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(54) Title: BOILER HAVING A HELICAL COIL OF SPIRALLY CORRUGATED PIPE

(57) Abstract

A compact boiler (100) suited for portable usage in generating hot water and/or steam is described. The boiler (100) incorporates just one helical coil (106) formed from a spirally corrugated metal pipe of 1 mm thick, 20 mm diameter stainless steel wound into a single helix with the peaks of the corrugations of adjacent turns just touching one another. The spirally corrugated pipe resembles a screw having four starts. A series of concentric baffles (108, 109, 110) ensure that hot gases from a burner will pass over or between the pipe of the helix (106) several times, thereby improving the transfer of heat to the water contained within the pipe.
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BOILER HAVING A HELICAL COIL OF SPIRALLY CORRUGATED PIPE

FIELD OF THE INVENTION
This invention relates in general to boilers and has particular (though not exclusive) application to the field of vegetation control and more particularly to vegetation control or weed-killing, comprising exposure to hot water and/or steam generated in such a boiler. The boiler can also be used for steam cleaning, hot water production, and the like.

BACKGROUND
A boiler is a device for the process of generating heat and transferring it to a contained body of water (or other fluid) which as a consequence has its temperature raised to its boiling point or beyond. Known boilers often include means to enhance a combustion process, and/or means to enhance a heat transfer process and/or means to contain a fluid under sometimes a considerable pressure because steam engines and the like ultimately rely on the pressure generated as a result of heating. Some boilers are developed with a primary requirement of being capable of providing a rapid initiation of steam generation soon after first ignition of a combustion process.

For small portable boilers, matters of efficiency and minimised weight are often of major importance. Boilers having a length of liquid-carrying pipe passing through a heated zone within a thermally insulated chamber are known but there are limitations to the effectiveness of heat transfer from gas through pipe and into liquid in boilers of this design. They generally have a relatively high resistance to water flow (friction), considerable weight, hold a significant quantity of liquid within the pipes, and therefore are not ideal for many applications.
There is a need for small, light, efficient, cheap boilers in many fields, such as in steam cleaning, food preparation, cooking, laundries, the textile industry, many aspects of light industry, and for weed control - an immediate application though clearly not the sole application.

Weeds (that is, plants growing in the wrong place) commonly require control and at least temporary eradication so that (for example) a desired crop can be grown and a commercial advantage can be realised. Heat leaves no residue, unlike chemical means for controlling plant growth. The application of heat has been used with or without water as a "carrier" or adjuvant.

Accordingly, there is a need for a portable boiler, and particularly one for facilitating the application of steam and/or hot water at herbicidal temperatures according to the general principles of herbicidal heat treatment.

**OBJECT**
It is an object of the present invention to provide an improved boiler or at least to provide the public with a useful choice.

**STATEMENT OF THE INVENTION**
In a first major aspect the invention provides a boiler of the type including a burner and a container for liquid within a chamber, wherein the container for liquid comprises a spirally corrugated pipe having an inlet and an outlet.

Preferably the pipe is a spirally corrugated pipe having external peaks and troughs.

Preferably the pipe also has internal peaks and troughs corresponding to the external troughs and peaks respectively.

Preferably the spirally corrugated pipe is formed with an optimum balance between the depth of the corrugations and the resulting increase in frictional flow of the liquid
Preferably the spirally corrugated pipe is made of stainless steel, and preferably this can withstand working pressures at a working temperature without failure.

5 Preferably the spirally corrugated pipe is shaped in the form of a coil.

Preferably the coil has one or more layers.

Preferably the coil is helical, with a circular outline although optionally the coil may have a non-circular outline.

10 Preferably each turn of any one layer of the coil is adjacent to, and in light contact with an adjoining turn.

15 Preferably each turn of any one layer of the coil makes light contact at the peaks of the corrugations with an adjoining turn, thereby allowing gas to pass between the intervening spaces.

In a preferred embodiment, the invention provides a boiler including a single helix of pipe or tube capable of holding a fluid to be heated at a working pressure and conducting the fluid past a source of heat, such as hot gases emanating from a burner.

20 In a further preferred embodiment the invention provides a boiler in which at least one baffle capable of redirecting the flow of gas increases the opportunity for heat to be transferred from the gas to the pipe or tube.

25 As an alternative to spiral corrugation of the tube, other configurations of deformation of the wall of the pipe may be used.

30 In a second major aspect the invention provides boiler means for controlling the growth of vegetation by providing for the generation of heated water and/or steam at a time and place appropriate for vegetation control.

