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(71) Applicant: **Lorenz, Klaus**
780 41 Gagnef (SE)

(72) Inventor: **Lorenz, Klaus**
780 41 Gagnef (SE)

(74) Representative: **Mrazek, Werner**
Aros Patent AB
P.O. Box 1544
751 45 Uppsala (SE)

(54) **Burner with helicoidal path for combustion products**

(57) The invention relates to a method of discharging products of combustion from a burner pipe (2) of a solid fuel burner (1), whereby combustion gases formed during combustion are passed in and out from the burner pipe in a first direction (A), substantially coinciding with the center axis (C) of the burner pipe, wherein the combustion gases after having left the burner pipe (2) are redirected substantially 180° and are subjected to a helical movement around the outer side of the burner pipe (2) while at the same time being conveyed back in a general second direction (B) along the outer side of the burner pipe (2), simultaneously emitting heat to a surrounding heat absorbing medium.

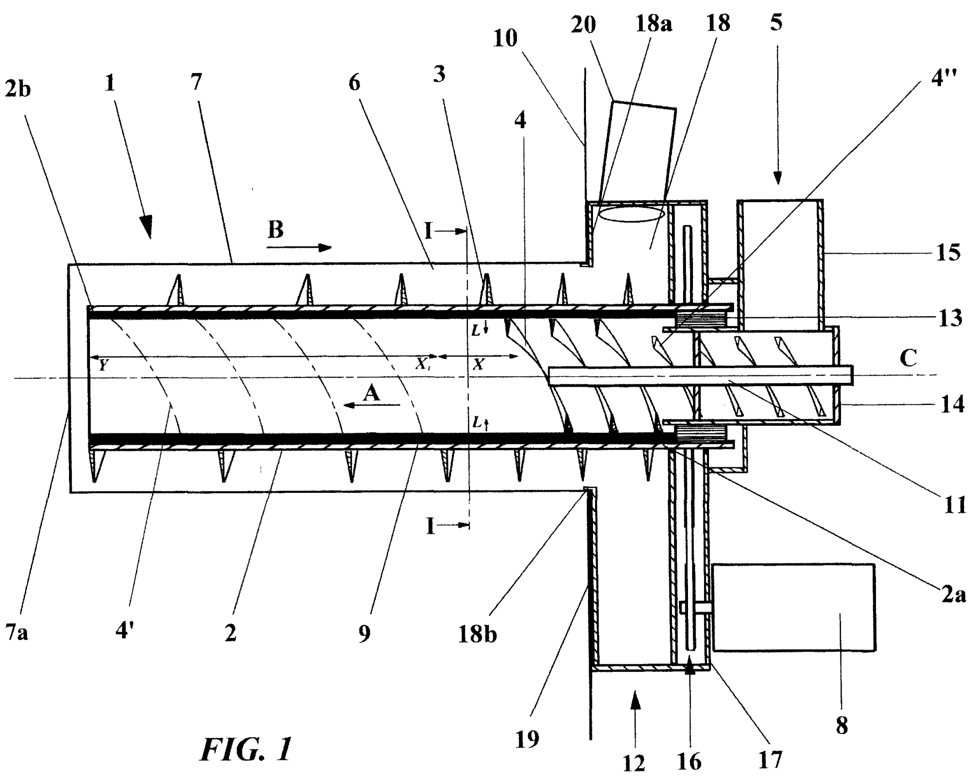

FIG. 1

Description

TECHNICAL FIELD

[0001] The present invention relates generally to the combustion of solid fuel for heating purposes, and specifically relates to a method of discharging products of combustion from a burner pipe of a solid fuel burner, as specified in the preamble of the attached claim 1, a combustion system or installation having a solid fuel burner, as specified in the preamble of the attached claim 6 and a solid fuel burner as specified in the preamble of the attached claim 12.

BACKGROUND

[0002] Burners and other equipment for burning different kinds of solid fuel, predominantly pellets, but also wood chips and to a certain degree also residual materials such as sawdust and certain types of waste, have been developed for a long time within the technical field in question. Said development has basically aimed at improving the burner designs as such for the purpose of theoretically optimizing the combustion of solid fuel, and not at finding new total solutions such as combinations of burner, boiler and possibly accumulator tank that are adapted to each other and that are optimized for the combustion of the type of fuel in question.

[0003] This has lead to the fact that although a very large number of burner designs have been developed, which in many cases have presented very good theoretical properties with regard to the combustion, said burners have with few exceptions been designed for the purpose of being installed in a traditional multi-fuel boiler or oil-fired boiler, as a replacement for the oil burner initially intended for the boiler. This is a bad starting-point when designing a combustion installation or system intended to be employed mainly for burning the type of fuel in question. In practice this approach leads to the fact that such a combination of a novel burner and a traditional boiler will suffer from a number of unfortunate limitations.

