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Ehrlich et al.

[11] **3,736,908**

[45] **June 5, 1973**

[54] **SYSTEM FOR STARTING A FLUIDIZED BED BOILER**

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[21] Appl. No.: **189,471**

[52] **U.S. Cl.** .....**122/4 D**, 110/28 J

[51] **Int. Cl.**.....**F22b 1/00**

[58] **Field of Search**.....122/4 D; 110/28 J

[56] **References Cited**

UNITED STATES PATENTS

2,729,428	1/1956	Milmore	122/4
2,842,102	7/1958	Blaskowski	122/4
3,387,590	6/1968	Bishop	122/4

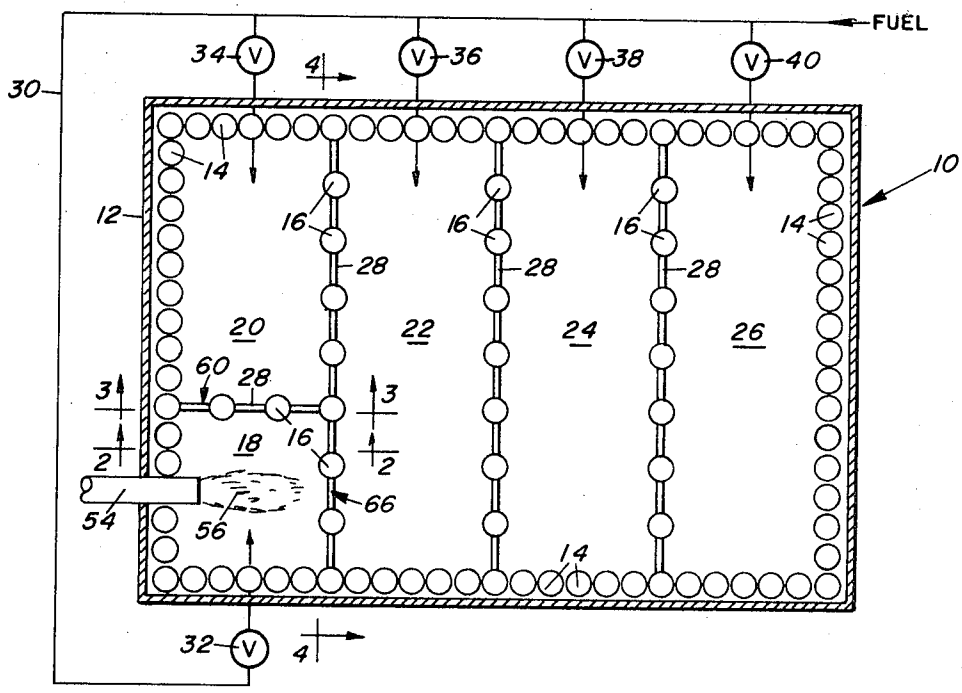
Primary Examiner—Kenneth W. Sprague

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[57] **ABSTRACT**

Vertical barriers divide a large fluidized bed boiler into smaller regions. During starting, openings in the barriers control mixing of the bed particles without mechanical intervention.

