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(71) Applicant(s):
Alley Enterprises Limited
(Incorporated in Ireland)
Grant Engineering Limited, Crinkle, Birr,
County Offaly, Ireland

(56) Documents Cited:
GB 0995342 A GB 0878938 A
EP 1267134 A FR 002646499 A
US 4671212 A

(72) Inventor(s):
Stephen William John Grant

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(74) Agent and/or Address for Service:
Cruickshank & Co
Unit 8A Sandyford Business Centre,
Sandyford, Dublin 18, Ireland

(54) Abstract Title: Solid fuel boiler

(57) The boiler 1, for burning solid granular fuel such as wood pellets, includes a base wall 11, a top wall 12 and side walls 13, 14 and 15 defining an enclosure 16 for hot gasses. At least a portion of the walls are hollow heat enclosures for carrying water to be heated. A burner 10 is also housed in the enclosure 16. A heat exchanger means 20 is mounted to an exhaust gas outlet 30 communicating with an exhaust gas flue 7. The heat exchanger means 20 may include at least one conduit and a vortex inducing baffle assembly 23 formed by spirally wound plate. The baffle may be a relatively loose fit and project through the conduit. Means 27, 28 may be provided to move the baffle back and forth within the conduit to clean the baffle.

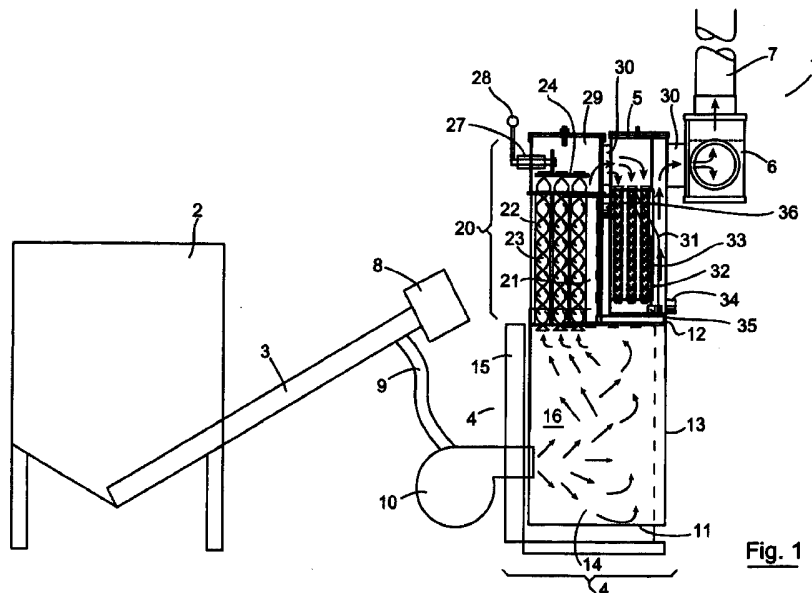


Fig. 1

30 45 07

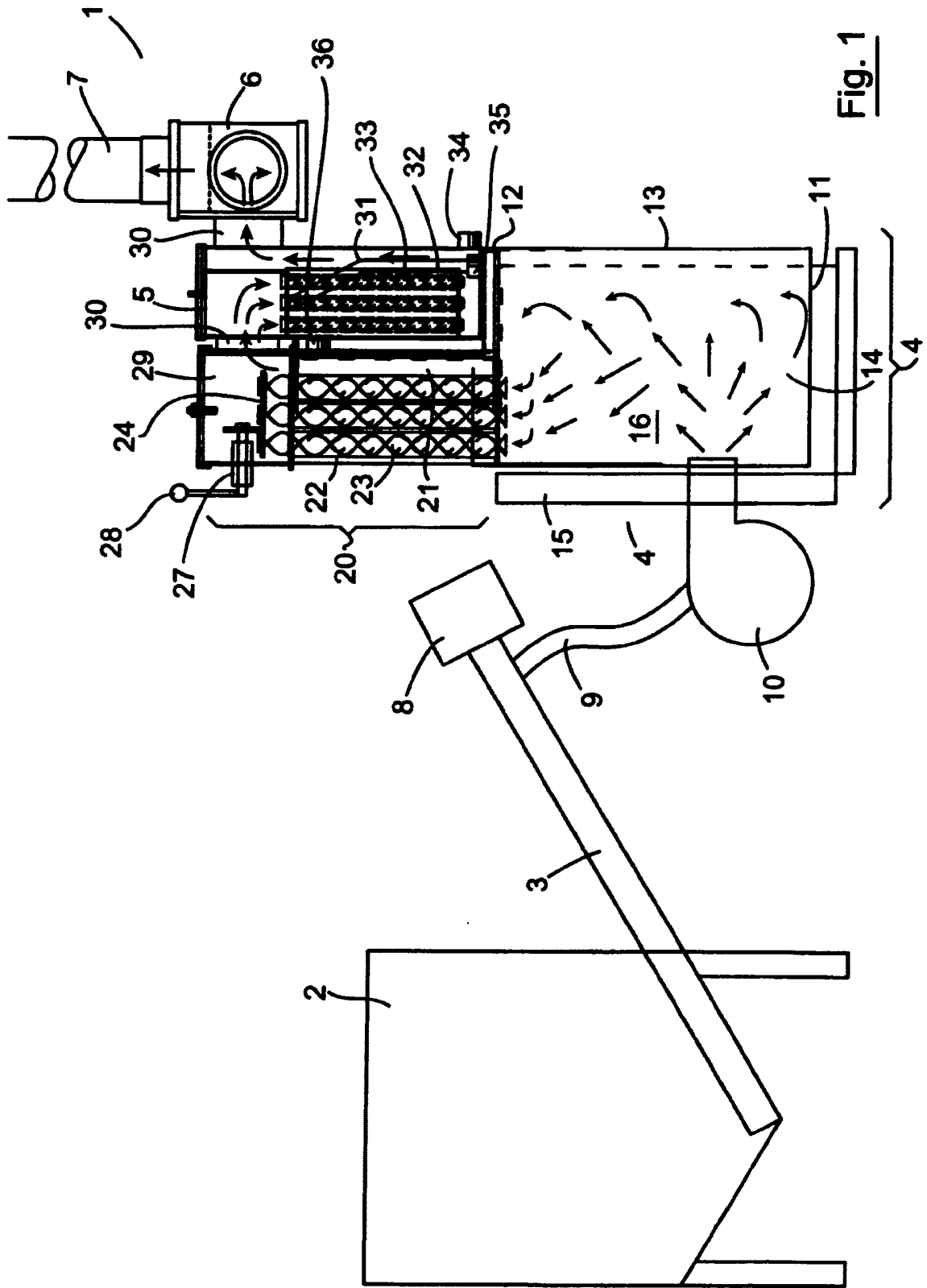


Fig. 1

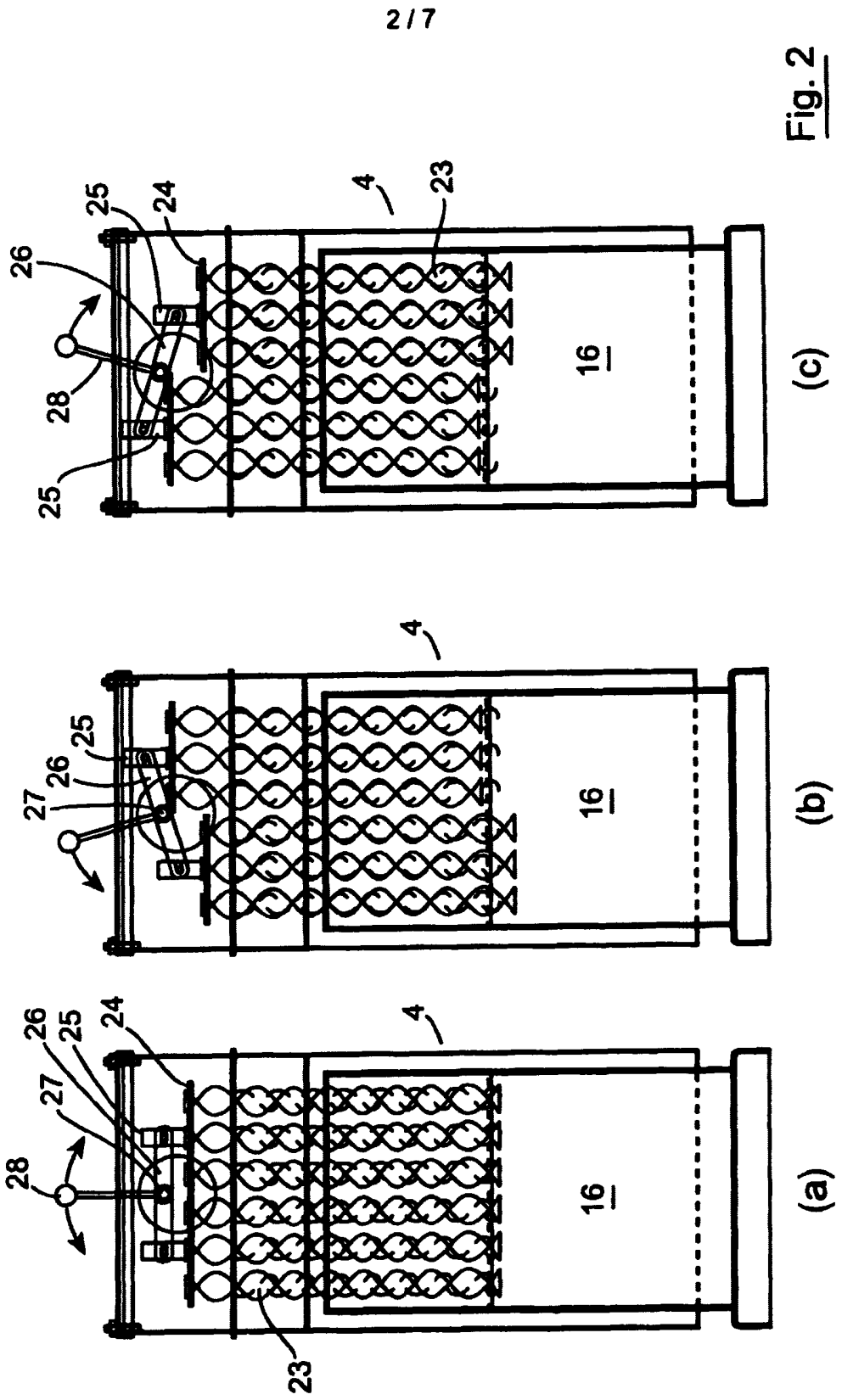


Fig. 2

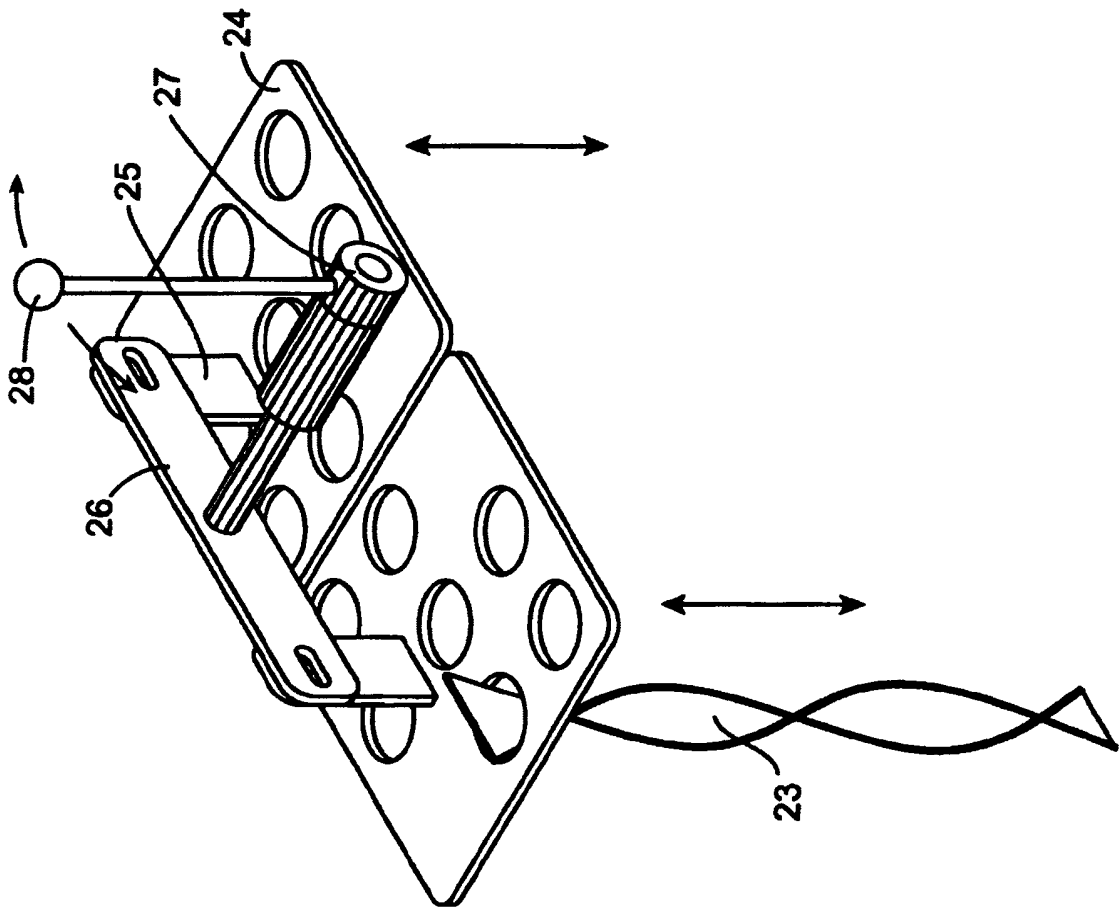
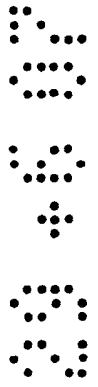


