series and so on downwards, while the channels around the tubes lead the air through from the bottom upwards in order to preheat it.

In the drawing a construction form of the invention is represented by way of example.

Fig. 1 is a vertical sectional view of the recuperator and a generator built together, the section being taken on the line B—B of Fig. 2.

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

Fig. 3 is a horizontal fragmentary section on the line C—C of Fig. 1, and

Fig. 4 is a detail perspective view of one of the tubes for the passage of combustion gases.

Referring to the drawing in detail, the smoke or combustion gases of the furnace heated by gas from the generator o come from the channel i and are led through a plurality of horizontal series of tubes a, passing first through the upper series a_1, then through the next series a_2 and so on until at last having passed through the lowermost series a_7 they pass into the chimney through the channel k. The plane of section shown in Fig. 2 passes through the tubes a_2, a_4, a_6, the arrows indicating the way of the smoke. From the channel i the smoke passes first from the left to the right in Fig. 2 through the series of tubes a_1, only one of these tubes appearing in Fig. 2. When the combustion gases have passed completely to the right in Fig. 2, they will turn in the so called turning-boxes q and return from the right to the left in the next lower series of tubes a_2 and thus the smoke is led back and forth on down through the several series of tubes until it reaches the uptake k to the chimney. In order to guide the smoke from one series of tubes to the next, the turning boxes q, are divided by zigzag partitions r separating to the left in Fig. 2 the series a_1 and a_2, a_3 and a_4, a_5 and a_6, so that in the turning-box in the left hand side of Fig. 2 the connection is open between the series a_2 and a_3, a_4 and a_5 and a_6 and a_7. In the right hand turning-box the connections are reversed, which will easily be understood from the drawing and the above explanation of the path of the smoke.

The air to be preheated in the recuperator is led through the horizontal channel b at the bottom of the recuperator and leading through one of the turning-boxes q. The vertical supporting walls d for the tubes are provided with openings u arranged in line with and having the same cross sectional area as the channel b, so that the sucked-in air is allowed to be distributed throughout the several air channels defined by the walls d. The air rises in zigzag path around the tubes a in order to pass as a preheated secondary air through the channel l, m and mix with the gas coming from the generator o through the channel n. The mixing takes place at p.

According to the present invention, the passage of combustion air to be preheated takes place solely by the natural draught so that this air need not be sucked through the recuperator. This is of the utmost importance because it is to be remembered that normally the combustion air coming from the recuperator is led to the fire place of a generator or of a furnace where it meets gases produced by a generator. In both cases the necessary suction of the air through the recuperator would mean also that there would be a suction through the generator which might be detrimental to the operation of the generator.

Furthermore the recuperator will insure uniform temperature of all tubes a in each series because if, for any reason one of the horizontal tubes a should become warmer than the neighboring ones, an increased local

draught of air upwards will immediately occur at this place and equalize the difference in temperature.

To enable a portion of the preheated air to be taken out and employed as a primary air in the generator *o* a series of holes *g* are provided in the vertical walls *d* adjacent one of the lower series of tubes, so that all the zigzag-shaped air channels in the recuperators communicate. Furthermore an S-shaped channel *h* leads from these intercommunicating air channels of the recuperator into the space below the grate *t* of the generator thus enabling a portion of the preheated air to be used as primary air. The channel *h* may be closed, or its cross sectional area be varied, by a valve *f*.

By thus taking out only a portion of the heated air the circulation of air around the lowermost series of horizontal tubes becomes more animated, while the quantity of air passing through the entire recuperator and leaving it at the top is still sufficient and may be regulated in the ordinary way. It is the employment of the natural draught for causing circulation of the air through the recuperator which enables a portion of the air to be taken out as primary air. It is already known to preheat the primary air by special channels but as the height of the furnace under which the recuperator is placed will seldom permit the arrangement of such channels it is of the greatest importance that in such furnaces this invention will allow the primary air to be preheated.

It will be noted by reference to Fig. 1 that the air to be preheated which passes upwardly through the vertical channels formed by the vertical walls *d* and the lateral walls of the recuperator moves in a zigzag path owing to the arrangement and shape of the horizontal tubes *a*. In order to make the conditions of the draught upwards the best possible and at the same time to expose the air to a maximum of heating surface, the corners of the tubes are rounded as shown in Fig. 4.

In order to prevent uninterrupted vertical movement of the heated air along the side walls of the recuperator, baffle members *e* are so arranged with respect to the outermost tubes of the several horizontal series as to cause such heated air to traverse the same zigzag path as is produced by the arrangement of the tubes relative to one another.

I claim:

1. A recuperator of the natural draught type including a plurality of horizontal series of tubes, spaced vertical walls, said tubes being approximately square in cross section and so arranged that the plane portions of their walls are inclined to the vertical and that the tubes of each series extend into the spaces of the tubes of the adjacent series, having means for conducting combustion gases into the upper series of tubes, means for causing the combustion gases to traverse the several series of tubes from the upper series to the lower series, and means admitting air to the lower portion of the spaces between the vertical walls externally of the tubes whereby, incident to heating of the air, the latter rises in the spaces.

2. A recuperator as claimed in claim 1 characterized by the provision of means permitting the withdrawal of a portion of the heated air at a point intermediate the upper and lowermost series of tubes.

3. A recuperator of the natural draft type including a plurality of horizontal series of tubes, spaced vertical walls, having means for conducting combustion gases into the upper series of tubes, means for causing the combustion gases to traverse the several series of tubes from the upper series to the lower series, and means for admitting air to the lower portion of the spaces between the vertical walls externally of the tubes, whereby incident to heating of the air, the latter rises in the spaces.

In testimony whereof I affix my signature.

SIGURD HJALMAR KRØYER.