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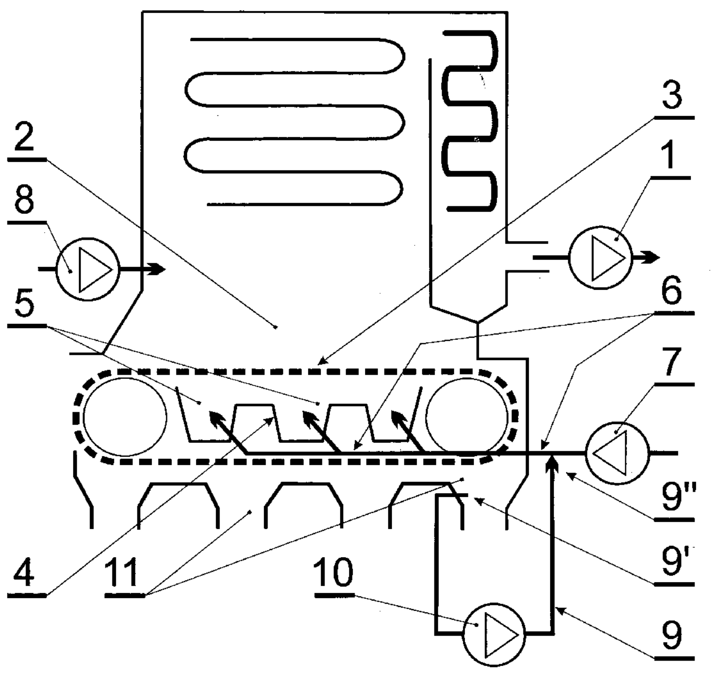

Fig.1

(57) Abstract: A boiler according to the invention contains an additional air channel (9) with an inbuilt fan (10) with adjustable output. The first end (91) of the additional air channel (9) is connected with the under-stoker space (11) located outside of the wind boxes (5) of the under-stoker wind boxes system (4). The other end (9") of the additional air channel (9) is connected with either the space of the channel (6) supplying outside air to the wind boxes (5) or with the atmosphere or with the secondary air channel of the combustion chamber (2). Modernization of the existing boilers consists in installation in the described above method of an additional air channel (9) with an inbuilt fan (10). The method of elimination of uncontrolled leakages in a stoker-fired boiler consist in leading out and air, getting through air gaps, from the under-stoker space of the boiler located outside of the wind boxes (5) to the described above additional air channel (6), wherein current output of the fan (10) built into this channel is proportional to the current difference between temperature of air supplied to the wind boxes (5) and temperature of air in the additional air channel (6).

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Stoker-fired boiler, a method of modernization of stoker-fired boilers and a method of elimination of uncontrolled leakages of air not taking part in the combustion process in a stoker-fired boiler

Technical Field

The subject of the invention is a stoker-fired boiler containing in the combustion zone a movable stoker and an under-stoker wind boxes system, a method of modernization of such a boiler as well as a method of elimination of uncontrolled leakages of air not taking part in the combustion process in the boiler.

Background Art

In the commercial power industry and heating industry, for generating heat stoker-fired boilers are commonly employed, in which the combustion of solid fuel, in particular of coal, takes place on a moving mechanical stoker. Above the stoker there is an combustion chamber with a secondary air channel, whereas under the stoker there is an under-stoker space containing the under-stoker wind boxes system with wind boxes, and a channel supplying the air from the atmosphere to the inside of the wind boxes, which is necessary for the combustion process on the stoker to take place. During utilization of the boiler, in the wind box spaces, the air pressure usually amounts to approximately 200-500 Pa. In the remaining part of the under-stoker space, the pressure is close to the pressure in the combustion chamber, and usually amounts to some -30 to -50 Pa. The appearing differences in pressure between the wind box spaces, the under-stoker space, and the atmosphere cause flows of uncontrolled leakages of air streams through the gaps existing between these spacer, however prober manufacturing of a boiler does not ensure its complete tightness. Sealing of the said spaces in a stoker-fired boiler, meaning the elimination of uncontrolled leakages of air not taking part in the solid fuel combustion process, was subject of many solutions and attempts. From the Polish patent No. 183654 description, it is known that a stoker-fired boiler burner has already been sealed by means of metallic membrane walls. Migration of air streams within a stoker-fired boiler may also be controlled through the appropriate shaping of wind boxes of the under-stoker wind boxes system. An example of a solution for the construction of an under-stoker wind boxes system, reducing the coefficient of excess air, was revealed in Polish patent application number P-355555.

