(12) UK Patent Application (19) GB (11) 2 015 359 A

(21) Application No **7904891**
(22) Date of filing **12 Feb 1979**
(23) Claims filed **12 Feb 1979**
(30) Priority data
(31) **882037**
(32) **28 Feb 1978**
(33) **United States of America (US)**
(43) Application published **12 Sep 1979**
(51) INT CL² **B01F 13/02**
(52) Domestic classification **B1C 30**
(56) Documents cited **None**
(58) Field of search **B1C**
(71) Applicants
Westinghouse Electric Corporation, Westinghouse Building, Gateway Center, Pittsburgh, Pennsylvania, United States of America
(72) Inventor
Ward Lewis Lyon
(74) Agents
Ronald Van Berlyn

(54) **Safe-geometry pneumatic nuclear fuel powder blender**

(57) A plurality of narrow flat-walled blending chambers (5) extend radially outward from a pneumatic spouting channel (6) having an inlet (10) and an outlet (12) at bottom and top, respectively, open to each blending chamber and contained within a cylindrical cone-bottomed shell (7) filled with neutron-absorbing material (31) between the blending chambers (5).

With this arrangement accumulation of critical masses is prevented.

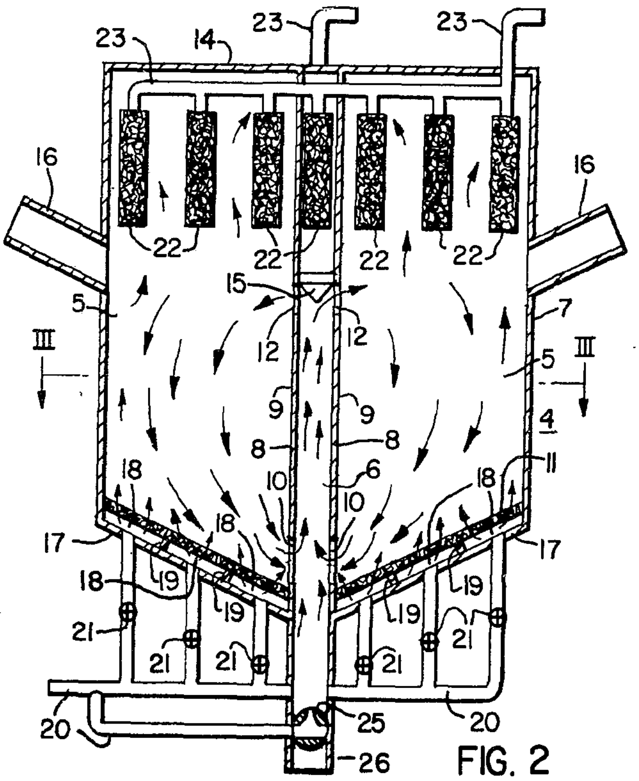

FIG. 2

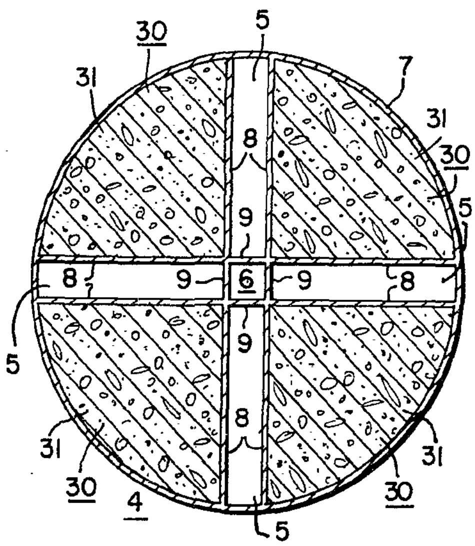

FIG. 3

GB 2 015 359 A

1/1 2015359

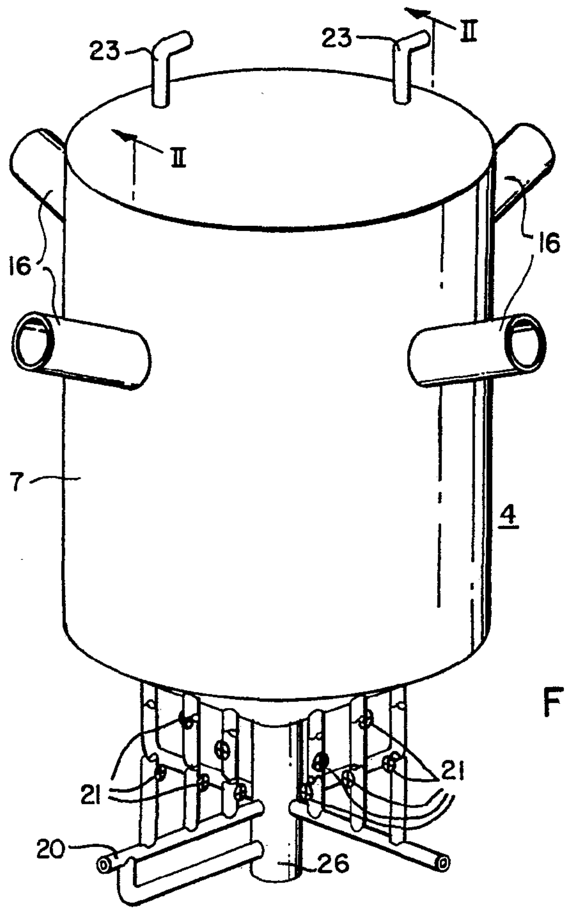

FIG. 1

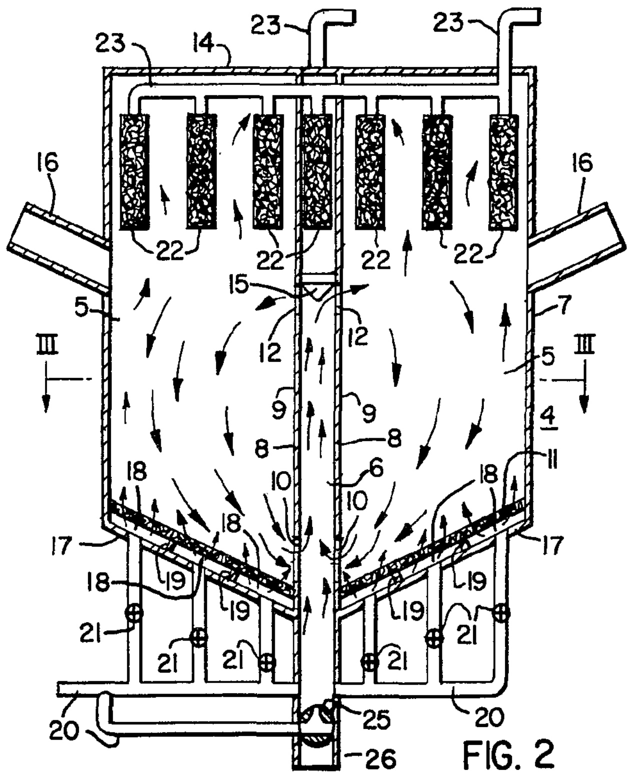

FIG. 2

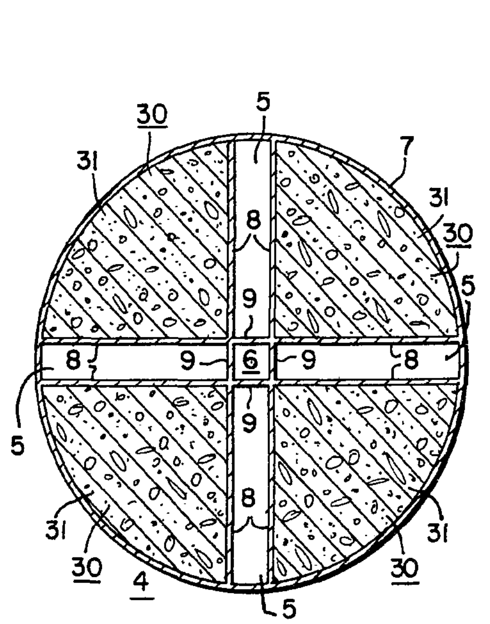

FIG. 3

SPECIFICATION

Safe-geometry pneumatic nuclear fuel powder blender

The present invention relates to a safe-geometry pneumatic nuclear fuel powder blender.

In the fabrication of nuclear fuel, it is necessary to blend large volumes of powders containing fissile material. A geometrically favorable equipment design can be employed for the blending chamber to prevent accumulation of a critical mass of fissile material during the blending operation. One geometrically favorable design is a narrow rectangular tank, referred to as a "slab tank", as disclosed in U.S. Patent 3,746,312 of Hans Pirk, for example, which exemplifies a relatively high degree of simplicity. Such a slab tank may range in thickness from about two-and-one-half inches to about seven-and-one-half inches, depending upon the type and concentration of fissile material being blended. The slab tank blender as shown in Fig. 3 of U.S. Patent 3,746,312 is described as being air operated to obtain a fluidized bed having upward and downward moving components arrived at by variable automatic preselected discharges from spaced-apart sites in a porous bottom member of the slab tank. Under not uncommon circumstances, however, the fissile material powder particles to be blended may be of such degree of fineness that the establishment of the counterflowing fluidized bed action relied on for the powder blending becomes difficult if not impossible to obtain, irrespective of tank width, and the technique becomes limited to blending of heavier powders, capable of fluidized bed action. At large tank widths to handle larger powder volumes, eight feet for example, excessive blending time and complex wall stiffening structures are required.