[0004] One problem encountered in this connection is the fact that regarding the size and configuration of the combustion chamber and of the heat exchanger surface the traditional boilers are not designed specifically for burning pellets. In particular they are designed having a large water-cooled surface that in practical operation easily leads to an incomplete combustion in combination with for instance a pellet burner. When the burner pipe of the burner is positioned horizontally the incomplete combustion in turn often leads to residual unburned particles accumulating in the boiler. Finally, the combustion residue, that is residual products of combustion in the form of ash, may conventionally be a source of problem, both with regard to the produced amount and to the actual ash-discharge, that is the removal of ash from the combustion chamber or fire.

[0005] As was mentioned above, very little has therefore been done to find total solutions that are specifically directed towards the combustion of solid fuel of the kind in question, and towards the subsequent heat exchange, instead of being compromises in the form of burners adapted to an application in conventional boilers.

SUMMARY OF THE INVENTION

[0006] A basic object of the invention is to find a simple and comparatively very inexpensive method of enabling the production of a combustion installation for solid material that is designed based on the current demands for functionality, compactness and possibility of integrating different heat sources. Expressed otherwise the object is to provide a method of solving the above discussed problems, starting directly from the conditions applicable to the combustion of the fuel in question, instead of the usual adjustment of a traditional combustion installation.

[0007] The invention is based on the insight that a very efficient cooling of the combustion gases in combination with an unprecedented functionality can be obtained by redirecting the combustion gases immediately after they have left the burner, and by passing them back a long path along the outer side of the burner pipe, in a direction opposite the in-feed direction of the fuel. In particular, the invention suggests subjecting the combustion gases to a helical motion around the outer side of the burner pipe while being simultaneously passed back along the outside of the burner pipe, in a direction generally opposite that of the fuel in-feed direction, and emitting heat to a surrounding heat absorbing medium. The burner pipe is caused to rotate and a first feed screw is provided at the outer periphery of the burner pipe, fixed to the burner pipe. In addition to the efficient cooling of the combustion gases this provides for an improved discharge of combustion residue in a very compact design that is very well suited for integration into installations or systems having anything from a very small water-filled jacket or cassette to an accumulator tank, for instance in a heating system designed for several different heat sources.

[0008] In accordance with the embodiments specified in claims 2 and 3 a very efficient and complete combustion may be obtained by subjecting a fuel-air mixture and the combustion gases as well as possible combustion residue to a rotary motion by means of a tangential secondary-air supply and/or by means of a formation on the inner surface of the burner pipe, which also supports the discharge of the combustion gases and combustion residue from the burner pipe.

[0009] According to a further embodiment of the invention, which is specified in claim 4, the combustion gases and the combustion residue is transported back along substantially the entire length of the burner pipe and is diverted from the burner in connection with a first end thereof, where the fuel supply is provided. This creates a possibility of designing an extremely compact unit consisting of an integrated burner and boiler, designed as a cassette that may be installed for instance in an accumulator tank or other water container.

[0010] In accordance with an embodiment of the invention specified in claim 5 the design in accordance with the basic object of the invention is combined with such a dimensioning and insulation of the burner pipe that a substantially complete combustion of the fuel takes place in the burner pipe, which will thereby practically form the burner as well as the heater.

[0011] In accordance with another aspect of the invention, specified in claim 6, a combustion installation of the kind stated in the introduction is provided, which employs the principles of the present invention. In this installation according to the invention, the combustion gas duct is substantially helical and consists of an outer duct wall that surrounds the outer circumference of the burner pipe, that is provided with an end wall at a distance outside one end of the burner pipe, that extends along the outer side of the burner pipe and that is in contact with a heat absorbing medium at its outer side. When the combustion gases have left said end of the burner pipe they are redirected 180° and are thereby lead back along the outer side of the burner pipe while emitting heat to the surrounding heat absorbing medium. The burner pipe is provided with an outer helix forming the helical duct as well as a feed screw is rotatably journalled and is caused to rotate by a drive means, thereby enhancing the discharge of combustion residue.

[0012] Embodiments of this second aspect of the invention are specified in the dependent claims 7-11.

[0013] Yet another aspect of the invention, as specified in claim 12, relates to a solid fuel burner designed in accordance with the basic principles of the invention. According to the invention the burner pipe of the burner is provided with a first feed screw at its outer circumference, said feed screw being rigidly attached thereto. The burner pipe is rotatably journalled and is connected to a drive means for rotating the burner pipe around its longitudinal center axis.

[0014] Embodiments of this last mentioned aspect of the invention are specified in the dependent claims 13-18.

[0015] Other objects, features and advantages of the invention will be readily appreciated upon reading the dependent claims and the below description of exemplifying embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The invention will now be described in detail below, with reference to the accompanying drawings, in which:

Fig. 1 illustrates a longitudinal section through a burner according to the present invention, in an embodiment where it is installed as a cassette in an accumulator tank, and

Fig. 2 illustrates a cross section through the burner illustrated in fig. 1, along the line I-I.

