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(54) **FIREPLACE AND FIREPLACE INSERT FOR SOLID FUEL**

(57) Fireplaces and fireplace inserts for solid fuel with increased thermal efficiency and reduced emissions of solid pollutants achieved by modifying the flue pathways and intensifying heat transfer from combustion products to the surroundings. Modifications of the flue pathways mainly consist in the placement of directing elements (8, 10) to direct combustion products in the flue and the installation of heat exchange surfaces between the flue and the surroundings.

A method of increasing the thermal efficiency and reducing emissions of solid pollutants of fireplaces and fireplace inserts for solid fuel by reducing the speed of flow of combustion products in the flue pathways and reducing the temperature of combustion products in the flue pathways by transferring heat through heat-conducting walls of the flue pathways to the surrounding environment.

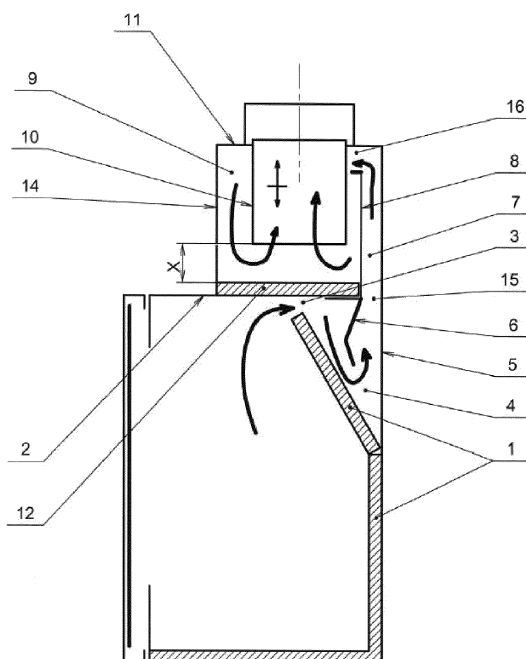


FIG. 1

Description

Technical Field

[0001] The invention relates to fireplaces and fireplace inserts for solid fuel with increased thermal efficiency and reduced emission of solid pollutants and a method for increasing their thermal efficiency and reducing the emission of solid pollutants and it belongs to the field of thermal technology.

Background Art

[0002] Among the most important utility parameters of heat sources, which include fireplace inserts and fireplaces for solid fuel, are their thermal efficiency and the amount of emitted solid pollutants. In order to increase the effective use of fuel and reduce harmful emissions arising in the process of fuel combustion, it is important to increase the efficiency of fuel combustion and, consequently, to maximize the use of heat generated in the combustion process.

[0003] Various constructions of combustion chambers and flue pathways of fireplace inserts and fireplaces for solid fuel are known from the state of the art, which are mainly characterized by the incorporation of various additional directing elements (deflectors) directing the flow of combustion products in such manner that the stay of gaseous products of combustion in the space of the heat source is prolonged and thus the temperature of outgoing combustion products is reduced due to the transfer of part of their enthalpy content to the surroundings of the heat source. The disadvantage of the solutions known so far is the low efficiency of exhausting the heat of combustion products to the surroundings because of the small or no heat exchange area of the flue pathway with the surroundings.

[0004] EP 2 418 426 B1 discloses a fireplace insert and a fireplace stove with a device for increase of heat efficiency and reduction of emissions by incorporating directing elements to direct the flow of combustion products. The disadvantage of this invention is that it has a very small heat exchange area of the flue pathway with the surroundings.

[0005] The aim of the present invention is to create fireplaces and fireplace inserts that enable increased capture of solid pollutants in the areas of flue pathways and also to increase their thermal efficiency by reducing the temperature of combustion products through intensive heat transfer and radiation to the surroundings even before combustion products enter the chimney.