12 Claims, 4 Drawing Figures



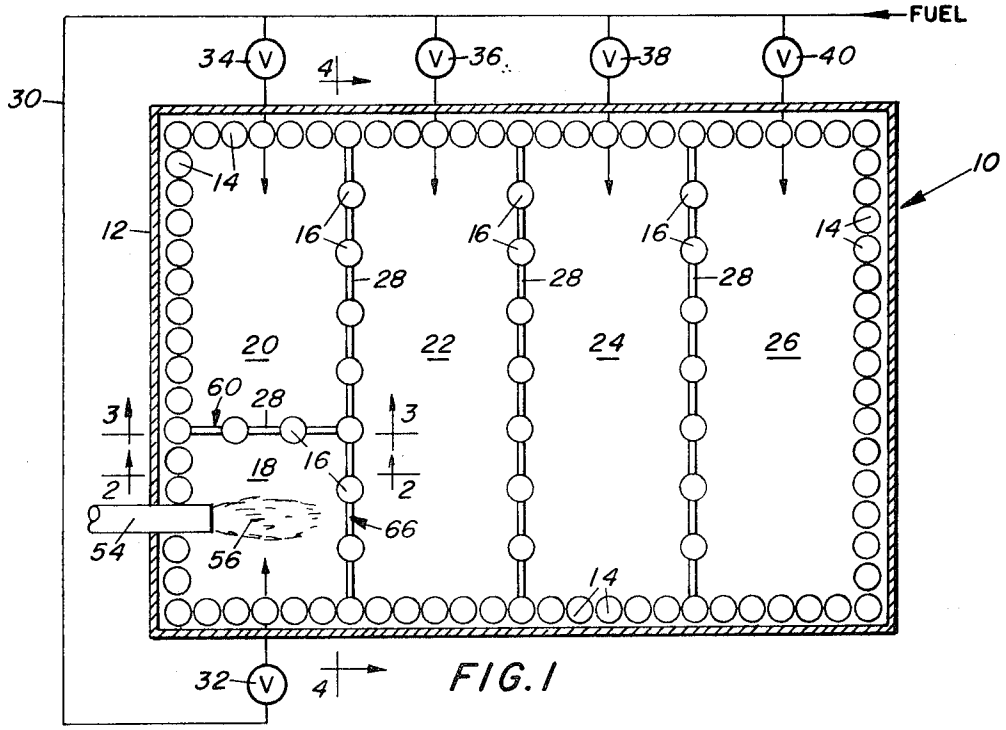


FIG. 1

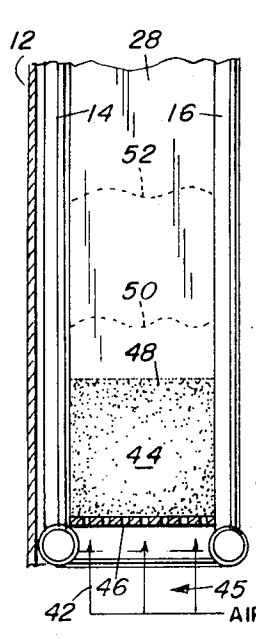


FIG. 2

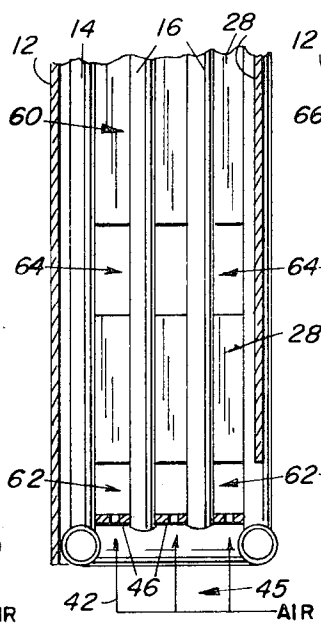


FIG. 3

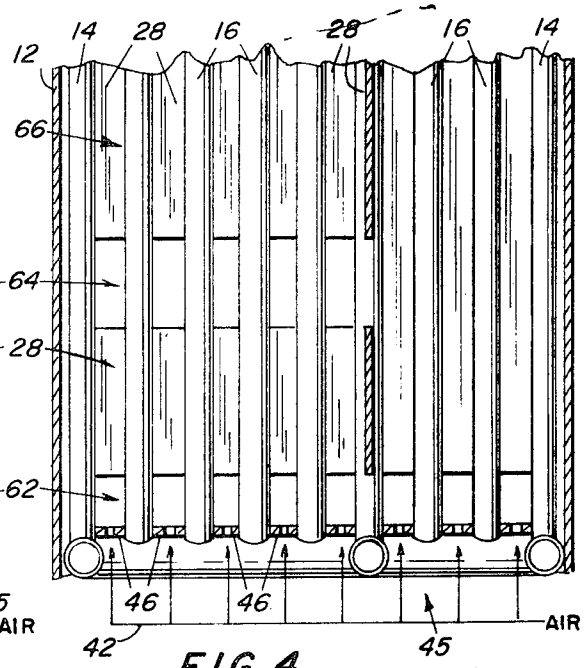


FIG. 4

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SYSTEM FOR STARTING A FLUIDIZED BED BOILER

BACKGROUND OF THE INVENTION

A fluidized bed is a mass of discrete particles suspended in an enclosure by a flowing fluid stream. The fluid, which is commonly a gas, enters the enclosure through a porous bottom surface and passes upward through the particles. Individual particles are separated from one another and suspended in the stream so that the mass of fluidized particles resembles a high viscosity liquid.

Recently developed fluidized bed boilers employ oxidizing fluidized beds for heat generation. A bed of inert granular material within the boiler is suspended in contact with heat exchange surfaces by a stream of air. When the fluidized bed is heated above a critical ignition temperature and supplied with a mixture of air and coal, intense combustion occurs. High heat releases, and heat transfer direct from the bed material to the heat exchange surfaces enhance the efficiency of the boiler, reducing the dimensions required for a specified thermal output, in comparison with more conventional boiler designs.

When a fluidized bed boiler is activated, the mass of bed material must be heated above the fuel ignition temperature. For large beds, the mass of material involved makes simultaneous startup of the entire bed expensive and inefficient. It has been found that greater efficiency can be obtained by starting the bed in increments, using an already active portion to ignite an adjacent portion. One such method employs a bed with a divided air supply. Fluidizing air is first supplied to a small section of the bed, and after it ignites increasingly larger areas are fluidized, each area activating in turn by the effects of particle and fuel migration. A second method, described in U. S. Pat. No. 3,387,590, employs controllable ports in the partitions of a divided bed. After one area of the bed is activated, the ports leading to another area are opened so that bed material and fuel migrate to the inactive area. Our invention is a modification of this second method, using continuously open ports in association with the normal operating characteristics of the bed to eliminate the need for mechanical controls.

SUMMARY OF THE INVENTION