35 Preferably the boiler means is compact and optimised for portability.
DRAWINGS
The following is a description of a preferred form of the invention, given by way of example only, with reference to the accompanying diagrams.

Fig. 1: is a longitudinal section through a boiler according to the invention.

Fig. 2: shows a short length of spirally corrugated heat exchanger pipe prior to being formed into the helix of figure 1.

Fig. 3: shows two short sections of adjacent turns of the helix of figure 1 with the adjacent turns lightly touching or nearly touching one another at the peaks of the spirally corrugated heat exchanger pipe.

PREFERRED EMBODIMENT
A boiler for commercial use should be optimised in a number of ways though most of them (weight, complexity, efficiency, safety, response speed, etc) can be reduced into economic costs. The boiler under discussion employs a deliberately deformed tubular fluid-carrying member (basically having the shape of a pipe) as its basic heat exchange element, in order to enhance the heat exchange process by promoting non-laminar flow within the member so that all portions of the fluid are exposed in turn to the heat diffusing through the walls of the pipe. The exact mechanism by which flow is disturbed can be important because many such mechanisms also result in significantly increased resistance to flow.

As can be seen in Fig 1, which is a longitudinal section through one preferred embodiment, the invention provides a preferably cylindrical boiler 100 comprising a burner 102 to burn a fuel, and a helical coil 106 of metal tubing, all held within a heat-insulating lining 101. A boiler can be considered as a special type of heat exchanger for transferring heat from a source into a fluid to be heated. The example boiler has inputs including fuel, air, and cold water (at 105), and its outputs include waste exhaust gases 103 and hot water 104 (which may in use be boiling, pressurised, or be at least partly converted into steam). The course of the hot gas issuing from the burner is shown with dashed open arrows. A set of baffles, 108, 109, and 110 help to ensure that the gases pass between the turns of the coil of pipe several times before
reaching the exhaust chimney 103.

In this example the boiler is vertical and has a downdraft burner 102 and an insulated flame reflector 112 to assist in redirecting the exhaust gases towards the helical coil and baffles.

Preferably the pipe or tube used in the invention is made of stainless steel, as this type of material can withstand the working pressures at a working temperature and minimise the risk of corrosion leading to a potentially catastrophic failure at a later date. Alternatively it could be made of copper, although this metal can be corroded especially with the presence of electrochemical effects (near dissimilar metals), and has a lower melting point. The additional strength of stainless steel allows use of a pipe having a thinner wall and hence less thermal resistance. We have found that a 1 mm wall thickness is suitable, with 20 mm diameter pipe.

This example boiler includes a single layer of coiled pipe or tube carrying water past hot gases. Previous boilers of similar output had to use several layers of coiled pipe in order to provide a similar rate of heat transfer, and they were relatively expensive, hard to make, and wasteful of resources as well as providing an impediment to flow because of the extra length of pipe. It is possible to make a multi-layered coil for the boiler of this invention and retain the advantages of the spirally corrugated pipe because otherwise even more pipe material would be required.

One improvement that the invention employs in order to make a single spiral work effectively is to make use of a pipe or tube that is spirally corrugated before being bent into a coil or helix; that is, its wall is deformed so that it somewhat resembles a rope as shown at 201 in Fig 2. This Figure shows a short section of spirally corrugated pipe, wherein the details impressed on the walls of the pipe on the side of the pipe towards the viewer is drawn in solid lines 202 and the far side is as dashed lines 203. One preferred pattern resembles a screw having four starts, and is used with 20 mm pipe. It is possible to vary the number of starts to a higher or lower number, the height of the corrugations, the pitch of the turns, and the shape of the corrugations and a preferred pattern is one that provides an optimum balance between a minimised impediment to flow and a maximised rate of heat transfer across the walls of the pipe, when in use.
This spirally corrugated pipe is preferably manufacture by the method described in PCT/NZ93/00087 by INNES, Rodney Mitchell (one of the inventors of the present invention). Such a pipe has both internal and external peaks and troughs formed by spirally or helically corrugating the thin wall of the pipe. We prefer to call the pipe "spirally corrugated pipe" to distinguish the shape of the corrugations of the pipe which are visible on the exterior of the pipe from the shape of the pipe when it is wound into a helix as shown in figure 1.

In use laminar flow within the pipe is repeatedly disturbed, so that water within the pipe is mixed and heated more quickly and evenly than might otherwise be possible. It should be noted that our preferred design of corrugation results in a preferred direction of flow; that is, the pipe is a more effective heat exchanger when used in one direction than when used in the other.