DETAILED DESCRIPTION

[0017] With reference primarily to figure 1 the basic principles of the invention will now be described with the aid of an embodiment thereof. Simultaneously the advantages of the invention over conventional installations will be explained. In both drawing figures the basic principles of the invention are illustrated by means of a very schematically illustrated embodiment.

[0018] Fig. 1 illustrates a longitudinal section through a burner that is generally designated by the reference numeral 1 and that in its illustrated design is intended for burning pellets. However, with small modifications that are not specifically illustrated or described herein the burner may be adapted for burning other solid fuels, such as chips and sawdust.

[0019] The burner 1 is illustrated in fig. 1 in an application for integration into an accumulator tank 10, which is only schematically indicated, or other corresponding water volume. For this application the burner 1 is designed as a unit, such as a cassette that may be inserted into a cavity 6 in the accumulator tank 10. In a manner that will be described more closely below the wall 7 of the cavity 6 in the accumulator tank 10 forms an outer duct wall of a combustion gas duct that leads out from the burner 1 and the inner channel wall of which is formed by the outer side of the burner pipe 2 of the burner 1. An end wall 7a closes the cavity or combustion gas channel 6 inwardly. With this design the effect is achieved that after having left the burner pipe 2 the combustion gases are redirected substantially 180° and are subjected to a helical motion around the outer side of the burner pipe 2, as will be described below. Simultaneously the combustion gases are lead back along the outer side of the burner pipe 2, in a direction B that is generally opposite to an in-feed direction A for fuel, while emitting heat to the surrounding heat absorbing medium in the tank 10.

[0020] In its installed condition the burner pipe 2 extends into the cavity 6, and a forward end 2b thereof ends at a distance from the end wall 7a of the combustion gas duct 6. At a rear end 2a thereof the burner pipe 2 is rotatably journalled in a base unit 12 through appropriate bearings 13. In the embodiment of fig. 1 the configuration of the base unit 12 is illustrated in principle. It shall be obvious though, that the details of the base unit design can be changed and modified to a great extent within the scope of the invention, for adaptation to the application in question.

[0021] The base unit 12 basically consists of a support pipe 14 on which the burner pipe 2 is rotatably journalled. A centre -pipe 11 coinciding with the longitudinal centre axis C of the burner 1 is provided in the interior of the support pipe 14, and serves to supply air, preferably primary air, to the combustion/gasification zone X of the burner 1. Furthermore, the support pipe 14 communicates with a fuel supply, generally designated by the reference numeral 5, through an infeed pipe 15. Thus, the fuel supply 5 is a gravity feed which, when required, may be supplemented by an active feeding by means of a screw or the like in the support pipe 14. An example of this is indicated in fig. 1 and is described more closely below. The fuel is fed from a storage container, not shown, for the type of fuel in question, into the support pipe 14 and further into the burner pipe 2. The fuel feed in the burner pipe is then performed in a manner described below.

[0022] A drive motor 8 is also supported by the base unit 12 to transmit rotation to the burner pipe 2 through a transmission 16 provided in a transmission housing 17. As is indicated in fig. 1, the transmission is suitably of the type including an endless chain or belt passed over corresponding wheels attached to the output shaft of the motor 8 and to the outer side of the burner pipe 2 respectively, but other types of appropriate transmissions may also be employed.

[0023] The transmission housing 17 is built together with a connecting portion 18, a connecting wall 18a of which is intended to form a fluid tight connection with the outer wall of the accumulator 10, surrounding the cavity 6. For this purpose the connecting wall 18a is formed having a central opening surrounded by a flange 18b that is intended to be inserted into the cavity 6. The base unit is then connected to the accumulator tank 10 by means of suitable connecting means, not shown, for instance in the shape of bolt connections. In order to provide the fluid-tight connection the connecting wall 18a and/or the connecting flange 18b are at their outer side provided with a suitable sealing material, as is indicated at 19.

[0024] At its upper part the connecting portion 18 is connected to a combustion gas pipe 20 through which the combustion gases are lead out to the atmosphere. Through the measures that are suggested according to the invention and that are described more closely below, the combustion gas temperature has been lowered so substantially in this stage that, if so desired, no chimney is required. At its lower part the connecting portion 18 is furthermore formed having an ash-collecting pocket 21, see fig. 2. Combustion residue that is discharged from the burner 1 and the cavity 6 in the manner described below, is collected in said pocket 21 so that it may be removed through a door that is not illustrated in the drawings,