Disclosure of Invention

The purpose of the invention was to reduce uncontrolled flows of air streams within a stoker-fired boiler, negatively affecting its performance.

A boiler according to the invention contains an combustion chamber with a secondary air channel, a movable mechanical stoker, and an under-stoker space containing an under-stoker wind boxes system with wind boxes, as well as a channel supplying the air into the inside of the wind boxes The essence of the invention is that the boiler contains an additional air channel with an inbuilt fan with adjustable output. One end of this additional air channel is connected with the under-stoker space located outside of the wind boxes of the under-stoker wind boxes system.

In other embodiments of the boiler according to the invention, the other end of the additional air channel is connected with either the space of the channel supplying the external air to the wind boxes of the under-stoker wind boxes system, or with the atmosphere or with the secondary air channel of the combustion chamber.

In another embodiment of the boiler according to the invention, in the space of the channel supplying the air from the atmosphere to the inside of the wind boxes as well as in the space of the additional air channel is located at least one air temperature sensor. These sensors may be connected to controller of the fan of the additional air channel.

A method of modernization according to the invention consists in that the under-stoker space of the aforementioned boiler, located outside of the wind boxes of the under-stoker wind boxes system, is connected with the first end of the additional air channel having an inbuilt fan with adjustable output.

In other embodiments of the method of modernization, the other end of the additional air channel is connected with either the space of the channel supplying the air to the wind boxes of the under-stoker wind boxes system, or with the atmosphere or with the secondary air channel of the combustion chamber.

In another embodiment of the the method of modernization, in the space of the channel supplying the air from the atmosphere to the inside of the wind boxes, as well as in the space of the additional air channel is located at least one air temperature sensor. These sensors may be connected to the controller of the fan of the additional air channel.

The method of elimination of uncontrolled air leakages according to the invention consists in leading out and air from the under-stoker space of a boiler, located outside of the wind boxes of the under-stoker wind boxes system, to an additional air channel having an inbuilt fan with changeable output. Current output of this fan is proportional to the current difference between temperature of air supplied to the wind boxes, and the temperature of air in the additional air channel.

In other embodiments of the method of elimination of uncontrolled air leakages, the air led out to the additional air channel is either supplied to the wind boxes of the under-stoker wind boxes system, or is led out further into the atmosphere, or supplied to the secondary air channel of the combustion chamber of the boiler.

The invention reduces the amount of air coming through the gaps and combining with the combustion fumes, giving in consequence a reduced coefficient of excess air in the fumes. This results in a reduction of a physical loss in the fumes, which also means the increase of boiler performance, usually by about 2 to 5%, depending on its technical condition, changes of the load, quality of the combustion charge, and proper maintenance and operation. The application of the invention also reduces the consumption of electric power by the components of the boiler by approximately 10-20%. As a result of general reduction of the amount of fumes removed from the boiler, the load of the extractor fan is smaller, and the consumption of energy by the fan of the additional air channel is balanced by limited energy consumption by the wind boxes air fan. A beneficial feature of the invention is also a short time needed for the modernization of the boiler, and a low cost of such modernization that amounts to ca. 10% of the cost of replacement of the under-stoker wind boxes system.

It unexpectedly appeared that a basic advantage of the invention is significant reduction of dust emission (20-70%), which gives hope for the possibility of meeting the requirements of future emission standards without installation of expensive electrostatic dust removers (dedusters). It also unexpectedly appeared that in the operation of the boiler with the invention being employed, emission of carbon oxide (CO) is reduced by 40-80%. This makes it possible not to equip boilers with secondary air fans, and reduces consumption of electricity.

Brief Description of Drawings

The invention has been shown in a drawing, presenting schematic vertical cross sections of a stoker-fired boiler, whereas fig. 1. presents a boiler with the first variant of an additional air channel, fig. 2 presents a boiler with the second variant of this channel, and fig. 3 presents a boiler with the third variant of such a channel.