Fig. 3

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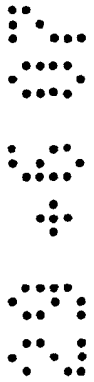
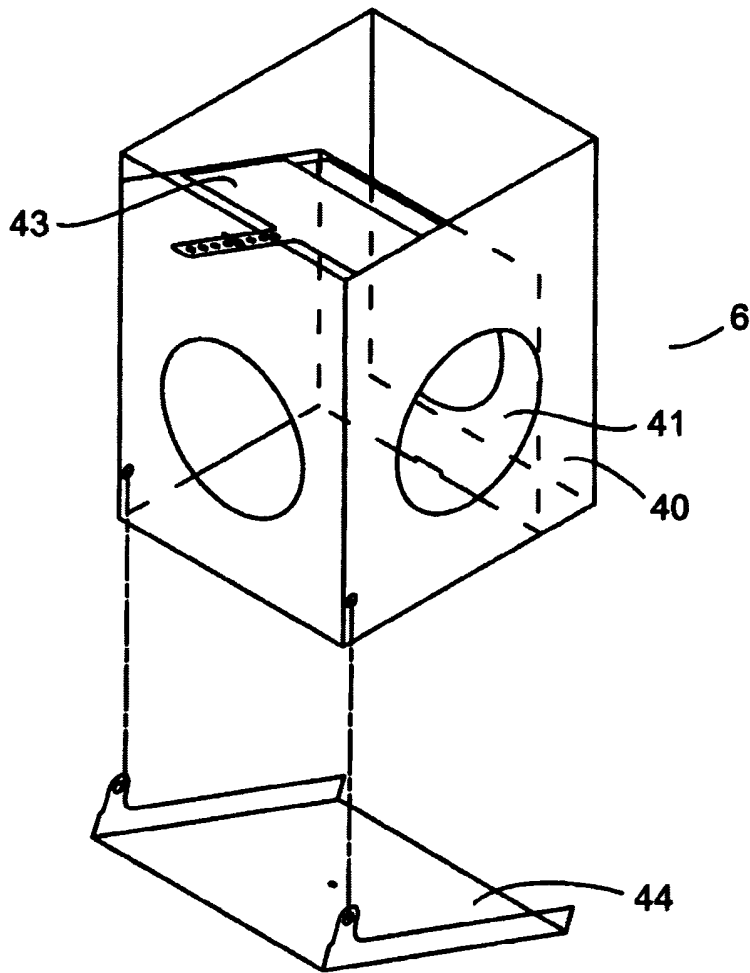
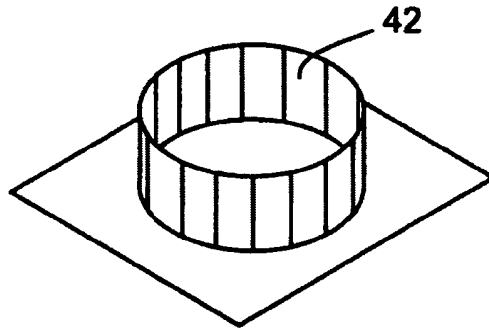


Fig. 4

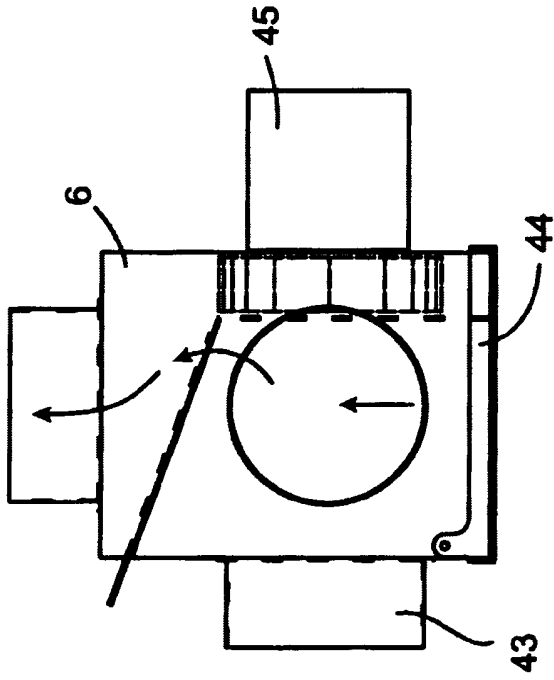


Fig. 6

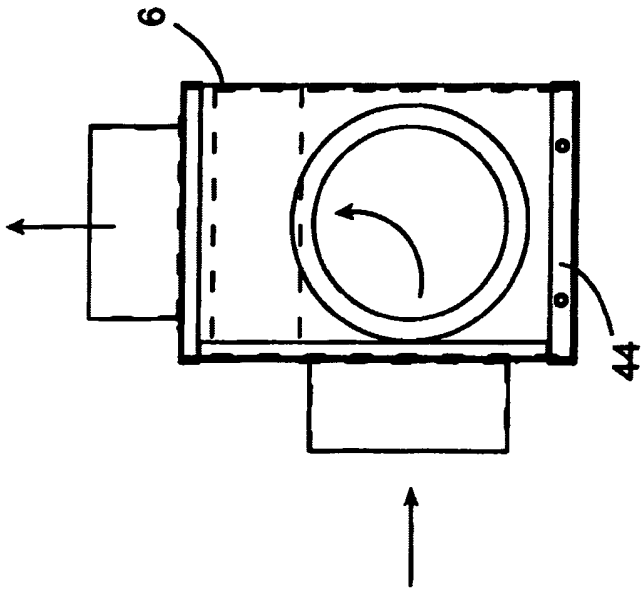
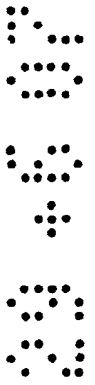