[0025] The actual burner pipe 2 shall now be described. As is clear from the above, the burner pipe 2 is rotatably supported on the support pipe 14 with its rear or first end 2a. In its installed condition the burner pipe 2 is inserted into the cavity 6 in the accumulator tank 10, so that its second or forward end terminates at a relatively short distance from the end wall 7a of the cavity 6. In the illustrated embodiment the burner pipe 2 basically consists of a cylindrical steel pipe that at its inner surface may be provided with a thermal insulation 9 preferably consisting of a ceramic material. The fact that the combustion gases are passed on the outside of the burner pipe 2, creates a kind of "insulation zone" between the combustion in the burner pipe 2 and the comparatively cold water in the tank 10. This may also be expressed so that the combustion zone is "insulated"- compared to a situation where it was directly surrounded by air or water - which results in a higher temperature in the afterburning zone X_1 - Y. By virtue of this insulation 9, or alternatively solely by the insulation of the burner pipe achieved by the surrounding combustion gas duct, and a corresponding dimensioning of the burner pipe 2 the gasification of the fuel as well as the afterburning may take place in the burner pipe 2, which does thereby also serve as a heater from which the combustion gases may be discharged directly to the combustion gas duct formed in the cavity 6.

[0026] In this connection it shall also be mentioned that within the scope of the invention it is conceivable to rotatably journal the burner pipe 2 directly in the cavity 6, that is without any specific bearings. Naturally, this can be done under the presumption that problems relating to friction and wear can be solved in the application in question.

[0027] Normally the infeed of the fuel is accomplished by the above mentioned gravity feed, possibly in combination with a separate feed screw. However, fig. 1 illustrates an example of a possible further alternative. A continuos inner helix 4 may be provided on the inner side of the burner pipe 2, extending substantially from the first end 2a of the burner pipe to the combustion zone X. This inner helix 4 forms a feed screw serving to continuously feed fuel into and through the burner pipe 2, up to the combustion zone X, when the burner pipe is rotated. As is indicated in fig. 1, it may be appropriate to perform the infeed of fuel from the area below the infeed pipe 15 and up to the rear end 2a of the burner pipe 2 by forming the inner feed screw 4 having an infeed portion 4". In the illustrated embodiment this infeed portion is formed having a smaller diameter than the main portion of the feed screw 4 and is extended in a cantilevered manner into the support pipe 14, almost up to the end wall thereof. In another embodiment the infeed portion 4" may be formed having substantially the same diameter as the main portion.

[0028] As is indicated with dash-dot lines in fig. 1, it is also possible to achieve a very favorable influence on the combustion by providing a formation 4', for instance having a helical shape, in the afterburning zone X_1 - Y, at the inner side of the insulation 9. This provides for a continuos "overturning" of the fuel such that new surfaces of unburned portions thereof are continuously exposed, thereby obtaining a very clean combustion. Such a helical shape 4' may also contribute to the discharge of the combustion gases and possible combustion residue, that is ash, from the burner pipe 2, at Y. Thereby, the formations 4', possibly in combination with a later described tangential secondary air supply, would serve the purpose of generating a rotating air/fuel vortex inside the burner pipe, so that unburned particles will be present in a hot environment along such a long and helical path that complete combustion is achieved.

[0029] An outer uninterrupted helix 3 is provided on the outer side of the burner pipe 2, likewise extended substantially from the first end 2a to the second end 2b thereof. This outer helix 3 forms an outer feed screw serving the purpose of discharging the combustion gases formed during combustion, upon rotation of the burner pipe 2. The combustion gases are discharged along a helical path from the forward end 2b of the burner pipe 2 and to the connecting portion 12 and further on to the combustion gas pipe 20. Moreover, the outer feed screw 3 serves the purpose of discharging the combustion residue that is brought out from the forward end 2b of the burner pipe 2 and falls down onto the bottom of the substantially horizontally provided cavity 6. This combustion residue, essentially in the form of ash, is pushed along the bottom of the cavity 6 by the outer feed screw, in a direction towards the rear end 2a of the burner pipe 2, until it falls down into the ash-collecting pocket 21, from which it can be removed at regular intervals.

[0030] In the illustrated embodiment the outer feed screw 3 is formed having a differing pitch along its length, as is clear from fig. 1. Here, the outer feed screw 3 has a decreasing pitch as seen in a direction from the forward end 2b of the burner pipe 2 towards its rear end, and this configuration is preferred in most cases, since the combustion gases have a higher temperature and thereby a larger volume closer to the forward end of the burner pipe. The inner helical formation 4'may likewise have a variable pitch.

[0031] In case an inner feed screw 4 is employed this may have a constant pitch that in itself is varied depending upon the specific application, the employed fuel etc., since the pitch of the feed screw in the rear area of the burner pipe 2 would determine the fuel feed rate at a fixed rotational speed of the burner pipe 2, and thereby would determine the effective output of the boiler.