Mode for Carrying Out the Invention

A typical stoker-fired boiler has a fume zone with a fume extractor fan 1, and a burner zone. In the burner zone there is an combustion chamber 2, a movable mechanical stoker 3, an under-stoker wind boxes system 4 with wind boxes 5, and a channel 6 supplying the air from the atmosphere to the inside of the wind boxes 5 by means of a wind boxes air fan 7. The combustion chamber 2 has a secondary air channel powered by a fan 8. The boiler according to the invention has an additional air channel 9 with an inbuilt fan 10 with adjustable output. One end 9' of the additional air channel 9 is connected with the under-stoker space 11 located outside of the wind boxes 5 of the under-stoker wind boxes system 4. The other end 9" of the additional air channel 9 may be connected with either the space of channel 6 supplying external air to the wind boxes 5 of the under-stoker wind boxes system 4, or with the atmosphere or with the secondary air channel of the combustion chamber 2. Through controlling the output of the fan 10, an appropriate amount of air deriving from uncontrolled leakages is removed from the under-stoker zone 11, and directed to a selected place via the additional air channel 9. Output of the fan 10 may be controlled manually, whereas it is beneficial to use for this purpose the knowledge of air temperature in the space of channel 6 supplying it from the atmosphere to the inside of the wind boxes 5, and temperature of the air in the space of the additional air channel 9. In order to do so, in these places at least one air temperature sensor (not shown in the drawings) should be placed. For typical stoker-powered boilers, the difference between the temperature of wind boxes air stream in the channel 6, and temperature of air stream in the additional air channel 9 not exceeding 5°C shows that through channel 9 flows only the air coming from uncontrolled leakages to the under-stoker space. The difference in temperatures amounting to 5 to 10°C constitutes information that in the additional air channel 9 there also is the air deriving from uncontrolled leakages taking place through the section of the stoker 3 on which the combustion process no longer takes place or takes place into a limited extent. In this case, uncontrolled leakages take place towards the bottom part of the combustion chamber 2, and their reception has positive effects on the physical loss in the fumes. The difference in temperature exceeding 10°C constitutes information that into the channel 9 additionally flow some of the fumes from the combustion chamber 2 without resulting in a physical loss in the fumes. These dependencies allow for automation of the adjustment of output of the fan 10, through connecting of the said temperature sensors to the fan controller, and the application of the difference between the temperatures measured by means of these sensors as a control parameter. It unexpectedly appeared that with small loads of the boiler, amounting to for instance 10-20% of the nominal load, the amount of air coming from the gaps is sufficient to conduct the process of combustion. In such a situation, when there is no possibility to isolate the channel 6 from the atmosphere, the wind boxes air fan 7 stops supplying air for the combustion process and only starts to block the out-flow of air from the boiler. Elimination of air coming through the gaps from the stream of fumes in most cases causes the situation that the natural pull of the chimney suffices to ensure the appropriate negative pressure in the combustion chamber 2, causing purposelessness of operation of the fumes extractor fan 1. However, according to the mandatory regulations, boiler operation without an extractor fan 1 is not permitted. A solution to this problem may be operation with lower pressure value (e.g. -50 to -80 Pa in the combustion chamber 2), and limitation of output of the extractor fan 1. Very important for proper utilization of the boiler appeared to be the point of connection of the space of the channel 6 supplying wind boxes air with the space of the additional air channel 9. Connection at the point which causes the situation that most of the air supplied by the fan 10 reaches the front wind boxes 5 is unbeneficial for functioning of the boiler, particularly with the aforesaid temperature difference exceeding 10°C, because this means that an additional stream of air is supplied with a lower oxygen content. The same stream of air directed to the last operating wind boxes 5 positively affects the parameters of boiler operation, also with the temperature difference exceeding 10°C. This is connected with low intensity of the combustion process in this part of the stoker, meaning at the same time lower demand for oxygen. It unexpectedly appeared that connecting of the under-stoker space 11 through an additional air channel 9 with the atmosphere does not require changes of the insofar applied operation of the boiler (manual or automated). With the under-stoker space 11 connected with the channel 6 or the secondary air channel of the combustion chamber 2, the mutual interaction of the streams of air, in particular with the temperature difference exceeding 5°C, changes the insofar existing course of the combustion process, causing the need for measuring the streams of air and changing the boiler control algorithms. However, economic and ecological benefits resulting from lower electricity consumption, and the use of heat of the stream of air from the gaps, justify additional outlays incurred on the implementation of this solution, instead of a simpler to control connection of the under-stoker space 11 with the atmosphere. It also unexpectedly appeared that the application of the invention gives additional operation benefits. Connecting of the first wind box separated from the stream of wind boxes air with the under-stoker space allows boiler operators to control the distance of the point of coal ignition on the stoker from the slide gate and the front part of the boiler structure. Similarly, connecting of the last non-operating wind boxes with the under-stoker space after prior separation from the stream of wind boxes air reduces uncontrolled leakages from the wind boxes space to the combustion chamber.