Fig. 5



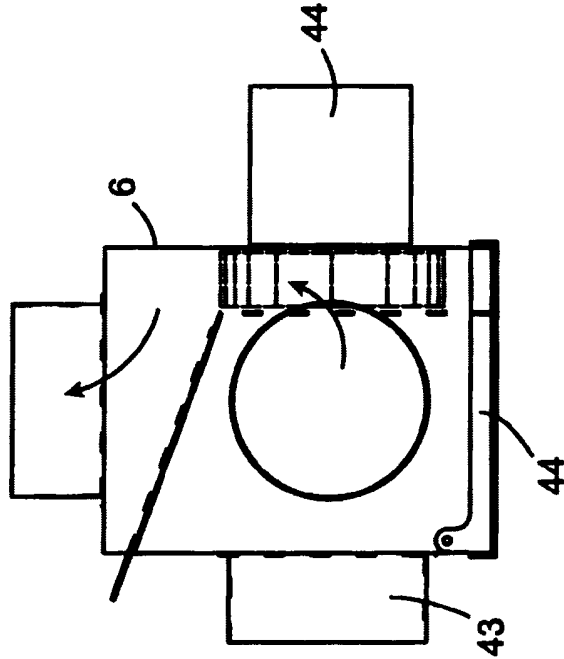


Fig. 8

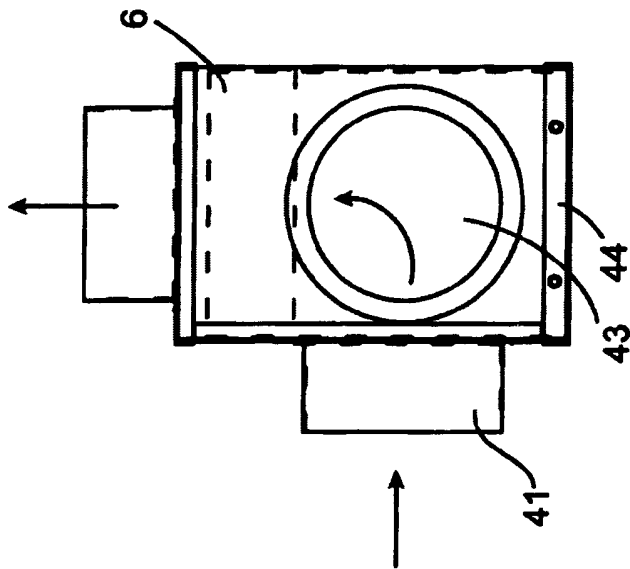
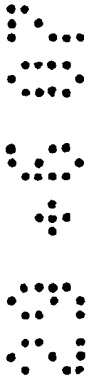


Fig. 7



30 40 07

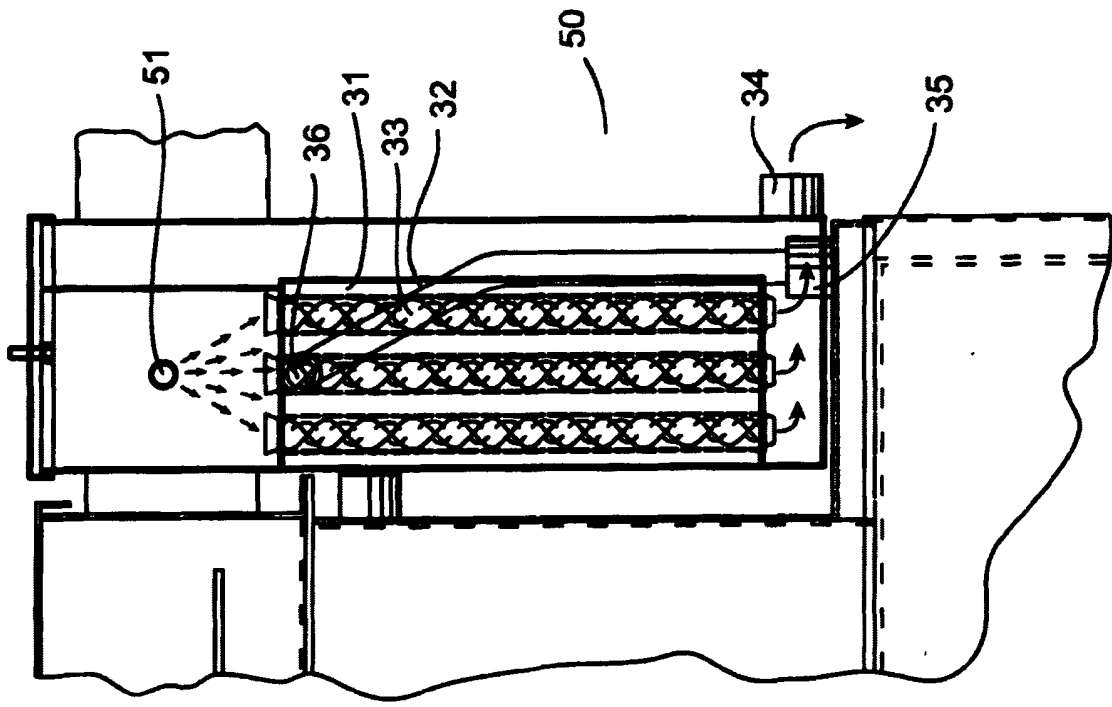


Fig. 9

“A Solid Fuel Boiler”**Introduction**

5

The present invention relates to an enclosed water heating boiler for burning solid granular fuel. Such enclosed boilers generally comprise:

a base wall;

10

a top wall;

side walls extending between the base and top walls and defining therewith an enclosure for hot gasses;

15

hollow heat exchangers arranged for carrying water to be heated formed by at least a portion of the base, top and side walls;

a burner housed in the enclosure; and

20

an exhaust gas outlet connecting with an exhaust gas flue.