[0032] The operation of the illustrated embodiment of the invention will now be briefly described. Fuel is introduced from the storage container, not shown, to the burner pipe 2 through the infeed pipe 15 and the support pipe 14. The fuel is fed into the burner pipe, in a direction towards the combustion zone X. In this connection it shall be emphasized that the speed of the motor 8 may be regulated by means of appropriate control equipment that forms no part of the present invention. However, in the case where the burner is installed in an accumulator tank the control equipment may be a simple on-off control, since the water volume of the tank serves as a buffer and provides for reasonable operating times. In other applications it may be justified to employ a more sophisticated control providing a continuos adjustment of the effective output to the particular demand.

[0033] In the indicated manner primary air is supplied at the beginning of the combustion zone X through the central pipe 11. In a manner not specifically illustrated, secondary air is supplied at the arrows designated by L in the combustion zone, preferably through channels in the burner pipe 2. The secondary air may advantageously be supplied in a tangential direction - with respect to the circumference of the burner pipe - in order to cause rotation of the fuel-air mixture in the burner pipe 2.

[0034] After the combustion zone X and the afterburning zone X_1 - Y the combustion gases and ash formed during combustion are brought out from the burner pipe 2 at Y and enter the cavity 6 in the accumulator tank 10. This cavity 6 together with the outer side of the burner pipe 2 and the outer feed screw 3 formed there, form a combustion gas duct as well as an ash discharge means or ash conveyor. Thus, through the rotation of the burner pipe and thereby also of the screw 3, the combustion gases will be passed along a long helical path around the wall 7 of the cavity so that they will be maximally cooled by the extended contact with the wall 7 in turn being cooled by the water or a corresponding medium in the tank 10. This means that when the combustion gases reach the connecting portion 18 and the combustion gas pipe 20 they have been cooled to such a low temperature that it does not present any problem to reach a solution where no chimney is required for discharging the combustion gases to the atmosphere, provided that the dimensioning and adjustment or setting is correct. As examples of such dimensioning and setting can be mentioned the dimensioning/control of the primary and secondary air blower, the selection of the pitch of the outer screw 3 or the radial size of the combustion gas duct, that is the spacing between the burner pipe 2 and the outer wall 7. Simultaneously the ash and other possible combustion residue collecting on the bottom of the cavity 6, is discharged therefrom by the outer screw 3, to finally fall down into the ash collecting pocket 21. In this connection, it shall be emphasized that in the drawing figures the distance between the outer feed screw 3 and the wall 7 of the cavity 6 has been exaggerated for the purpose of clarifying the illustration, and that the distance is in reality essentially smaller.

[0035] In certain applications, especially in combination with an accumulator tank, where the temperature of the combustion gases might be lowered so much that condensation within the combustion gas duct would cause a serious problem, the pitch of the first outer helix 3 as well as the distance between the burner pipe 2 and the duct wall 7 may be varied so that the desired combustion gas temperature is achieved.

[0036] On the other hand, using corrosion resistant materials in combination with the provision of an outlet for condensate, an efficient condensing burner may be designed by means of the invention.

[0037] In view of the above description it is now clear that the characterizing feature of the invention, in its basic scope, is the fact that the supply of fuel and the discharge of combustion gases as well as the removal of ash is carried out generally from the same area of the installation, in mutually opposite directions. Hereby, the burner may be designed to be very compact so that it is very well suited for a direct installation in a water volume, the wall of which contributes to forming the combustion gas duct. The burner may easily be installed in an accumulator tank as a direct substitution for an electric heating element. In this manner is provided a possibility of performing a very simple connection of the combustion gas discharge as well as of the fuel supply.

[0038] Another advantage that is achieved by virtue of the design comprising one single moveable part in the form of the rotary burner pipe being provided with outer and inner helixes, is a very simple and service friendly design. Such a design is well suited for being produced as a cassette that may be readily installed and replaced.

[0039] The feeding of the combustion gases in the helical combustion gas duct formed by the flange is achieved through an appropriate setting and control of an appropriate separate blower or by means of the blower performing the supply of primary and secondary air.

[0040] Furthermore, the invention is very well suited for an application in systems integrating several heat sources and requiring an accumulation volume, such as a combination system utilizing solar heat, solid fuel heating, preferably with pellets, and night tariff.

[0041] In an alternative use of the invention a combustion installation is provided having minimal dimensions. This is accomplished by inserting the burner 1 into a cavity of a water cassette that may have a minimal water volume of from for instance 10 liters and upwards. In the example of a water volume of 10 liters the burner pipe 2 would be jacketed by a water gap of approximately 2 cm and would in practice function as a flow-through heater. This solution may well be applied to anything from a tiled stove or an iron stove having a thin water jacket, to a boiler having a small water volume and up to a cassette in an accumulator tank.

[0042] It will be understood by those skilled in the art that various modifications and changes may be made to the present invention without departure from the scope thereof, which is defined by the appended claims.