It is the principal object of the present invention to provide a nuclear fuel powder mixing tank in which the powder can be rapidly and safely mixed and in which accumulation of critical amounts of fuel is prevented.

With this object in view, the present invention resides in a safe-geometry powdered nuclear fuel blender comprising, a container having inlet means for receiving powdered nuclear fuel and exit means for discharging the nuclear fuel after blending, characterized in that said container has a vertical updraft pneumatic spouting channel means, and an array of narrow filter blending chambers extending radially outward from said spouting channel means and being in communication therewith at least at vertically-spaced locations, the space between adjacent blending chambers being occupied by neutron absorbing material.

Preferably, a pneumatically-fed porous bottom plate assists flow of particles thereover at the bottom of each blending chamber, particularly during unloading of the blended powder material which occurs by downward flow to the central lower end of the con-bottomed shell to a combined discharge control valve and spouting nozzle at the lower end of the spouting tube. A filtered exhaust assembly permits withdrawal of air from the blending chambers at the same rate as entry thereto via spouting tube and porous bottom. Powder inlet tubes provide for the charging of the slab-tank blending chambers in upper regions thereof with the nuclear fuel fissile powders to be blended.

The invention will become more readily apparent from the following description of a preferred embodiment thereof shown, by way of example only, in the accompanying drawings, in which:

Fig. 1 is a three dimensional isometric view of an illustrative embodiment of a nuclear fuel powder blender; and

Figs. 2 and 3 are vertical and horizontal section views of the blender taken along the lines II-II and III-III of Fig. 1.

Referring to the several figures in the drawing, a pneumatic nuclear fuel powder blender 4 comprises a plurality, four being exemplified in the drawing, of thin blending chambers 5 extending radially outward from a common spouting channel 6. The chambers 5 are disposed within a cone-bottomed cylindrical shell 7 and are defined thicknesswise by parallel side walls 8 extending radially inward from the outer wall of the shell 7 to a transverse wall 9 that forms a side wall of the spouting channel 6 at the center of the shell. The spouting channel walls 9 have powder inlet ports 10 adjacent to the lower ends of downwardly tapering porous bottom walls 11 of the blending chambers 5 and powder outlet ports 12 opening into such chambers at an effective working height above the bottom walls 11 and at some overhead clearance distance beneath the top wall 14 of the shell 7 which closes the tops of the blending chambers 5. A flow diverter member 15 closes the top of the spouting channel 6 immediately above the outlet ports 12. Powder-inlet filler tubes 16 open through the outer wall of the shell 7 into the chambers 5 at a site about equal to the height of the diverter member 15 in the spouting channel 6 for introduction of fissile material powders to be blended. The downwardly slanting porous bottom walls 11 of the blending chambers 5 are disposed slightly above and parallel to the conical bottom wall 17 of the shell 7 to form pneumatic supply chambers 18 for the porous walls 11. Partitions 19 segregate the chambers 18 one from the other. Three chambers 18 distributed along the length of each bottom wall 11 is exemplified in the illustrative embodiment. More or fewer numbers of these chambers may be found to be necessary. Each chamber 18 is availed of compressed air via a pneumatic supply line 20 an branches thereof, together with respective valves 21 for controlling flow and admission of compressed air to the chambers 18. Near the top of each blending chamber 5 are located a number of filtered exhaust members 22 connected to vacuum exhaust duct means 23. At the bottom of the spouting channel there is a combination exhaust valve and spouting nozzle member 25. In one operative position of member 25, compressed air is directed upwardly through the spouting channel 6 at a high velocity, and in a second operative position of such member the bottom of such spouting channel is opened to a blended powder outlet spout 26 continuing downwardly from such spouting channel. Between the blending chambers 5 and confined within the shell 7 there is disposed a neutron absorbing material 30, on containing hydrogen atoms, for example, capable of slowing down neutrons from fissile material in the blending chambers. Such neutron absorbing material is concrete 31, water 32, paraffin 33, polyethylene beads 34, etc. Such material, by dint of its rigidity or density, assists in support of the side walls 8 against the pneumatic pressurization within, which pressurization, although slight, less than five p.s.i. may, for example, tend to create a considerable force on such walls due to their relatively large area of exposure to such pressure. With such external support from the neutron absorbing material, the walls 8 may be made somewhat thinner and/or less rigidizing structure employed than otherwise would be found necessary. Where the neutron absorbing material is in the form of loose fill, such as polyethylene beads, for example, a pneumatically-availed porous bottom may be disposed beneath such fill to effect pressurization of the exterior of the respective walls 8 into equality with the chamber 5 pressure on the other side.