In this specification the term “granular fuel” is used to include not only granular fuel such as pelleted wood, but also other solid materials such as ground or semi-shredded husks of maize and similar products together with particles of other recognised fuels such as coal, peat and the like.

25

Such enclosed boilers are relatively environmentally friendly when they burn products such as bio-fuels, for example, bio-diesel, bio-kerosene or wood pellets or shredded maize. The reason is that while they do generate carbon dioxide, they also advantageously, in growing, absorb carbon dioxide and thus are, for example, gas production neutral and environmentally friendly.

30

Such boilers do, however, have certain problems. The first problem is that they

generate ash and, more importantly, they generate a fine ash which quickly coats the interior of the enclosure causing a reduction in the heat transfer between the hot combustion gasses and the water in the boiler walls. For example, a boiler such as described in European Patent Specification Nos 1106937B1, 11069371, 0616676Bi
5 are only efficient in use when used with conventional gas and oil burners and would be relatively inefficient for any form of solid fuel boiler of the type hereinbefore described. These boilers when fired with granular fuel would require frequent cleaning.

10 Further, because of the very nature of the boilers, efficient heat transfer is more difficult to achieve and secondly, and more importantly as stated above, because of the amount of fine ash, strictly speaking dust, that is formed on the baffles of the boiler, it is absolutely essential that these baffles be regularly cleaned. Heretofore, this has required the boilers to be opened and the enclosure to be exposed for
15 cleaning. This substantially reduces the convenience for the owner, many of whom cannot or will not carry out the cleaning themselves. By their very design, these boilers have generally been relatively heat inefficient and this has been exacerbated by the need to keep the baffles clean.

20 The present invention is directed to providing a more efficient construction of such a boiler and, in particular, providing one that will not require regular cleaning by the owner.

Statements of Invention

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According to the invention there is provided an enclosed boiler for burning solid granular fuel comprising:

a base wall;

30

a top wall;

side walls extending between the base and top wall defining therewith an enclosure for hot gasses;

hollow heat enclosures arranged for carrying water to be heated formed by at least a portion of the base, top and side walls;

5 a burner housed in the enclosure;

an exhaust gas outlet connecting with an exhaust gas flue in which heat exchanger means are mounted within the enclosure communicating with the exhaust gas outlet.

10

In one embodiment the heat exchanger means comprises a heat exchanger tank for carrying water to be heated and at least one gas conduit projecting through the heat exchanger tank to connect the enclosure to the exhaust gas outlet and a vortex inducing baffle assembly mounted within the heat exchanger conduit. In this latter
15 embodiment the vortex inducing baffle may be a spirally wound plate or the baffle may comprise a bar mounting at least one helically wound continuous vane. Such a vortex inducing baffle may be a relatively loose fit within the conduit.

In one embodiment the baffle projects through substantially all of the conduit.

20

In some embodiments means are provided to move the baffle back and forth within the conduit to clean the baffle and may be provided by a link mechanism.

In another embodiment some of the walls form part of the heat exchanger tank.

25

In the former embodiments comprising a vortex inducing assembly there are two sets of baffles and their associated conduits and in which each set of the baffles is connected adjacent one free end to a suspension plate mounted intermediate its end on a pivot shaft, whereby pivoting of the shaft alternatively raises one set of baffles
30 and lowers the other within their respective conduits. In this embodiment the means to move the pivot shaft may be one of:

a lever arm;

an hydraulic or pneumatic ram; or
server motor.

5 In another embodiment a condensing unit is provided and comprises a condensing
flue, having a condensate drain- off outlet, connected between the exhaust gas
outlet and the exhaust gas flue and housed within a heat exchanger tank for
connection between a system water return and a system water feed pipe and
further comprises an elongate conduit housing a heat exchanger baffle.

10 In this embodiment the baffle comprises a spirally wound plate and there may be a
plurality of conduits and associated baffles. In one embodiment the conduits are
mounted at a sufficient angle to the vertical to allow condensate to flow from the
conduits through the condensate drain-off outlet. In another embodiment there is
15 mounted a spray bar spaced remote from one end of the conduit and the
condensate drain-off outlet whereby pressurised water can be delivered through
the conduit and out the condensate drain-off outlet. The exhaust gas flue may
comprise an exhaust box having an exhaust inlet and outlet , a damper sited within
the exhaust box, an exhaust fan , and means to control the operation of the damper
and fan for draught regulation.

20

In this latter embodiment the damper may be a plate slidable within the exhaust box
and there may be provided a cleaning access door in the exhaust box.

Detailed Description of the Invention

25

The invention will be more clearly understood from the following description of some
embodiments thereof given by way of example only with reference to the
accompanying drawings, in which:-

30

Fig. 1 is a side view of a wood pellet condensing boiler in accordance with the
invention;

Figs. 2 (a), (b), and (c) side views of heat exchanger means incorporated in the
boiler;

Fig 3 is a diagrammatic view of the heat exchanger means;

5 Fig. 4 is a three dimensional exploded diagrammatic view of an exhaust box according to the invention,

Fig. 5 is a side view of the exhaust box in one position of use,

10 Fig. 6 is a front view of the exhaust box in the same position of use,

Fig. 7 is a side view of the exhaust box in a different position of use,

Fig. 8 is a front view of the exhaust box in this latter configuration of use, and

15 Fig. 9 is a diagrammatic view of an alternative construction of a condensing unit according to the invention.

Referring to the drawings and initially Fig 1 thereof, there is illustrated a wood pellet boiler installation indicated generally by the reference to numeral 1 comprising a
20 wood pellet hopper 2, a feed auger 3, an enclosed water boiler, indicated generally by the reference numeral 4, condensing unit 5, exhaust fan box 6 and an exhaust flue 7.