Our invention is a system for rapid, efficient startup of combustion in a fluidized bed boiler. Instead of starting the entire bed at once, isolated compartments are activated one after another, beginning with a small, easily started portion and continuing with larger portions until the entire bed is activated. By designing the compartment partitions to control bed particle migration in response to varying states of fluidization, this serial startup is made possible with conventional boiler components and without the use of moving mechanical controls.

To control particle migration, our invention employs slots opening through the partitions between the compartments of a divided boiler. The slots are located at a height just above the normal level of fluidization occurring in the bed before combustion occurs. When the bed is activated in one compartment, combustion causes it to rise above the level of the slots and to spill over into the adjacent compartment. Lower slots near the air distribution grid enable the bed particles to circulate between the two compartments, replenishing the bed in one as bed material and burning fuel spill over into the other. When the second compartment reaches ignition temperature, fuel injection is begun so that combustion causes the bed to spill through the slots into a third compartment. In this way the bed in any number of compartments can be activated in series.

Therefore, one object of my invention is a system for activating a fluidized bed boiler by controlling fluidized particle migration within a series of compartments.

This and other objects of the invention are apparent in the following specification and drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a plan view of the interior of a fluidized bed boiler.

FIG. 2 is a sectional view taken along lines 2—2 of FIG. 1.

FIG. 3 is a sectional view taken along lines 3—3 of FIG. 1.

FIG. 4 is a sectional view taken along lines 4—4 of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A fluidized bed boiler **10** is shown in horizontal cross-section in FIG. 1. Within an insulating shell **12**, vertical tubes **14–16** divide the boiler into five compartments **18–26**. For converting water to steam, the tubes connect with a circulation system (shown in part in FIGS. **2–4**) in a conventional manner. Around the outer wall of the boiler, tubes **14** are closely spaced and connected by continuously welded fins, forming a barrier to contain the particulate bed and gases within the boiler. Between the compartments, tubes **16** are widely separated, with heat transfer surfaces **28** extending between them, again in a conventional manner.