A further advantage of the spirally corrugated pipe is that the turns of the coil can be made to lightly touch or almost touch at the peaks 201 of the corrugations to provide relatively narrow spaces 208 between adjacent turns 206, 207 as shown in figure 3. This leads to increased turbulence in the hot gases and thereby aids heat transfer. Thus we prefer to wind the coils with the layers just touching, though generally not, of course, tightly intermeshing.

We have not shown any details of the actual burner 102 because its construction and the kind of fuel consumed is not relevant to this improvement; other than to provide a flow of hot gaseous combustion products (first flowing downwards in the drawing).

ADVANTAGES:

Boilers made according to the enclosed principles have the major advantage that there is less heat exchange material in use than in prior-art boilers having comparable outputs. As a result, boilers made according to the invention are generally lighter, cheaper, easier to make, and have more latitude to increase safety limits than their antecedents. For example, two or three concentric spirals of pipe used to be used to extract a similar amount of heat from the burner gases. In the embodiment described, there is just one spiral and the boiler is more optimised. A significant improvement in flow resistance is also evident.
One application of this invention is as a means for controlling the growth of vegetation by applying heated water and/or steam to ground including the unwanted vegetation (that is, weeds). While this method avoids the use of chemical weed killers, with the associated problems of toxicity and many toxic residues which may be dispersed onto wanted plants or persist in the environment for lengthy periods (and see the growing body of literature relating breast cancer in humans to herbicide usage, for example), methods involving heat necessarily involve the use of energy.

VARIATIONS:
Only one example of a preferred embodiment has been illustrated, and only one application has been discussed. Other configurations incorporating the essentials of this invention may be devised. For example, more than one layer of coiled pipe may be used in certain designs.

This type of boiler can of course be used for other applications than in herbicidal applications, wherein water is desired to be converted into hot water, or steam, or a mixture of the two. Other applications include domestic hot water heating, all kinds of steam cleaning, generating steam for motive power, food processing, and industrial applications. The boiler is illustrated as a vertical boiler but it can also be used as a horizontal boiler, with suitable changes to the chimney.

The baffles themselves could be made of pipe material and could also carry the fluid to be heated.

It may be more efficient to have the water flow through in the other direction, so that it is exposed to the hottest gases last.

Finally, it will be appreciated that various alterations and modifications may be made to the foregoing without departing from the scope of this invention as set forth in the claims.
CLAIMS

1. A boiler of the type including a burner and a container for liquid within a chamber, wherein the container for liquid comprises a spirally corrugated pipe having an inlet and an outlet and characterised-in-that the pipe is a spirally corrugated pipe having external peaks and troughs.

2. A boiler as claimed in claim 1 characterised-in-that the pipe is a spirally corrugated pipe having internal peaks and troughs.

3. A boiler as claimed in claim 2 characterised-in-that the spirally corrugated pipe is made of stainless steel.

4. A boiler as claimed in claim 3 characterised-in-that the spirally corrugated pipe is shaped in the form of a coil.

5. A boiler as claimed in claim 4 characterised-in-that the spirally corrugated pipe is shaped in the form of a coil.

6. A boiler as claimed in claim 5 characterised-in-that the coil has one or more layers.

7. A boiler as claimed in claim 6 characterised-in-that the coil is helical, with the or each layer of the coil having a plurality of turns.

8. A boiler as claimed in claim 7 characterised-in-that each turn of any one layer of the coil is closely adjacent to an adjoining turn whilst allowing gas flow therebetween.

9. A boiler as claimed in claim 8 characterised-in-that the burner is mounted within or adjacent to the coil.

10. A boiler as claimed in claim 9 characterised-in-that the coil is a single helix.
Fig 1
INTERNATIONAL SEARCH REPORT

International Application No. PCT/NZ 97/00072

A. CLASSIFICATION OF SUBJECT MATTER

Int Cl®: F22B 27/08, F24H 1/16 // F28F 1/06, A01M 21/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: F22B 27/–, F24H, F28F, A01M, F23M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

AU: IPC as above

Electronic database consulted during the international search (name of database and, where practical, search terms used)

WPAT: IPC as above with keywords BOILER#, WATER (W) HEATER#, CORRUGAT#, SPIRAL, HELIX#

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>DE 3519315 A (KABELMETAL ELECTRO GMBH) 4 December 1986 Figures 1, 2; column 2, line 56 - column 4, line 1</td>
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Date of the actual completion of the international search: 2 September 1997

Date of mailing of the international search report: 08 SEP 1997

Name and mailing address of the ISA/AU

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INTERNATIONAL SEARCH REPORT
Information on patent family members

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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