Claims

1. A method of discharging products of combustion from a burner pipe (2) of a solid fuel burner (1), whereby combustion gases and combustion residue formed during combustion are conducted in and passed out from the burner pipe in a first direction (A), substantially coinciding with the center axis (C) of the burner pipe, whereby the combustion gases after having left the burner pipe, (2) are conveyed in the general second direction (B), back along the outer side of the burner pipe (2) while emitting heat to a surrounding heat absorbing medium, **characterized in that** the combustion gases at the same time as they are redirected substantially 180° are subjected to a helical motion around the outer side of the burner pipe (2) by means of an outer helix (3) fixed to its outer circumference and in that combustion residue after having left the burner pipe, (2) are conveyed back along the outer side of the burner pipe (2) in the general second direction (B) through rotation of the burner pipe (2) and the outer helix (3) forming a first feed screw.

2. A method according to claim 1, **characterized in that** initially an fuel/air mixture and then the combustion gases and possible combustion residue are set in a rotary motion in the burner pipe (2) by means of a tangential secondary air supply, thereby also supporting the discharge of the combustion gases and combustion residue from the burner pipe (2) in said first direction (A).

3. A method according to claims 1 or 2, **characterized in that** initially an fuel/air mixture and then the combustion gases and possible combustion residue are set in a rotary motion in the burner pipe (2) by the provision of a formation (4') at the inner surface of the burner pipe (2), thereby also supporting the discharge of the combustion gases and combustion residue from the burner pipe (2) in said first direction (A).

4. A method according to any of claims 1-3, **characterized in that** the combustion gases and the combustion residue is conveyed back in the general second direction (B) along substantially the full length of the burner pipe (2) and is discharged from the burner (1) in connection with a first end (2a) thereof, at which the fuel supply (5) to the burner is provided.

5. A method according to any of claims 1-4, **characterized in that** the burner pipe (2) is dimensioned having such a diameter and length and is insulated such that an essentially complete combustion of the fuel takes place in the burner pipe, which does thereby also form the combustion chamber of the burner.

6. A combustion installation having a burner (1) for solid fuel, consisting of a burner pipe (2) with a first end (2a) thereof being adapted for connection to a fuel supply (5) and with a second end (2b) thereof communicating with a combustion gas duct (6) consisting of an outer duct wall (7) that surrounds the

outer circumference of the burner pipe (2), that has an end wall (7a) provided at a distance outside the second end (2b) of the burner pipe, that is extended along the outer side of the burner pipe (2) and that at its outer side is in contact with a heat absorbing medium, whereby the combustion gases, after having left the second end (2b) of the burner pipe (2) are conveyed back along the outside of the burner pipe (2) while emitting heat to the surrounding heat absorbing medium, **characterized in that** the burner pipe (2) is provided with a firmly attached outer helix (3) at its outer circumference, said first outer helix forming a substantially helical combustion gas duct (6) through which the combustion gases are fed from the burner pipe in a helical path, and in that the burner pipe (2) is rotatably journalled, whereby combustion residue discharged from the second end (2b) of the burner pipe (2) are fed by the outer helix (3) as a first feed screw towards the first end (2a) of the burner pipe as the burner pipe is rotated by a drive means (8).

7. A combustion installation according to claim 6, **characterized in that** the burner pipe (2) has a generally cylindrical shape and is provided substantially horizontally, centered in the combustion gas duct (6).

8. A combustion installation according to claim 6 or 7, **characterized in that** the outer helix (3) forming the first feed screw is designed having a varying pitch and in that the pitch decreases stepwise or gradually in a direction from the second end (2b) of the burner pipe (2) towards its first end (2a).

9. A combustion installation according to any of claims 6-8, **characterized in that** in an afterburning zone (X_1-Y) the burner pipe (2) is provided with a formation (4') at its inner surface, said formation serving to set a fuel-air mixture and the combustion gases as well as possible combustion residue in a helical motion and also to support the discharge of the combustion gases and the combustion residue from the burner pipe (2).

10. A combustion installation according to any of claims 6-9, **characterized in that** the outer wall (7) of the combustion gas duct (6) is formed in a storage unit (10) for a heat absorbing medium and in that he burner (1) is designed as a unit, in the form of a cassette being insertable into and mountable to the storage unit (10), whereby, in the installed condition, the combustion gas duct (6) extends along substantially the full length of the burner pipe (2) and whereby the burner (1) in connection with the first end (2a) of the burner pipe is provided with a base unit (12) being sealed against the storage volume and communicating with the combustion gas duct (6) for discharging cooled combustion gases and/or combustion residue from the combustion gas duct.

11. A combustion installation according to claim 8, **characterized in that** the burner pipe (2) forms the combustion chamber of the burner (1), by being designed having such a relationship between its length and its cross section and by being provided with such an insulation that an essentially complete combustion of the fuel takes place therein.