Nature of Invention

[0006] The present invention solves an increase in thermal efficiency and a reduction in the emission of solid pollutants from fireplace inserts and fireplaces for solid fuel by means of adjusting a flue pathways and intensi-

fying the heat transfer from combustion products to the surroundings even before combustion products enter a chimney. By the term combustion products, a mixture of flue gas and solid pollutants is meant.

5 [0007] Fireplaces and fireplace inserts for solid fuel with increased thermal efficiency and reduced emissions of solid pollutants containing a combustion chamber and a flue pathway according to the present invention, the nature of which is that between a back wall and an upper wall of the combustion chamber there is an adjustable gap designed for exhausting combustion products from the combustion chamber into the flue pathway and the flue pathway has the following construction:

10 In the first part of the flue pathway there is a settling space, which is bounded by a part of the back wall of the combustion chamber and a part of a back wall of the flue pathway made of a heat-conducting material. The combustion product flow directing element A is located in this settling space. This directing element is located opposite the adjustable slot and directs the flow of combustion products in such manner that in the settling space they flow from the adjustable slot downwards around the directing element A. After passing around the directing element A, the mixture of flue gas and solid pollutants begins to rise up into the second part of the flue pathway.

15 [0008] By directing the flow of combustion products, a reduction in the speed of combustion products is achieved and at the same time their direction is changed. Due to the influence of gravity and the change in the velocity vector of solid pollutants, these solid pollutants settle down in this settling space. By reducing the speed of combustion products, a longer residence time of combustion products in this part of the flue is obtained, and thus a more intense heat transfer from combustion products to heated surroundings is achieved through the wall of the flue pathway made of a heat-conducting material.

20 [0009] It is advantageous if the back wall of the combustion chamber, which is in contact with the surrounding environment, is also made of a heat-conducting material, as this increases the area through which heat is transferred from combustion products to the heated surroundings.

25 [0010] In a preferred embodiment, the directing element A has a bent shape so that the flue pathway between the directing element A and the back wall of the first part of the flue pathway widens at the site of bending of the directing element A, and in the largest cross-section of this part of the flue pathway, there will be a significant reduction in the speed of the combustion products.

30 [0011] The first part of the flue pathway is connected to the second part of the flue pathway through an opening Z, through which combustion products flow from the first part to the second part of the flue pathway.

35 [0012] In the second part of the flue pathway, a vertical channel is formed by the back wall of the flue pathway and a directing element B, and a wall of the flue pathway is made of a heat-conducting material, and heat is transferred from combustion products to the heated surround-

ings through the heat-conducting wall of the flue pathway. The directing element B directs the flow of combustion products in the vertical channel upwards, and through an opening Y located in the upper part of the vertical channel between the directing element B and the upper wall of the flue pathway, combustion products flow into the third part of the flue pathway. The second part of the flue pathway is connected to the third part of the flue pathway by the opening Y.

[0013] The third part of the flue pathway has an outer wall made of a heat-conducting material. In this part of the flue pathway, there is a cooling-settling space. In this part, a combustion product flow directing element C having the shape of a pipe, is located. The directing element C is attached to a wall of a chimney flange and its height is smaller than the height of the third part of the flue pathway. Thus, a space for the flow of combustion products is created in the upper part of the flue pathway between the outer wall of the third part of the flue pathway and the directing element C, and there is a free space for the flow of combustion products marked as X between the bottom wall of the flue pathway and the directing element C.

[0014] From a technological and structural point of view, it is advantageous if the directing element C has the shape of a cylindrical pipe.

[0015] It is also advantageous if the directing element C is adjustable and can be set to the optimal position with respect to the draft conditions of the chimney at the installation site.

[0016] Combustion products coming from the second part of the flue pathway through the opening Y into the area of the third part of the flue pathway are directed downwards into the free space by the directing element C and combustion products continue to flow inside the directing element C into the chimney.