Combustion in boiler **10** takes place in compartments **18–26** when the bed is in a fluidized state at ignition temperature and granular coal is injected through a supply line **30** and any of five control ports **32–40.** For bituminous coal the minimum ignition temperature is approximately 800° F. Because of the massive bulk of material involved, elevating the entire bed to this ignition temperature at one time is expensive and inefficient. To avoid this difficulty our invention employs a serial start-up, beginning with compartment **18** and proceeding to compartments **20, 22, 24** and **26.**

As previously indicated, combustion in boiler **10** requires three ingredients — a fluidized bed, ignition temperature, and a supply of fuel. As shown in FIG. **2,** fluidizing air **42** is injected into the bed **44** from a plenum **45** below an air distribution grid **46.** From the static or settled bed height **48,** the fluidizing air raises the bed to a cold, expanded level **50,** shown by a dotted line in FIG. **2,** at which fluidization is achieved, but without combustion. Later, at operating temperature the bed reaches a higher level **52,** shown again by a dotted line in FIG. **2.**

To begin startup of boiler **10,** the bed in compartment **18** is first raised to ignition temperature. With the bed somewhere between levels **48** and **50,** gas or oil and air are injected into compartment **18** through a burner nozzle **54** and ignited to burrow a flame **56** through the bed particles. As the bed approaches coal ignition temperature, sufficient fluidizing air is supplied to bring the bed to level **50.** For most efficient opera-

tion during this initial warmup a divided plenum may be used and compartments 20–26 left in a static state. When ignition temperature is reached, coal feed is started through control port 32, coal combustion commences, and the bed rises to operating level 52 as the temperature rises to operating temperature (1,450° – 2,150° F). At this time the flame from burner 54 is stopped. With combustion occurring in compartment 18, compartment 20 is ignited in the following manner.

In FIG. 3, the common wall 60 between compartments 18 and 20 is shown. Between the vertical boiler tubes 14–16 are the heat transfer surfaces 28, which act as a barrier to migration of the bed particles between the compartments. By permitting particle migration past this barrier at an optimum time in the startup cycle, ignition of the bed in compartment 20 is achieved without auxiliary heating. For this purpose, slots 62 and 64 are open between the tubes in the common wall. Slots 62 are located at the level of the air distribution grid 46 and are necessary to maintain equal operational bed levels in the adjacent compartments. Slots 64 are located just above the cold, expanded bed level 50 and are used to enable particle migration between the adjacent portions of the bed only after level 50 is exceeded when combustion occurs in compartment 18. To limit particle migration directly from compartment 18 to compartment 22, slots 64 are omitted from the common wall 66 between them, as shown in FIG. 4. However, slots 62 are again required to insure a level bed during steady state operation of the entire boiler.

As a result of the position of slots 62 and 64 in common wall 60, particle migration between compartments 18 and 20 is minimal during initial heating of the bed. Since compartment 18 is relatively small, the bed within it can be heated rapidly with minimum fuel consumption. If bed 18 is approximately 1 foot square and burner 54 supplies about 2,000,000 Btu/hr, the coal ignition temperature can be achieved within about 10 minutes. Once self-sustaining combustion is achieved, the bed rises above level 50 and overflows through slots 64. With the bed in compartment 20 fluidized at level 50, bed particles and burning fuel continuously circulate between the compartments. When ignition temperature is reached, control valve 34 is opened, and fuel injected into compartment 20. Combustion commences, and the process is repeated through slots 62 and 64 in the common wall 66 separating compartment 20 and 22. In a similar manner the bed in compartments 24 and 26 is ignited through slots 62 and 64 in their common walls.