12. A burner (1) for solid fuel consisting of a burner pipe (2) having a first end (2a) being adapted for connection to a fuel supply (5) and having a second end (2b) therof communicating with a combustion gas duct (6), **characterized in that** the burner pipe (2) is provided with a firmly attached outer helix (3) at its outer circumference, in that the burner pipe is rotatably journalled and is connected to a drive means (8) for rotation thereof around its longitudinal center axis (C).

13. A burner (1) according to claim 12, **characterized in that** the burner pipe (2) forms the combustion chamber of the burner (1), by being designed having such a relationship between its length and its cross section and by being provided with such an insulation that an essentially complete combustion of the fuel takes place therein.

14. A burner (1) according to claims 12 or 13, **characterized in that** the outer helix (3) is designed having a varying pitch and in that the pitch decreases stepwise or gradually in a direction from the second end (2b) of the burner pipe (2) towards its first end (2a).

25. A burner (1) according any of claims 11-14, **characterized in that** in an afterburning zone (X_1-Y) the burner pipe (2) is provided with a formation (4') at its inner surface, said formation serving to set a fuel-air mixture and combustion gases as well as possible combustion residue in a rotary motion.

16. A burner (1) according to any of claims 11-15, **characterized in that** the burner pipe (2) has a generally cylindrical shape.

17. A burner (1) according to any of claims 11-16, **characterized in that** at its inner peripheral surface the burner pipe (2) is provided with a layer (9) of refractory material, preferably a ceramic material.

18. A burner (1) according to any of claims 11-17, **characterized in that** it is designed as a unit, in the form of a cassette being insertable into and mountable to a storage unit (10) for a heat absorbing medium, whereby the burner (1) in connection with a first end (2a) of the burner pipe (2) is provided with a base unit (12) being sealed against the storage volume, forming an outlet (18, 20) for discharging cooled combustion gases, and/or an outlet (21) for discharging combustion residue and rotatably supporting the burner pipe therein.