[0017] In the third part of the flue pathway, the velocity field is oriented in the direction of gravity. Combustion products are cooled in the third part of the flue pathway by convection and then also radiation transport of heat through the outer heat-conducting wall into the heated surroundings. At the same time, the speed of flow of combustion products decreases in the lower part by widening the cross-section of the flue pathway, which both increases heat transfer to the surroundings and also leads to the settlement of solid pollutants that were not captured in the previous part of the flue pathway.

[0018] A heat-insulating plate can be placed on the bottom wall of the third part of the flue pathway, the main task of which is to prevent heat transfer between the combustion chamber and the third part of the flue pathway and thus prevent the heating of combustion products that are already going into the chimney.

[0019] The advantages of the invention consist mainly in that an increase in thermal efficiency and a reduction in the emission of solid pollutants from fireplace inserts and fireplaces for solid fuel are achieved by the disclosed construction of fireplaces and fireplace inserts and the disclosed method.

Overview of Figures

[0020] On Fig. 1, the layout of the flue pathway of the fireplace insert according to the present invention is shown.

Examples of Embodiment of the Invention

Example 1

[0021] A fireplace insert for solid fuel according to this invention is made. On Fig. 1, the layout of the flue pathway in this fireplace insert is shown. The increased thermal efficiency and a reduction in the emission of solid pollutants of the fireplace insert is mainly achieved by the construction of the flue pathway.

[0022] The fireplace insert according to this invention contains a combustion chamber and a flue pathway. Between a back wall 1 and an upper wall 2 of the combustion chamber, there is an adjustable gap 3 designed for exhausting combustion products from the combustion chamber into the flue pathway. The flue has the following construction:

In the first part of the flue pathway there is a settling space 4, which is bounded by a part of the back wall 1 of the combustion chamber and a part of a back wall 5 of the flue pathway made of a heat-conducting material. In the settling space 4, a combustion product flow directing element A 6 is located. The combustion product flow directing element A 6 is located opposite the adjustable slot 3 and directs the flow of combustion products so that in the settling space 4 they flow from the adjustable slot 3 downwards around the directing element A 6. After passing around the combustion product flow directing element A 6, the mixture of flue gas and solid pollutants begins to rise up into the second part of the flue pathway.

[0023] By directing the flow of combustion products, a reduction in the speed of combustion products is achieved and at the same time their direction is changed. Due to the influence of gravity and the change in the velocity vector of solid pollutants, these solid pollutants settle down in the settling space 4. By reducing the speed of combustion products, a longer residence time of combustion products is obtained in this part of the flue pathway, and thus a more intensive heat transfer from combustion products to the heated surroundings through the back wall 5 of the flue pathway made of a heat-conducting material is achieved. In this example of embodiment, a metal sheet was used.

[0024] Also, the back wall 1 of the combustion chamber, which is in contact with the surrounding environment, is made of a heat-conducting material. This increases the area through which heat is transferred from combustion products to the heated surroundings.

[0025] The combustion product flow directing element A 6 is bent into the shape of a circumflex and is located in such a way that the flue pathway between the directing element A 6 and the back wall 5 of the first part of the

flue pathway is widened at the site of bend of the directing element A 6 and in the largest cross-section of this part of the flue pathway comes to a significant reduction in the speed of combustion products.

[0026] The first part of the flue pathway is connected to the second part of the flue pathway through an opening Z 15, through which combustion products flow from the first part to the second part of the flue pathway.

[0027] In the second part of the flue pathway, a vertical channel 7 is formed by the back wall 5 of the flue pathway and a directing element B 8, and the wall 5 of the flue pathway is made of a heat-conducting material and heat is transferred from combustion products to the heated surroundings through the heat-conducting wall of the flue pathway. The directing element B 8 directs the flow of combustion products in the vertical channel 7 upwards, and through an opening Y 16 located in the upper part of the vertical channel 7 between the directing element B 8 and the upper wall of the third part of the flue pathway, combustion products flow into the third part of the flue pathway. The second part of the flue pathway is connected to the third part of the flue pathway through the opening Y 16.