The wood pellet hopper 2 is a conventional wood pellet hopper, as is the auger 3 driven by a motor 8. The auger 2 feeds a delivery hose 9 which, in turn, feeds a burner 10. The burner 10 is ideally a dual fuel burner for wood pellets and oil,
25 whether kerosene or diesel or bio-kerosene or bio-diesel.

The boiler 4 comprises a base wall 11, top wall 12, and side walls 13, 14 and 15 defining an enclosure 16. The side wall 14 and the top wall 12 and the portion of the side wall 13 which is effectively the rear wall are hollow heat exchangers or water
30 jackets arranged for carrying water to be heated. The base wall 11 in conventional manner normally houses a removable ash pan (not shown). The front side wall 15 is an insulated cleaning door allowing access to the enclosure 16. Again, all this would be of relatively conventional construction.

There is provided a heat exchanger means indicated generally by the reference numeral 20 which heat exchanger means comprises a heat exchanger tank 21 housing a plurality of conduits 22, in turn, housing baffles 23. The heat exchanger means 20 is effectively an extension of the enclosure 16 and could easily be formed
5 integral with the enclosure. The baffles 23 are spirally wound strips of metal forming baffles similar to those used in the condensing unit described in our co-pending European Patent, namely specification no. EP1267134 A.

Referring now to Figs. 2 and 3, it will be noted that there are two sets of baffles 23,
10 each connected to a support plate 24 which plates 24 in turn are suspended by links 25 from the free ends an arm 26 mounted on a pivot shaft 27 to which is attached a lever 28. This is more clearly shown in Fig 3.

Again, referring to Fig. 1, the conduits 22 each feed a manifold 29 which, in turn, is
15 connected to the condensing unit 5 of the type described in European published Patent Specification No. EP1267134 A2. The condensing unit 5 is connected to an exhaust gas outlet 30 which, in turn, is connected via the exhaust fan box 6 to the exhaust gas flue 7. The condensing unit 5 comprises a condensing flue 31 which is formed from a plurality of elongate conduits 32 housing heat exchanger baffles 33. A
20 condensate drain off pipe 34 is provided. A return water pipe connector 35 and a boiler feed pipe connector 36 are shown.

Figs. 4 to 8 inclusive illustrate the exhaust box 6 which comprises an enclosure 40
25 having an inlet 41, a flue gas outlet 42 and a damper 43. An exhaust fan 44 is mounted on the box 40. The damper 43 in the form of a plate can be used to control the draught. There is also provided a hinged cleaning door 44.

Needless to say the use of a condensing unit is desirable but not essential.

30 In use, operation of the lever 28 will cause the baffles 23 to be raised and lowered and shaken so that all the combustion residue or fine ash that will adhere thereto will be shaken off and will fall down the conduits 22 to the ash pan. This then cleans what is, effectively, the major heat exchange part of the boiler. It is envisaged that automatic operation of the lever may be provided by a ram powered in any suitable

way and for example, could be controlled to operate periodically.

It will be appreciated that the exhaust box 6 may or may not be fitted with a fan and that in operation, depending on the draught, the damper 43 can be adjusted to
5 provide the necessary draught for general operation while if a fan is needed, it can be mounted as shown.

Referring to Fig. 9, there is illustrated an alternative construction of a condensing unit, indicated generally by the reference numeral 50, with similar parts as described
10 above identified by the same reference numerals which is essentially the same as the condensing unit 5 previously described except that there is now mounted above the conduits, a spray bar 51 having a plurality of cut out slots (not shown) through which air or water under pressure can be delivered to wash the interior of the conduits. This can then be delivered out the condensing drainpipe 34.

15 In operation, it has been discovered that the baffles 23 provide very efficient heat transfer. While it is not quite known exactly what happens, it appears that a vortex is formed to provide more efficient heat transfer than would be expected as the gases scour the inner walls of the conduits. It appears that the hotter gasses are
20 transferred towards the interior wall of the conduit as the gasses proceed through the conduit.

It is envisaged that other vortex forming means could also be used to make the gasses swirl around the conduits without necessarily having baffles such as
25 illustrated in the accompanying drawings. It is normal, for example, to provide fans that will impart cyclonic motion to gasses. It is also envisaged that various vortex flow forming devices could be mounted within the conduits such as having vortex flow forming vanes mounted on the interior surface of the first part of the conduit. Examples of such vortex flow forming devices are illustrated in PCT Patent
30 Specification No. WO 03/092902 A1 in the name of Solid Solutions Limited. Any disclosure of this specification is incorporated herein by way of direct reference.

Another construction of baffle comprises a bar mounting one or more helically wound vanes.