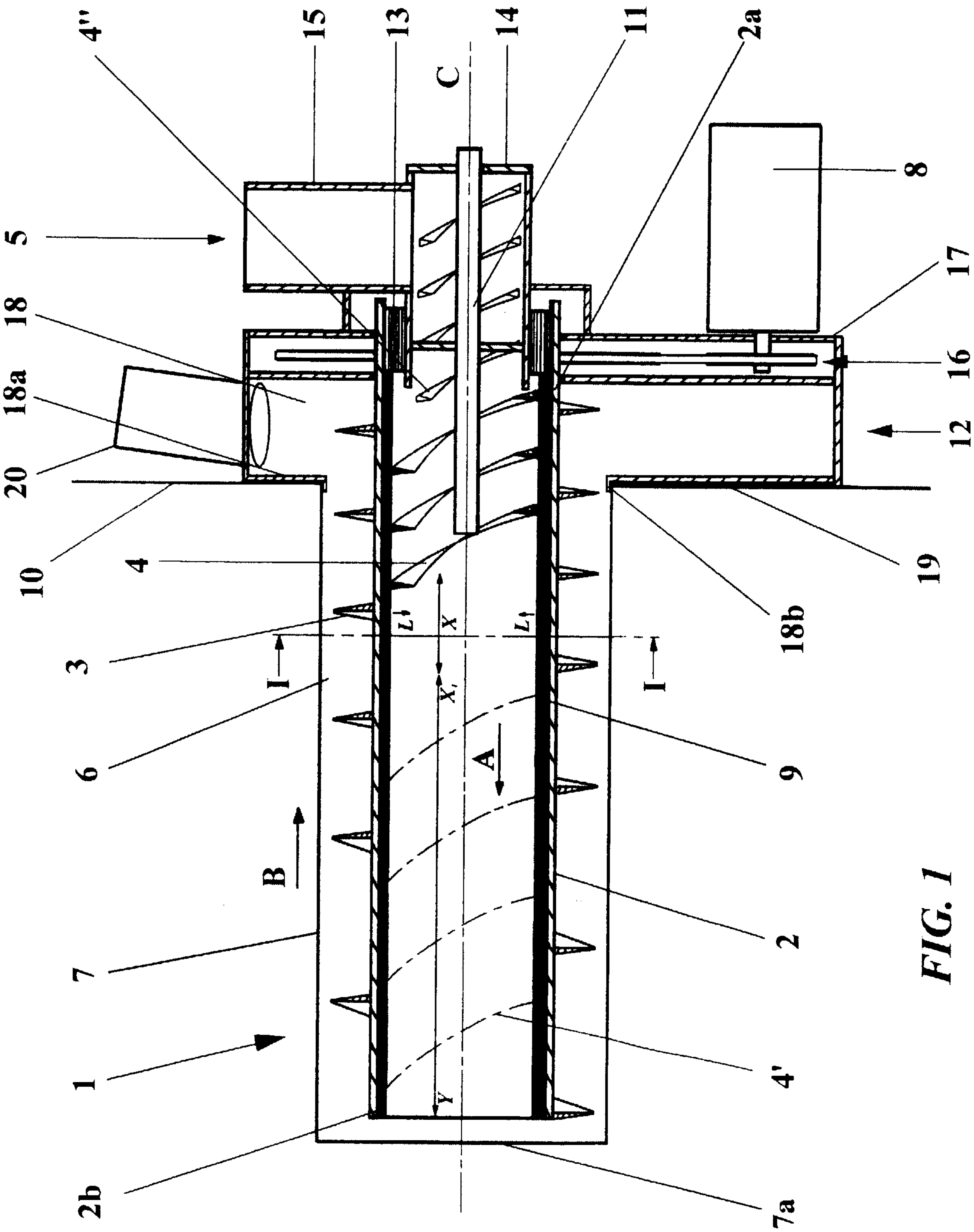
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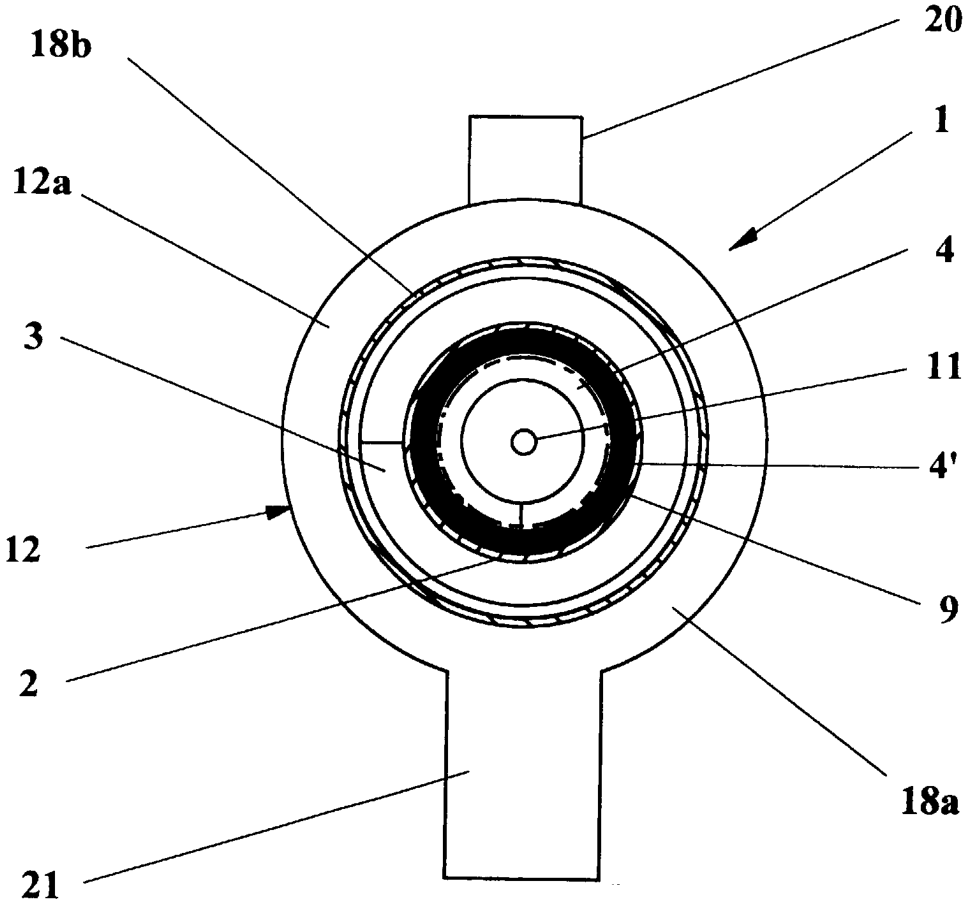
FIG. 1

FIG. 2



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 00 85 0063

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X Y	WO 98 10223 A (FUTATSUGI TAKEHIKO) 12 March 1998 (1998-03-12) & EP 0 926 440 A (TAKEHIKO FUTATSUGI) 30 June 1999 (1999-06-30) * page 10, line 20 - line 36 * * page 5, line 49 - line 58 * * figures 1,3 *	1,3,4,6, 7,12,16 2	F23G7/10 F23B1/32 F23B1/34 F23J1/00
Y	US 4 748 918 A (CHANG SHIEN F) 7 June 1988 (1988-06-07) * figure 1 * * column 3, line 16 - line 28 *	2	
X	US 3 878 798 A (DU-CHAMBON MICHEL G J) 22 April 1975 (1975-04-22) * column 1, line 3 - line 8 * * column 1, line 55 - line 62 * * column 2, line 38 - line 55 * * figures 1-3 *	1,4-7, 11-14,16	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	6 July 2000	Mougey, M

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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