[0028] The third part of the flue pathway has an outer wall 14 made of a heat-conducting material. In this part of the flue pathway, there is a cooling-settling space 9. In this part, a combustion product flow directing element C 10 having the shape of a pipe, is located. In this exemplary embodiment, the pipe has the shape of a cylinder. The directing element C 10 is attached to a wall 11 of a chimney flange and its height is smaller than the height of the third part of the flue pathway. Thus, between an outer wall 14 of the third part of the flue pathway and the directing element C 10, a space for the flow of combustion products is created in the upper part of the flue pathway, and between a bottom wall 12 of the flue pathway and the directing element C 10, there is a free space for the flow of combustion products, marked as X in the figure.

[0029] The directing element C 10 is adjustable and can be set to the optimal position with respect to the draft conditions of the chimney at the installation site.

[0030] Combustion products coming from the second part of the flue pathway through the opening Y 16 into the space of the third part of the flue pathway are directed downwards into the free space by the directing element C 10 and combustion products further flow inside the directing element C 10 into the chimney.

[0031] In the third part of the flue pathway, the velocity field is oriented in the direction of gravity. Combustion products in the third part of the flue pathway are cooled by convection and subsequently by radiation transport of heat through the heat-conducting outer wall 14 into the heated surroundings. At the same time, in the lower part, by widening the cross-section of the flue pathway, the speed of flow of combustion products decreases, which both increases heat transfer to the surroundings and also leads to the settlement of solid pollutants that

were not captured in the previous part of the flue pathway.

[0032] On the bottom wall 12 of the third part of the flue pathway, a heat-insulating plate is located, the main task of which is to prevent heat transfer between the combustion chamber and the third part of the flue pathway and thereby prevent the heating of combustion products that are already going into the chimney.

[0033] The construction of the fireplace insert according to this invention has achieved increased thermal efficiency and a reduction in the emission of solid pollutants.

[0034] Tests were performed with the following results:

- Thermal efficiency: 83.5 %
- CO concentration at $O_{2ref} = 13 \%$ in dry combustion products: 1217 mg/m^3_N
- Dust concentration at $O_{2ref} = 13 \%$ in dry combustion products: 26 mg/m^3_N

Example 2

[0035] The same construction of the combustion chamber and the flue pathway as disclosed in the Example of embodiment 1 was made in the fireplace.

Reference signs

[0036]

- 1 - back wall of the combustion chamber
- 2 - upper wall of the combustion chamber
- 3 - adjustable slot
- 4 - settling space
- 5 - back wall of the flue pathway
- 6 - combustion product flow directing element A
- 7 - vertical channel
- 8 - combustion product flow directing element B
- 9 - cooling-settling space
- 10 - combustion product flow directing element C
- 11 - wall of chimney flange
- 12 - bottom wall of the third part of the flue pathway
- 14 - outer wall of the third part of the flue pathway
- 15 - opening Z between the first part and the second part of the flue pathway

- 16 - opening Y between the second part and the third part of the flue pathway

Claims

1. Fireplaces and fireplace inserts for solid fuel with increased thermal efficiency and reduced emissions of solid pollutants, containing a combustion chamber and a flue pathway, **characterized in that** there is an adjustable slot (3) between a back wall (1) and an upper wall (2) of the combustion chamber, designed for exhausting combustion products;

- In the first part of the flue pathway, there is a settling space (4) bounded by a part of the back wall (1) of the combustion chamber and a part of a back wall (5) of the flue pathway made of a heat-conducting material, and the settling space (4) contains a combustion product flow directing element A (6) which is located opposite the adjustable slot (3);

- in the second part of the flue pathway, there is a vertical channel (7) formed by the part of the back wall (5) of the flue pathway and a directing element B (8) and the walls (5) of the flue pathway are made of a heat-conducting material;

- in the third part of the flue pathway, there is a cooling-settling space (9) containing a combustion product flow directing element C (10), which is attached to a wall (11) of a chimney flange and its height is smaller than the height of the third part of the flue pathway, and thus between a bottom wall (12) of the flue pathway and the directing element C (10) there is a space X for the flow of combustion products, wherein the directing element C (10) has the shape of a pipe and an outer wall (14) of the third part of the flue pathway is made of a heat-conducting material;

the first part of the flue pathway is connected to the second part of the flue through an opening Z (15) and the second part of the flue pathway is connected to the third part of the flue pathway through an opening Y (16).