The heat exchanger conduits housing the vortex forming means are usually spaced relatively short distances apart often of the order of $\frac{1}{4}$ to $\frac{1}{3}$ of their outside diameter. A typical construction has conduits of the order of 43 mm OD and 12mm spacing.

5

In the specification the terms "comprise, comprises, comprised and comprising" or any variation thereof and the terms "include, includes, included and including" or any variation thereof are considered to be totally interchangeable and they should all be afforded the widest possible interpretation and vice versa.

10

The invention is not limited to the embodiments hereinbefore described which may be varied in both construction and detail

CLAIMS

1. An enclosed boiler for burning solid granular fuel comprising:
 - 5 a base wall;
 - a top wall;
 - side walls extending between the base and top wall defining therewith an
10 enclosure for hot gasses;
 - hollow heat enclosures arranged for carrying water to be heated formed by at
least a portion of the base, top and side walls;
 - 15 a burner housed in the enclosure;
 - an exhaust gas outlet connecting with an exhaust gas flue in which heat
exchanger means are mounted within the enclosure communicating with the
exhaust gas outlet.
20
2. A boiler as claimed in claim 1 in which the heat exchanger means comprises a
heat exchanger tank for carrying water to be heated and at least one gas
conduit projecting through the heat exchanger tank to connect the enclosure to
the exhaust gas outlet and a vortex inducing baffle assembly mounted within
25 the heat exchanger conduit.
3. A boiler as claimed in claim 2 in which the vortex inducing baffle is a spirally
wound plate.
- 30 4. A boiler as claimed in claim 2 in which the baffle comprises a bar mounting at
least one helically wound continuous vane.
5. A boiler as claimed in claim 3 or 4 in which the vortex inducing baffle is a
relatively loose fit within the conduit.

6. A boiler as claimed in any of claims 2 to 5 in which the baffle projects through substantially all of the conduit.
- 5 7. A boiler as claimed in any of claims 2 to 6 in which means are provided to move the baffle back and forth within the conduit to clean the baffle.
8. A boiler as claimed in claim 7 in which the means to move the baffle is a link mechanism.
- 10 9. A boiler as claimed in any preceding claim in which some of the walls form part of the heat exchanger tank.
- 15 10. A boiler as claimed in any of claims 2 – 9 in which there are two sets of baffles and their associated conduits and in which each set of the baffles is connected adjacent one free end to a suspension plate mounted intermediate its end on a pivot shaft, whereby pivoting of the shaft alternatively raises one set of baffles and lowers the other within their respective conduits.
- 20 11. A boiler as claimed in claim 10 in which means to move the pivot shaft is one of:
 - a lever arm;
 - 25 an hydraulic or pneumatic ram; or
 - server motor.
- 30 12. A boiler as claimed in any preceding claim in which a condensing unit is provided and comprises a condensing flue, having a condensate drain- off outlet, connected between the exhaust gas outlet and the exhaust gas flue and housed within a heat exchanger tank for connection between a system water return and a system water feed pipe and further comprises an elongate conduit housing a heat exchanger baffle.

13. A boiler as claimed in claim 12 in which the baffle comprises a spirally wound plate.
- 5 14. A boiler as claimed in claim 12 or 13 in which there are a plurality of conduits and associated baffles
- 10 15. A boiler as claimed in any of claims 12 to 14 in which the conduits are mounted at a sufficient angle to the vertical to allow condensate to flow from the conduits through the condensate drain-off outlet.
- 15 16. A boiler as claimed in any of claims 12 to 15 in which there is mounted a spray bar spaced remote from one end of the conduit and the condensate drain-off outlet whereby pressurised water can be delivered through the conduit and out the condensate drain-off outlet.
- 20 17. A boiler as claimed in any of claims 12 to 16 in which the exhaust gas flue comprises an exhaust box having an exhaust inlet and outlet , a damper sited within the exhaust box, an exhaust fan , and means to control the operation of the damper and fan for draught regulation.
- 25 18. A boiler as claimed in claim 17 in which the damper is a plate slidable within the exhaust box.
- 30 19. A boiler as claimed in any of claims 12 to 18 in which there is provided a cleaning access door in the exhaust box.
20. A boiler substantially as described herein with reference to and as illustrated in the accompanying drawings.

Application No: GB0706119.5

Examiner: Ian Blackmore

Claims searched: 1-20

Date of search: 26 July 2007

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1-11	GB995342 A (VANDEVELDE) see figure and page 1, line 66 to page 2, line 27
X	1-11	FR2646499 A (ENGLER) see abstract and figure
X	1-7,9,12-14	US4671212 A (SMITH) see abstract and claims
X	1-6,9,12-15	EP1267134 A (ALLEY) see figures 1-15
X	1-6.9	GB878938 A (TRIANCO) see figures and page 2, line 18-129

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category	P	Document published on or after the declared priority date but before the filing date of this invention
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^X:

F4A

Worldwide search of patent documents classified in the following areas of the IPC

F24H

The following online and other databases have been used in the preparation of this search report

EPODOC, WPI

International Classification:

Subclass	Subgroup	Valid From
F24H	0001/28	01/01/2006
F24H	0009/00	01/01/2006