Using our invention a fluidized bed of many tons can be activated in a very short time with only a small amount of costly burner fuel. Obviously, the arrangement of boiler tubes may be either horizontal or vertical and dispersed evenly or in banks with appropriate modifications. In applications where boiler tubes are not ordinarily provided, such as a calciner, vertical barriers can easily be added to perform the function of our invention. In view of the many obvious modifications of this type that might be made, our invention is not limited to the details of the above disclosure, but only by the scope of the following claims.

We claim:

1. A method for activating an oxidizing fluidized bed comprising of steps of:
   - dividing a particulate bed into separate portions,
   - fluidizing the bed to an expanded level,
   - preventing any substantial migration of bed material between the separate portions at this expanded level by means of physical barriers between the portions,
   - heating one separate portion of the bed to the ignition temperature of an oxidizing fuel,
   - injecting the fuel into the heated portion to cause combustion and raise the heated portion to an operating level,
   - providing openings through the physical barriers so that as the height of any portion of the bed increases from the expanded to the operating level the fuel and heated portion spills over into and heats an adjacent portion,
   - when the adjacent portion reaches the ignition temperature, injecting fuel into the adjacent portion to cause combustion and raise the adjacent portion to the operating level,
   - injecting fuel into subsequent portions of the bed when they reach the ignition temperature as a result of fuel and heated bed material spilling over into them.

2. A method for activating an oxidizing fluidized bed as claimed in claim 1 in which the step of providing openings includes:
   - providing openings above the expanded level to enable spilling over and heating of the adjacent portion, and
   - providing openings near the bottom of the bed to enable migration of bed material from the adjacent to the heated portion to maintain a level bed.

3. A method for activating an oxidizing fluidized bed as claimed in claim 1 in which:
   - the one separate portion has a smaller mass than the other portions, and
   - the openings through the physical barriers are arranged so that, as any portion reaches the operating level, spilling over from that portion affects only one inactive portion of the bed at a time.

4. A method for activating an oxidizing fluidized bed as claimed in claim 2 in which:
   - the one separate portion has a smaller mass than the other portions, and
   - the openings through the physical barriers are arranged so that, as any portion reaches the operating level, spilling over from that portion affects only one inactive portion of the bed at a time.

5. In an oxidizing fluidized bed combustion chamber having a vessel, a bed of particulate material within the vessel, a source of gas for fluidizing the particulate material, and a source of fuel for combustion within the bed of particulate material, the improvement comprising:
   - an array of vertical barriers dividing the bed into separate portions,
   - means for heating one of the portions to the ignition temperature of the fuel,
   - openings through the physical barriers above the expanded level of the bed caused by fluidization without combustion, but below the normal operating level of the bed caused by combustion, so that combustion in any one portion of the bed causes fuel and heated bed material to spill over into an adjacent portion.

6. An oxidizing fluidized bed combination chamber as claimed in claim 5, further comprising:

openings through the physical barriers near the bottom of the bed to enable migration of bed material between the portions in order to maintain a level bed.

7. An oxidizing fluidized bed as claimed in claim **5** in which:

the one separate portion is relatively small, and

the openings through the barriers are arranged so that, as any portion reaches the operating level, spilling over from that portion affects only one inactive portion of the bed at a time.

8. An oxidizing fluidized bed as claimed in claim **6** in which:

the one separate portion is relatively small, and

the openings through the barriers are arranged so that, as any portion reaches the operating level, spilling over from that portion affects only one inactive portion of the bed at a time.

9. An oxidizing fluidized bed as claimed in claim **5** in which the vertical barriers include boiler tubes.

10. An oxidizing fluidized bed as claimed in claim **6** in which the vertical barriers include boiler tubes.

11. An oxidizing fluidized bed as claimed in claim **7** in which the vertical barriers include boiler tubes.

12. An oxidizing fluidized bed as claimed in claim **8** in which the vertical barriers include boiler tubes.

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