2. Fireplaces and fireplace inserts according to claim 1, **characterized in that** the combustion product flow directing element A (6) has a bent shape.
3. Fireplaces and fireplace inserts according to any of claims 1 and 2, **characterized in that** the back wall of the combustion chamber, which is in contact with the surrounding environment, is made of a heat-conducting material.
4. Fireplaces and fireplace inserts according to any of claims 1 to 3, **characterized in that** the combustion

product flow directing element C (10) is adjustable.

5. Fireplaces and fireplace inserts according to any of claims 1 to 4, **characterized in that** the combustion product flow directing element C (10) has the shape of cylindrical pipe.

6. Fireplaces and fireplace inserts according to any of claims 1 to 5, **characterized in that** a heat-insulating plate is placed on the bottom wall of the third part of the flue pathway.

7. A method of increasing the thermal efficiency and reducing emissions of solid pollutants in fireplaces and fireplace inserts for solid fuel disclosed in claims 1 to 6, **characterized in that**

- combustion products from the combustion chamber flow through the adjustable slot into the settling space of the flue, in which their flow is directed downwards, thus combustion products reduce their speed, stay longer in the flue pathway and more intensively transfer heat to the external environment and due to the influence of gravity and change in the velocity vector of solid pollutants from combustion products, these solid pollutants settle down;

- the directed flow of combustion products further flows into the vertical channel, where heat is transferred from combustion products to the external environment through the heat-conducting material of the outer wall of the flue pathway and thus the temperature of combustion products is reduced;

- the flow of combustion products is further directed into the cooling-settling space, in this space it is further directed downwards and heat is transferred from combustion products to the outside environment through the heat-conducting outer wall, and in the lower part, by widening the cross-section of the flue pathway, the speed of flow of combustion products is reduced and thus heat transfer to the surrounding environment is increased and also solid pollutants that were not caught in the previous part of the flue pathway are settled down.

8. The method of increasing the thermal efficiency and reducing emissions of solid pollutants of fireplaces and fireplace inserts according to claim 7, **characterized in that** the largest cross-section of the first part of the flue pathway between the directing element A (8) and the back wall (1) of the flue pathway is formed at the place of bending of the directing element A (8), thus the speed of combustion products is reduced and heat is transferred from combustion products to the surrounding environment and also to the solid pollutants are settled down.

9. The method of increasing the thermal efficiency and reducing emissions of solid pollutants of fireplaces and fireplace inserts according to any of claims 7 and 8, **characterized in that** the adjustable directing element C is set to the optimal position with respect to the draft conditions of the chimney at the installation site. 5
10. The method of increasing the thermal efficiency and reducing emissions of solid pollutants of fireplaces and fireplace inserts according to any of claims 7 to 9, **characterized in that** the heat-insulating plate prevents heat transfer between the combustion chamber and the flue pathway. 10