According to the invention, it is possible to build new boilers, as well as quickly, cheaply and effectively modernize the existing ones. For example, modernization of a popular boiler type WR-10 entails installation of an additional air channel 9 with a centrifugal fan type WWOax-50 (made by Owent Olkusz) equipped with a 5.5 kW motor, whose rotation speed is controlled by means of a frequency converter. With manual control of this fan, decrease of stream of air supplied to the boiler was obtained by 6000m^3/h on average, with the boiler load within 30 to 80%. The application of both fans type WWOax-50 for modernization of a double-stoker boiler type WR-25 with the same manner of control of the fans caused a situation that within the load range of 40 to 80%, the excess air coefficient in the fumes dropped from the level of 2.0–2.5 to approximately 1.4-1.7. Temperature of combustion fumes after the boiler was reduced by 15 to 20°C, dust content in theses fumes stream was reduced by 20 to 70% and content of carbon oxide (CO) was reduced by 40-80%.

Patent claims

1. A stoker-fired boiler having a combustion chamber (2) with a secondary air channel, movable mechanical stoker (3), and the under-stoker space (11) containing an under-stoker wind boxes system (4) with wind boxes (5), as well as a channel (6) supplying the air from the atmosphere to the inside of the wind boxes (5), **characterized in that** it contains an additional air channel (9) with an inbuilt fan (10) with adjustable output, wherein the first end (9') of the additional air channel (9) is connected with the under-stoker space (11) located outside of the wind boxes (5) of the under-stoker wind boxes system (4).

2. The boiler according to claim 1, **characterized in that** the other end (9") of the additional air channel (9) is connected with the space of the channel (6) supplying outside air to the wind boxes (5) of the under-stoker wind boxes system (4).

3. The boiler according to claim 1, **characterized in that** the other end (9") of the additional air channel (9) is connected with the atmosphere.

4. The boiler according to claim 1, **characterized in that** the other end (9") of the additional air channel (9) is connected with the secondary air channel of the combustion chamber (2).

5. The boiler according to any one of claims 1 to 4, **characterized in that** in the space of the channel (6) supplying the air from the atmosphere to the inside of the wind boxes (5) as well as in the space of the additional air channel (9) is located at least one air temperature sensor.

6. The boiler according to claim 5, **characterized in that** the air temperature sensors are connected to controller of the fan (10) of the additional air channel (9).

7. A method of modernization of a stoker-fire boiler containing a combustion chamber (2) with a secondary air channel, a movable mechanical stoker (3), and an under-stoker space (11) containing an under-stoker wind boxes system (4) with wind boxes (5), as well as a channel (6) supplying the air from the atmosphere to the inside of the wind boxes (5), **characterized in that** the under-stoker space (11) located outside of the wind boxes (5) of the under-stoker wind boxes system (4) is connected with the first end (9') of the additional air channel (9) having an inbuilt fan (10) with adjustable output.

8. The method of modernization of a boiler according to claim 7, **characterized in that** the other end (9") of the additional air channel (9) is connected with the space of the channel (6) supplying the outside air to the wind boxes (5) of the under-stoker wind boxes system (4).

9. The method of modernization of a boiler according to claim 7, **characterized in that** the other end (9") of the additional air channel (9) is connected with the atmosphere.

10. The method of modernization of a boiler according to claim 7, **characterized in that** the other end (9") of the additional air channel (9) is connected with the secondary air channel of the combustion chamber (2).

11. The method of modernization of a boiler according to any one of claims 7 to 10, **characterized in that** in the space of the channel (6) supplying the air from the atmosphere to the inside of the wind boxes (5) as well as in the space of the additional air channel (9) is located at least one air temperature sensor.

12. The method of modernization of a boiler according to claim 11, **characterized in that** the air temperature sensors are connected with controller of the fan (10) of the additional air channel (9).