In operation, the blending chambers 5 are filled with powdered fissile material, such as uranium dioxide, plutonium dioxide, etc., to a maximum level of slightly below the powder outlets in the spouting channel 6 by introducing powders through the filler tubes 16 assisted by such as withdrawal of air from such blending chambers via the filters 22 and vacuum exhaust duct means 23 at the top of the shell 7. The width of the chambers will be designed to be no greater than the safe layer thickness for the fissile component of the material to be blended, in accord with well-known practice, and this may be in the order of five and one-half inches when working with such as four percent enriched uranium dioxide. The width and useful height dimensions may be made to accommodate a considerable volume in excess of the so-called safe volume amount by virtue of abiding by the safe-layer-thickness limitation. For example, the four-chamber embodiment exemplified in the drawing may have a working height within chambers 5 of three feet, for and a shell diameter of four and one-half feet to give a working capacity of seven hundred kilograms.

Once filled with the fissile material powder to be blended, the filler tubes will be closed, and the spouting channel 6 brought into play by turning of the rotary valve 25 to the position in which it is shown in Fig. 2, wherein such valve becomes a spouting nozzle to cause high velocity compressed air to travel upwardly through such spouting channel, while an equal amount of air is quiescently withdrawn from the tops of the blending chambers via the exhaust duct means 23 and the filter members 22. The high velocity upward flow of compressed air through the spouting channel 6 pass the powder inlet ports 10 at the bottom inner regions of the blending chambers 5 will cause withdrawal of the powdered fissile material therefrom into and upwardly through such spouting channel to the diverter member 15 at the top of the mixing region and into the blending chambers 5 via the exit ports 12. Such powder flow into the bottom and out of the top of the spouting channel causes downward circulation and mixing of the powdered fissile material through the several blending chambers 5 simultaneously. After a period of time sufficient to complete such mixing or blending, the valve member 25 may be turned to a cutoff position to terminate supply of spouting air to the spouting channel 6. The blended powdered fissile material may be stored in the chambers 5 until needed, if desired, whereupon the valve member will be turned to a position connecting the bottom of the spouting channel 6, hence the inner bottom portions of the blending chambers 5 via ports 10, to the blended powder outlet 26 below the valve. The powder will thereby exit such chambers via such valve 25 and outlet 26, either by influence of gravity, and/or by pneumatic inducement, which can be brought about by flow of compressed air upwardly through the porous bottom walls 11 of the blending chambers 5 during a time, for example, when withdrawal of air via the exhaust ducts 23 is diminished or ceased momentarily. Flow via the porous bottom walls 11 also may be employed during the blending operation by the spouting channel to further aerate the powder and aid flow through the blending chambers 5 and prevent any adherence of powder to the chamber surfaces which would act to bypass the mixing action. The pneumatic flow through the several regions of the porous bottom walls 11 fed from the different chambers or supply regions 18 can be regulated by the several control valves 21 to optimize the action, which may be enhanced by flow pulsation, for example, or local flow differentials.

It will be appreciated that the number of blending chambers 5 may be greater than four exemplified, five or six, for example, to further expand the working volume while preserving the compactness of the overall dimensions of the shell 7. It also may be possible to employ one filler tube 16 for all blending chambers 5, rather than a filler tube for each as shown in the drawing. In the case of a single filler tube 16, powder introduced via the one filler tube to one chamber will become distributed to all chambers 5 by mixing in the spouting channel 6.

CLAIMS

1. A safe-geometry powdered nuclear fuel blender comprising, a container having inlet means for receiving powdered nuclear fuel and exit means for discharging the nuclear fuel after blending, characterized in that said container has a vertical updraft pneumatic spouting channel means (6), and an array of narrow filter blending chambers (5) extending radially outward from said spouting channel means (6) and being in communication therewith at least at vertically-spaced locations, the space between adjacent blending chambers (5) being occupied by neutron absorbing material.

2. A blender as claimed in claim 1, characterized in that each of said blending chambers (5) has a bottom slanting downwardly toward said spouting channel means (6), said spouting channel means (6) forming part of said fuel exit means (26).

3. A blender as claimed in claim 1 or 2, characterized in that said blended powdered fuel exit means includes a means (25) for connection of the bottom of said spouting channel means (6) selectively to

either a source of fluid under pressure or to a blended fuel outlet spout (26).

4. A blender as claimed in claim 1, 2 or 3, characterized in that a hollow cylindrical shell (7) encases said blending chambers (5) and neutron absorbing material (30).

5. A blender as claimed in any of claims 1 to 4, characterized in that said blending chambers (5) have bottom plates of porous materials and means (18, 20) are provided for supplying compressed air to said bottom plates to pass therethrough into said blending channels (5) to provide fluidizing support for the fuel powder on said plates.

Printed for Her Majesty's Stationery Office by The Tweeddale Press Ltd., Berwick-upon-Tweed, 1979.
Published at the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.