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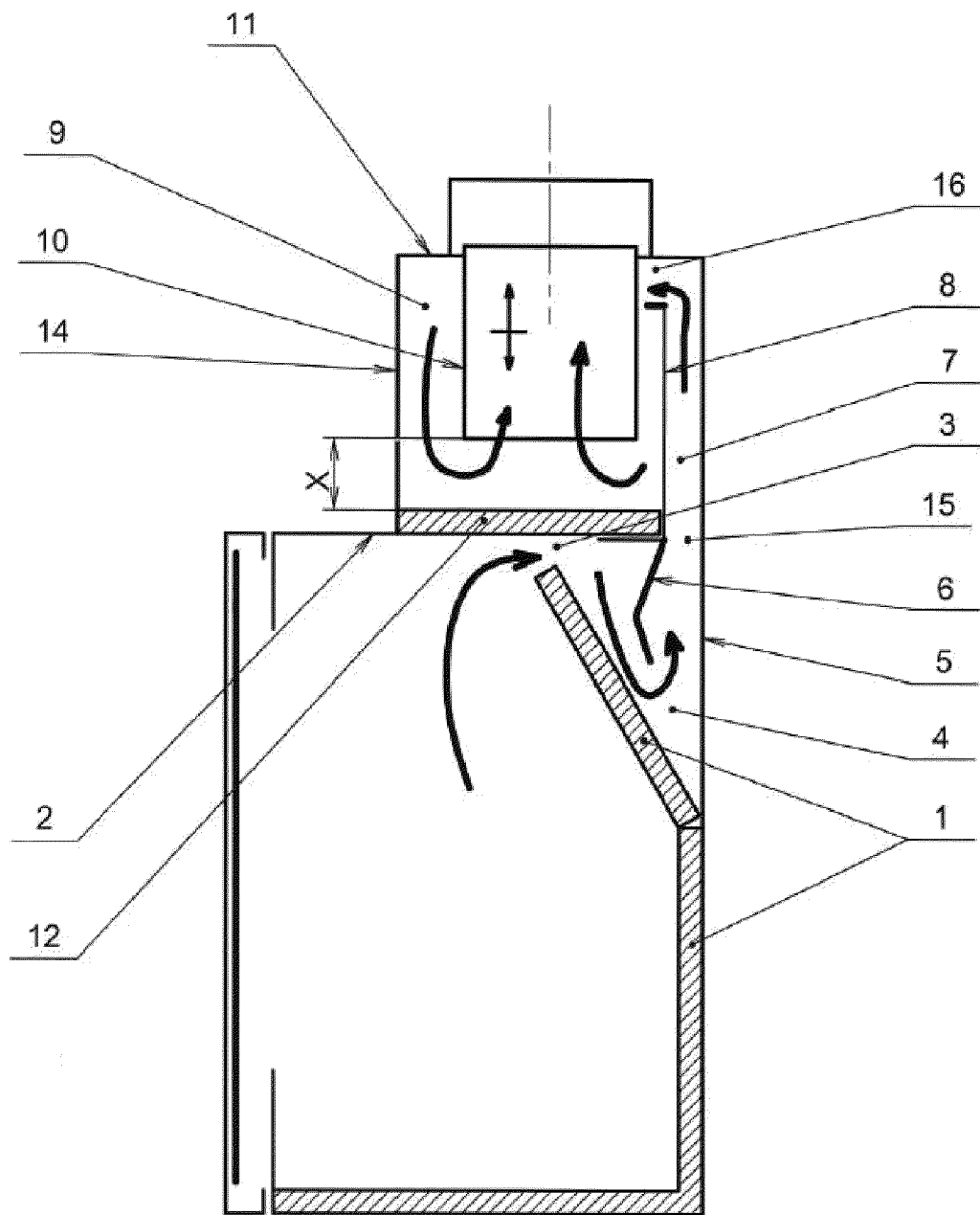


FIG. 1



EUROPEAN SEARCH REPORT

Application Number

EP 23 17 4163

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EPO FORM 1503 03.82 (P04C01)

DOCUMENTS CONSIDERED TO BE RELEVANT			
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			TECHNICAL FIELDS SEARCHED (IPC)
			F24B F23B F23J
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 4 September 2023	Examiner Adant, Vincent
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 23 17 4163

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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04-09-2023

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REFERENCES CITED IN THE DESCRIPTION

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