13. A method of elimination of uncontrolled leakages of air not taking part in the combustion process in a stoker-fired boiler containing a combustion chamber (2), movable mechanical stoker (3), and the under-stoker space (11) containing an under-stoker wind boxes system (4) with wind boxes (5), as well as a channel (6) supplying the air from the atmosphere to the inside of the wind boxes (5), **characterized in that** the air is led out from the under-stoker space (11) located outside of the wind boxes (5) of the under-stoker wind boxes system (4) to the additional air channel (9) with an inbuilt fan (10) with adjustable output, wherein current output of this fan (10) is proportional to the current difference between temperature of air supplied to the wind boxes (5) and temperature of air in the additional air channel (9).

14. The method of elimination of uncontrolled leakages according to claim 13, **characterized in that** the air led out to the additional air channel (9) is supplied to the wind boxes (5) of the under-stoker wind boxes system (4).

15. The method of elimination of uncontrolled leakages according to claim 13, **characterized in that** the air led out to the additional air channel (9) is led out further to the atmosphere.

16. The method of elimination of uncontrolled leakages according to claim 13, **characterized in that** the air led out to the additional air channel (9) is supplied to the secondary air channel of the combustion chamber (2).

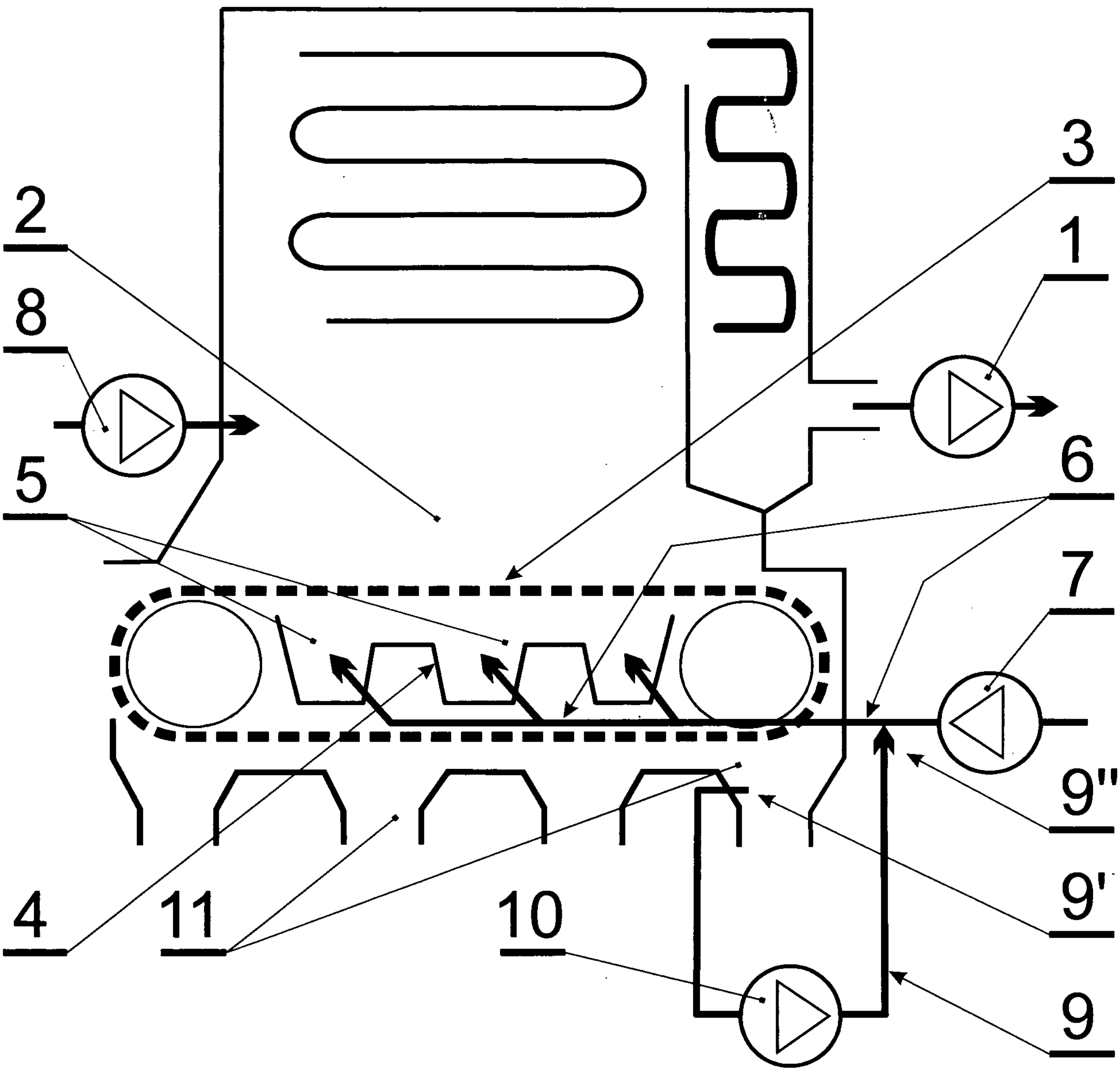

Fig.1

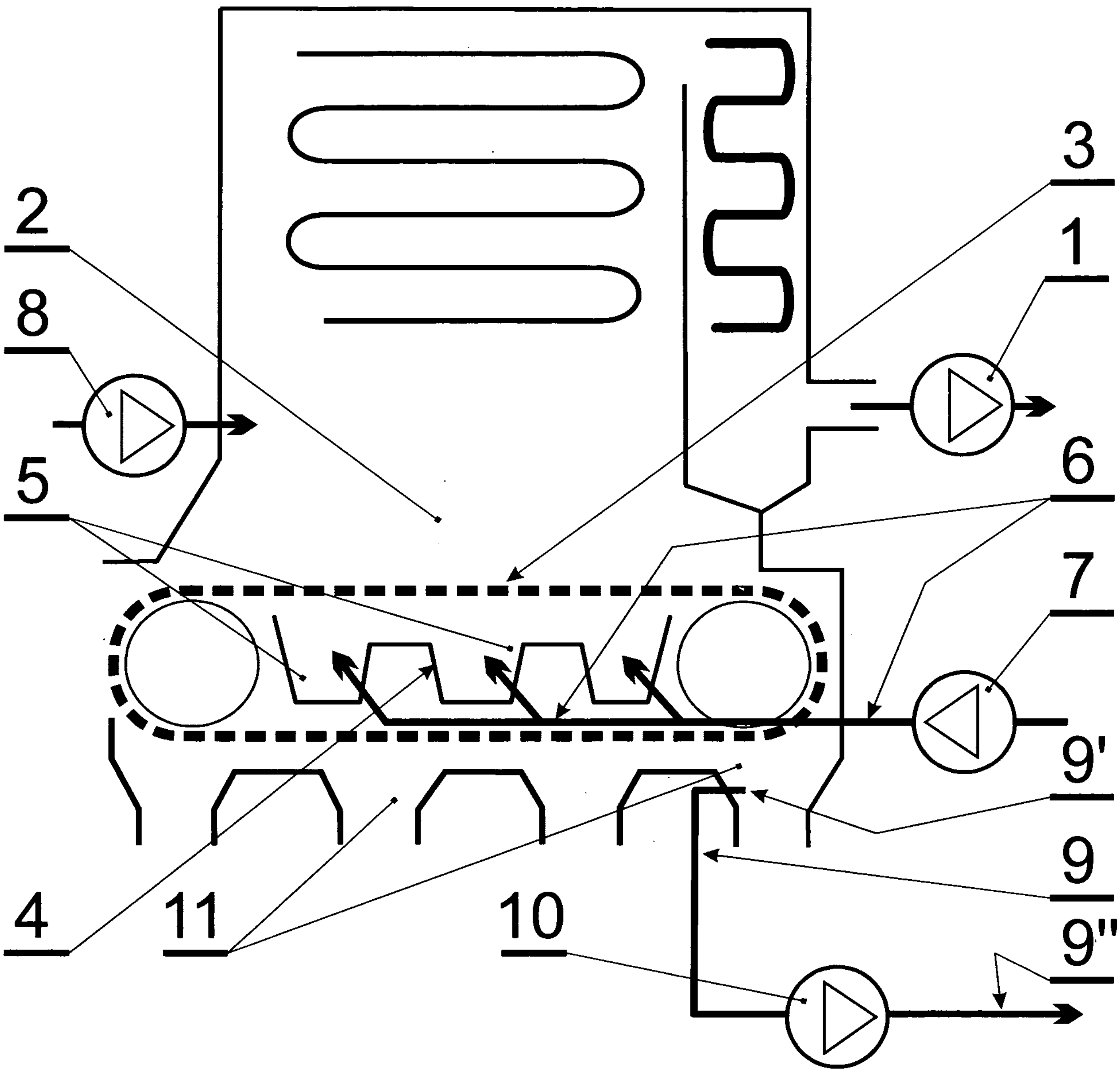

Fig.2

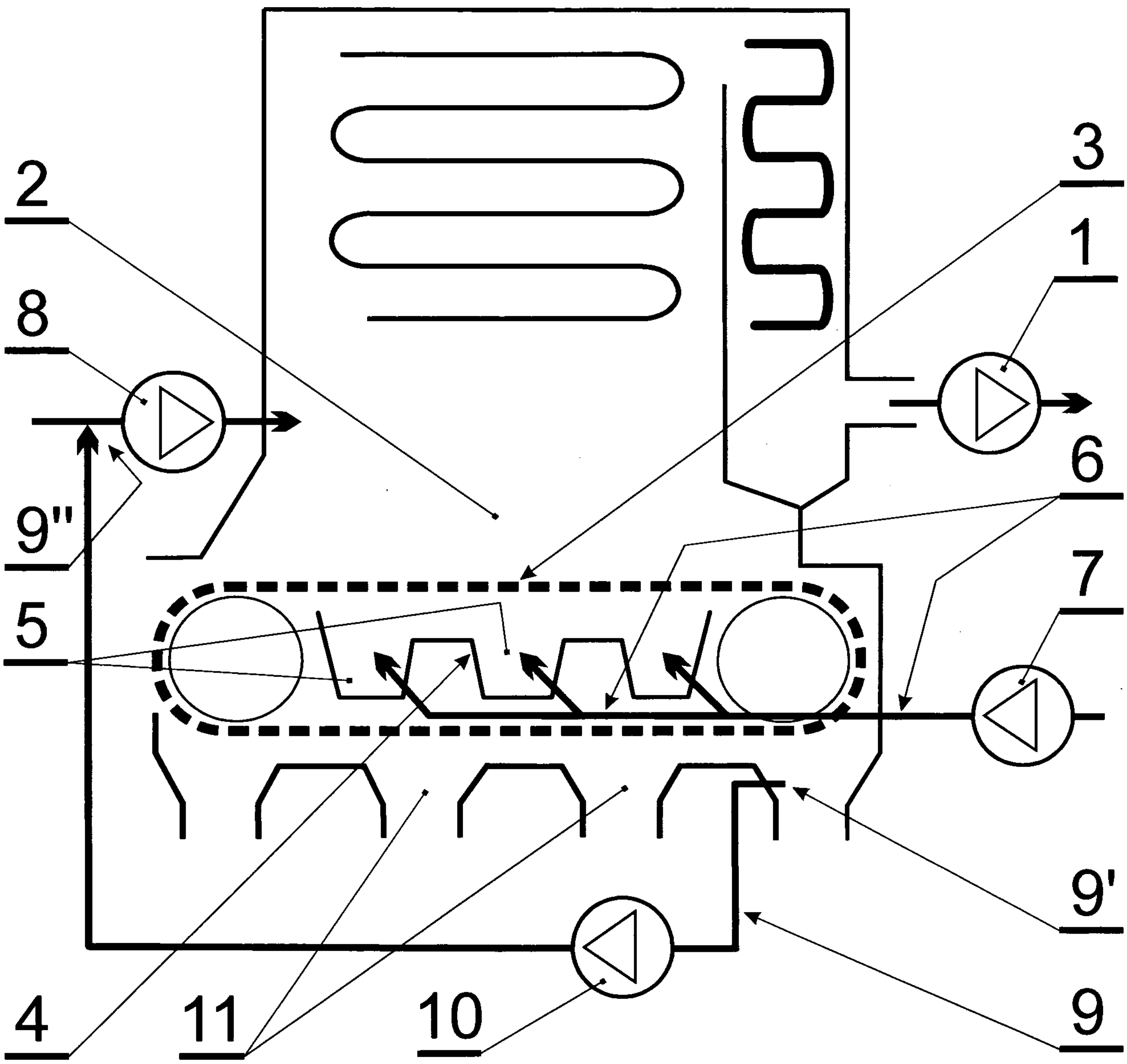

Fig.3